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## The destruction and conservation of the Egyptian Fruit bat *Rousettus aegyptiacus* in Cyprus: a historic review

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**Abstract** In Cyprus, there are 16 species of bats most of which are threatened with extinction. With the exception of the megachiropteran Egyptian Fruit bat *Rousettus aegyptiacus* that feeds on fruit, the rest of them are insectivorous microchiropterans. The Fruit bat was declared as a pest by the Department of Agriculture and Environment of Cyprus since the early 1900s. To reduce the number of this “pest”, the above-mentioned Department, since 1927, used fumigation, shooting, and the purchase of dead bats. Fumigating and closing caves not only destroyed Fruit bats by direct poisoning, but the entire cave ecosystems, including highly beneficial and protected insectivorous species. The first attempt to protect bats on the island was in 1988 with law No. 24 of 1988, ratifying the Convention on the Conservation of European Wildlife and Natural Habitats, 82/72/EEC. This convention protects all microchiroptera species except *Pipistrellus pipistrellus* that is strictly protected. *R. aegyptiacus* is rare, with small populations that are not at present endangered or vulnerable but at risk. Cyprus recently became a member state of the European Union. This provided the opportunity to include *R. aegyptiacus* in the Annexes II and IV of the council directive 92/42/EEC of May 21, 1993 on the conservation of natural habitats and of wild fauna and flora, which will guarantee the long-range protection and survival of this species.

**Keywords** Egyptian Fruit bat · *Rousettus aegyptiacus* · Cyprus · Bats

### Introduction

In Cyprus, there are 16 species of bats, 15 microchiropterans and one megachiropteran (Boye et al. 1990). With the exception of the Egyptian Fruit bat *Rousettus aegyptiacus* which feeds on fruit, the rest of them are insectivorous. Unfortunately, most of the bat species of Cyprus are in danger of extinction.

For decades, bats in Cyprus were persecuted and killed by the thousands every year, and their habitats and hibernation places were destroyed (Hadjisterkotis 1990). The first attempt to protect bats on the island was to declare them protected species with law No. 24 of 1988, ratifying the Convention on the Conservation of European Wildlife and Natural Habitats, 82/72/EEC (Official Gazette of the Republic No. 2309, 18 March 1988; Commission of the European Communities 1992). This convention considers all microchiroptera species protected, except *Pipistrellus pipistrellus* that is strictly protected. However, because there were no megachiroptera in the European Community, there was no providence for the protection of the Egyptian Fruit bat.

This species is a large, heavily build bat, with a clawed second digit. Males have the glandular hair on the throat more developed than females but not distinctively colored. *R. aegyptiacus* is one of the few megachiroptera roosting in caves with group sizes from two to several thousand individuals, and occasionally, when numbers are low, individually. Moreover, within the megachiroptera, only the genus *Rousettus* uses echolocation to find food. This species emits clicks from the side of its mouth using its tongue, which enables it to navigate in complete darkness. As a result, it can roost deep inside caves where no light can penetrate (Robertson 1990). Its geographical distribution ranges from the Persian Gulf through to Arabia, Turkey, Cyprus, and Africa (Harrison and Bates 1991). Throughout the 20th century (with the exception of the last few years), this bat was considered as an agricultural pest by the Department of Agriculture of the Ministry of Agriculture and Natural Resources of the British colonial government of Cyprus (which ruled the island until 1960),

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and later by the Republic of Cyprus. To protect fruit crops from bat depredation, the above-mentioned Department was applying extensive population controls. By 1990, the control campaign stopped because there were almost no bats left. Realizing that *R. aegyptiacus* was close to extinction, I decided to gather information on the past and present population numbers of this species in the Pafos District, where I was assigned as the District Officer of the Game and Fauna Service in 1990. The population control methods and their effect on Fruit bats and their habitats were examined. In this paper, I present the results of this study. The effect of the Egyptian Fruit bats on agriculture and the usefulness of the control campaign are discussed. Finally, I present the recent protection measures taken to safeguard the long-term survival of this species.

## Methods and material

The history of the *R. aegyptiacus* destruction program was investigated by searching the files of the Ministry of Agriculture and Natural Resources (recently renamed Ministry of Agriculture, Natural Resources and Environment (MANRE) in Nicosia as far back as 1899. Information was gathered by (1) interviewing people in charge of the control program, (2) getting information from the District Agriculture office of the MANRE, the agrarian police, and local farmers about the location of the caves inhabited by bats presently or in the past, and how many animals they estimated visually to live in each cave, and (3) visiting all known caves, underground water passages, ancient tombs, and mines that could house bats. A boat was used to enter sea caves that were filled with seawater; however, they allowed sufficient space for a boat to enter. Sea caves with narrow entrance were entered by swimming and artificial lights. All visits took place in 1991 and 1992, with the exception of cave Akamas 6 (Table 1), which was discovered by Nikos Klerides in 1995. Because according to Attenborough (1987), during winter *R. aegyptiacus* roost in lowland caves, we visited the lowland caves in winter and highland caves in the summer. Every care not to disturb the bats was taken. Roosting animals were identified in situ and flying specimens by sightings. In this paper, the localities are given only inaccurately to prevent the roosts from disturbance. For the same reason we do not distinguish between caves, mines, and ancient tombs, instead all subterranean roosts are called caves.

Although no caves were visited in the other districts of Cyprus, in 1990 and 1991 (with the exception of Kalavassos mine), I visited the District Agriculture office of the MANRE in Limassol and the Central office in Nicosia, collecting information on the control campaign in the rest of Cyprus.

To monitor the Egyptian Fruit bat situation over the last 15 years, I have gathered information from farmers and the pest control department of the Ministry of Agriculture, Natural Resources and Environment. In addition, I conducted a survey at bat feeding locations.

**Table 1** Caves examined for bats in Paphos District from 1991 to 1995

Locality	No. of Fruit bats seen in 1990–93	No. of Fruit bats present in the 1960s	No. of insectivorous bats seen in 1990–1993
Steni <sup>a</sup>	Nil	SH	Nil
Polemi <sup>a</sup>	Nil	SH	Nil
Kissonerga <sup>b</sup>	Nil	SH	Nil
Empa <sup>a</sup>	Nil?	SH	Nil?
Empa <sup>a</sup>	Nil	SH	Nil?
Stroumbi <sup>a</sup>	50	SH	Nil
Vretsia <sup>a</sup>	Yes	SH	Nil?
Akamas 1 (Thalassines spilies) <sup>a</sup>	1	SH	Nil
Akamas 2 (Petratis) <sup>a</sup>	~1000	ST	~20
Akamas 3 (Aphrotides paths)	Nil	?	~50
Akamas 4 (Thalassines spilies)	Nil	?	Nil
Akamas 5 (Thalassines spilies)	Nil	?	~50
Akamas 6 <sup>c</sup>	<1000	?	?
Asproyia <sup>a</sup>	Nil	?	Nil
Asproyia <sup>a</sup>	Nil	SH	Nil
East of Pafos city (Anavargos) <sup>a</sup>	Nil	?	Nil
Tsada (Agia Eleni)	Nil	?	Nil
South of Pafos city 1 (Geroskipos)	Nil	?	~200
South of Pafos city 2 (Geroskipos)	Nil?	?	Nil?
South of Pafos city 3 Asprokremmos dam	Nil		9
Asprokremmos dam	Nil		3

*Nil?* Bats were not seen in the cave but only part of it was searched due to obstacles, *Yes* bats were present but not counted, *SH* several hundred, *ST* several thousands, *?* unknown

<sup>a</sup>Caves where Fruit bats were seen in the past

<sup>b</sup>Mouth of the cave closed down

<sup>c</sup>Visited only in 1995

## Results

The first campaign for the destruction of the Egyptian Fruit bats on Cyprus took place in 1927 (Noble 1928). According to the 1933 report (Blunt 1934), “rewards had been paid for the destruction of bats in former years but not during the last two or three years.” The campaign included methods such as fumigation of the caves, which killed also all the microchiropteran bats using the same roosting sites as *R. aegyptiacus*. In the words of the Director of Agriculture (loc. cit.): “Searches and inquiries in previous years had discovered some caves used by bats but it had not been found practicable to close these sufficiently well for smoking or fumigation to be effective, but the commissioner in Limassol was able to apply this treatment in some

caves during 1933. It was subsequently decided to pay a reward of 1 cp. each for bats brought in, this being limited in the first place to bats with a wing stretch of not less than 1 foot to exclude the common small insect-eating species. This limit was, however, found to be too small, but by that time the officers concerned were able to recognize the fruit-eating bat, which is much larger than the other kinds and has a wing stretch of about two feet, and subsequently only this species was accepted. The reward was paid for a total of 5,859 bats during the year". The payment of the reward was continued in 1934. The reward was paid for 1,156 bats in 1934 compared to 5,859 in 1933. From 1933 up to 1938, 4,066 bats were bought by the colonial government (Table 2). No rewards were paid from 1939 until 1954. The reward started again in 1955 with 25 mils for each bat (25 mils = 4.2 cent, approximately 24 bats per Euro). This resulted in 1,100 bats being destroyed during 1955 (Allan 1956), and 472 in 1956 (Allan 1957). No numbers of bats killed were given from 1958 up to 1964.

Shooting of bats in the caves started in 1966. The damage to crops by *R. aegyptiacus* was considered substantial, so the district Agricultural staff in cooperation with the Plant Protection Service carried out a campaign for the shooting of bats in their caves by a group of hunters. The government provided free cartridges and also paid the people participating in the shooting.

In 1976, the extermination took place in the British Sovereign Bases with the cooperation of the British authorities. No accurate estimates of kills were provided, but rough estimates said that the killings were by the thousands.

After 1974, the government stopped buying bats but continued providing free cartridges for their shooting. Shooting of bats extended until 1983. Most of the shooting campaign took place during the months February and March, and sometimes in November and May. Most of the campaigns usually took place in March because it was observed that during this month they give birth. After 1983, visits to different caves by officers of the Department of Agriculture revealed that there were no bats left to justify the campaign.

Extermination campaigns were taking place in five out of the six districts of Cyprus, except Larnaca. It seems that in the latter district there were no caves to host bats. In Famagusta District, the last campaign was in 1965. In

Kyrenia District, which is under Turkish military occupation since 1974, no more campaigns took place since then.

According to the Agriculture officer for Lemesos District, P. Koursaros, visits in the caves in Lemesos District in 1988 and 1989 revealed that they were empty of bats. In the summer of 1990, I visited Kalavastos mines in Lemesos district where in the past there were large number of bats, only to discover that the entrance was shut down from household solid waste deposited in front of the entrance.

All caves visited in 1991 and 1992 in Paphos District, and the number of bats estimated for each cave are reported in Table 1. With the exception of cave Akamas 2 which had several thousands specimens, the rest of the caves were reported by local people to host in the 1960s and 1970s at least several hundreds of bats. The only cave that was not visited was cave Akamas 6, which was discovered in 1995.

The extermination campaign stopped officially in 1993, after I discussed the benefits of *R. aegyptiacus* with Dr. Zingas, the Director of the Department of Plant Protection of the Ministry of Agriculture, Natural Resources, and Environment. Large quantities of gun shells that were kept for the campaign were given by Dr. Zyngas to the Game and Fauna Service to be used for the spring shooting of corvids (Hadjisterkotis 2003a,b). Based on observations and complaints of the farmers of Pafos District, crop damages from Fruit bats were observed in 1995. Based on recent bat sightings during the night visiting orchards or isolated fruit trees in the districts of Pafos and Nicosia, it seems that the bat populations are recovering. Since 1988, in Pafos District, several people were seen having their fruit trees in their backyards covered with fishing nets to protect them from bats, and people begin to demand from the government to commence the extermination campaigns. One farmer was seen using mist nets to protect his plantation of Loquat *Eriobotrya japonica* (Thumb.) Lindl. from *R. aegyptiacus* exterminating a number of them. Personal observation in Nicosia district on the fruits of several Date Palms *Phoenix dactylifera* L., Chinaberry or China tree *Melia azedarah* L., Loquat, and Fig trees *Ficus carica* L., which were visited by *R. aegyptiacus* for the last 7 years, provide some evidence that the numbers of Egyptian Fruit bats are recovering.

## Discussion

The purchase of bats by the government of Cyprus might have kept the numbers of bats low, but it did not endanger the species. The beginning of the shooting campaign had almost driven the species to extinction. The reason for having Fruit bats present on Cyprus today is perhaps because some remote caves were not known to the hunters.

Contrary to the belief that *R. aegyptiacus* are damaging commercial fruit crops, (which was the cause of their calamity), studies of Tuttle (1986) in Kenya and Makin and Mendelsohn (1986) in Israel show that commercial fruits are picked for shipment several days before they are fully ripe, and Fruit bats avoid unripe fruit. Therefore, most

**Table 2** Number of bats killed from 1933–1938 for which a reward 1 cp each was paid by the Department of Agriculture

Year	Number of bats
1933	5,859
1834	1,516
1935	870
1936	253
1937	765
1938	662
Total 1933–1938	9,925

commercial fruits are harvested before they become attractive to Fruit bats. By eating only ripe, unmarketable produce missed by pickers, Fruit bats may help reduce fungi and destructive orchard pests such as the Mediterranean Fruit fly (*Ceratitis capitata*).

Bats form the largest and most easily destroyed aggregations of any warm-blooded animal, and most rear only one young a year (Tuttle 1986). *R. aegyptiacus* females usually have two young per year (Makin and Mendelssohn 1985). The effects of fumigation on bats could be seen in Israel. The fumigation campaign not only destroyed fruit bats by direct poisoning, but entire cave ecosystems, including highly beneficial and protected insectivorous species. Within 15 years, the population of insectivorous bats decreased by approximately 90% (Makin and Mendelssohn 1985; Robertson 1990). Surveys have documented that the common Schreiber's bat (*Miniopterus schreibersi*), the moderately common Mediterranean (*Rhinolophus eurayle*), and Mehley's (*R. mehelyi*) Horseshoe bats disappeared entirely. Other previously abundant species, including Large (*Myotis myotis*) and Lesser (*M. blythii*) Mouse-eared bats and Blasius' Horseshoe bats (*Rhinolophus blasii*) were found only as isolated individuals. The ecological consequences of cave poisoning appear to be far reaching. The result was a population explosion of several species of Noctuid moths which were causing major crop damage, requiring extensive chemical control, and resulting in heavy environmental pollution (Makin and Mendelssohn 1985).

Shooting bats in Cyprus must have had similar effect on every bat species coinhabiting the same cave because it was done by hunters with no training on how to distinguish between bat species. The closing down of caves eliminated not only the habitat for Fruit bats, but also for insectivorous bats. It is not possible to know if any insectivorous bats were eliminated in Cyprus because there were no records of bats existing before the extermination campaign. However, similarly to Israel, a number of species most probably were eliminated, perhaps including a number of endemic species. Cyprus is considered a biodiversity "hotspot" area (Myers et al. 2000; Hadjisterkotis 2001) and a center of endemisms for plants, mammals, birds, reptiles, and insects (Meikle 1977–1985; Hadjisterkotis 1995, 2001, 2003b; Hadjisterkotis and Masala 1995; Tsintides and Kourtellarides 1995; Blosat et al. 1996; Kourtellarides 1998; Hadjisterkotis et al. 2000; Hadjikyriakou and Hadjisterkotis 2002; Tsintides et al. 2002; Makris 2003). Although the island is rich in endemic species, among the 16 species of bats recorded by Boye et al. (1990), there were no endemic bats noted—an indication that they were perhaps eliminated.

The destruction of insectivorous bats most probably had a positive effect on the increase of the mosquito population as well as on other insects such as Noctuid moths because one bat may eat more than 1,000 mosquitoes per hour (Rydel 1990). Bats are the only major predators of nocturnal insects and one (endangered) gray bat (*Myotis grisescens*) may eat up to 3,000 insects in a single night Tuttle (undated). Bats will eat moths, grasshoppers, large

insects like dung beetles (8 g), and small ones like caddis flies (100 mg), insects that fly, and those that don't (Fenton 1983).

In the near past, Cyprus had suffered from Malaria transmitted from host to host by female *Anopheles* mosquitoes. This mosquito was exterminated from Cyprus in the 1940s, and consequently malaria, due to the extensive use of DDT and the drying of some marshes. However, in the late 1980s and early 1990s, at least two species of *Anopheles* mosquitoes capable of transmitting this disease were identified to exist on the island (Hadjisterkotis 1990). These mosquitoes are free from the parasite but perhaps can become infected if a visitor who is a carrier is fed on by *Anopheles*. Therefore, the protection of the insectivorous bats is required for the protection and welfare of the public. Lakes and rivers, which are the emerging sites for mosquitoes and other aquatic insects, are favorable foraging habitats for many bat species. In Europe, three species of bat, all belonging to the genus *Myotis* (Chiroptera: Vespertilionidae), habitually hunt low over water, i.e., between 10 and 50 cm above the water surface (Jones and Rayner 1988; Kalko and Schnitzler 1989; Kalko 1990; Médard and Guibert 1990; Britton et al. 1997; Siemers et al. 2001b).

These three species are Daubenton's bat *Myotis daubentonii* (Kuhl), the pond bat *M. dasycneme* (Boie), and the long-fingered bat *M. capaccinii* (Bonaparte). The last one was recorded in Cyprus by Kahmann and Çađlar (1960) based on one animal collected in Kyrenia (Kock 1974; Boye et al. 1990). However, none of the above three bats were seen by Boye et al. (1990) about 30 years later. These bats often collect arthropods from the water surface; a behavior termed "trawling". It is worth noting that "trawling *Myotis*" do not gather through the water at random, as the literal meaning of "trawling" would suggest. Instead, they gaff prey from the surface with their feet in directed "pointed dips" (Jones and Rayner 1988; Kalko and Schnitzler 1989; Siemers et al. 2001a,b). Siemers et al. (2001b) use the term "trawling bats" to characterize bats gaffing prey from the surface. "Trawling *Myotis*" also catch insects emerging from or swarming over their aquatic habitat in the air. At least for *M. daubentonii*, there is strong telemetric evidence indicating that the bats spend more than 90% of their foraging time over water (Siemers et al. 2001b). The construction of a number of dams all over Cyprus in the 1970s and in the 1980s provided additional foraging habitats for such bats. If these bats were present on the island, the improved foraging conditions could help them to increase their numbers. However, most probably, they did not survive the extensive destruction of their roosting caves during the 20th century.

The opportunity to protect Fruit bats on Cyprus was given when Cyprus became a candidate country for membership in the European Community. In view to EU Enlargement, Cyprus went through the process to formally transpose the EU environmental aquis into Cyprus law, as well as to implement it in practice. One of the most important directives regarding nature protection, which we had to transpose, was the Habitats Directive No 92/43/EEC

of May 21, 1992 on the conservation of natural habitats and of wild fauna and flora (Official Journal of the European Communities No L 206/7-49, 22.7.92; Commission of the European Communities 1996). A committee was assigned by the government to complete this transposition, and to complete the technical sheets on the habitats and species for which we had to propose adaptations of the technical annexes. These were Annex II (animal and plant species of community interest whose conservation requires the designation of special areas of conservation) and Annex IV (animals and plants species of community interest in need of strict protection). The committee, in which I represented, the Ministry of the Interior, proposed the following vertebrate species, which were accepted by the European Commission in both annexes: *R. aegyptiacus*, *Ovis orientalis ophion*, *Coluber cypriensis*, *Natrix natrix cypriaca*, and *Chelonia mydas*. The reasons for inclusion in the Annexes II and IV of *R. aegyptiacus* is that it is rare with small populations that are not at present endangered or vulnerable but at risk. The species is located within restricted geographical areas or exists at low densities.

After this event, the next action was to declare important localities with roosting caves as “natura 2000 sites” to make sure that the habitats of this species will be protected from future distraction (Commission decision of December 18, 1996, concerning a site information format for proposed Natura 2000 sites, Official journal of the European Communities No L 107/107-156).

The inclusion of *R. aegyptiacus* in the above annexes, and the protection of their habitat under the “natura 2000” network, hopefully is going to stop any future persecution and is going to safeguard the survival of the species. Therefore, almost after one century of persecution the future of *R. aegyptiacus* on Cyprus seems promising.

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