"EURASIAN BRIDGE'99"

BAT RESEARCH IN NORTHWESTERN TURKEY

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The Project "Eurasian Bridge '99"

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which is recognised by BirdLife Int., BP Amoco p.l.c. and Fauna & Flora Int. as an outstanding initiative for the conservation of globally threatened biodiversity and has been selected to recieve

The Threatened Species Category Award

by

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BirdLife INTERNATIONAL

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INTRODUCTION

The Çatalca-Kocaeli region is situated in northwestern Turkey and extends approximately 100 kilometres eastwards and westwards from the Bosphorus strait. The region functions as a natural bridge between Balkan and Anatolian ecosystems, providing habitats to a large variety of plant and animal species (Dönmez, 1979, 1990; Demirsoy, 1996).

The population of the region, 14 million people, doubled in the last ten years. About the fifth of Turkish population lives in this region and its development is very rapid. Every year thousands of industrial and residential structures are built. Thus, all wildlife in the region may soon confront serious problems. Similarly to all other species, bat populations are under continuous and direct threat from the process of urbanisation. It might be possible, that some bat species are on the brim of extinction and we do not even know about them.

Relatively little is known about bat community in Turkey. The most recent and comprehensive information about the bats' distribution can be found in the paper of Benda and Horacek (1998), who compiled all known chiropteran records from Turkey. Yet all but one reference from the Çatalca-Kocaeli region reported there, refer to the studies conducted between years 1953 and 1972; the latest data were collected in 1987 (Albayrak, 1993). The region, however, is constantly changing and, accordingly, the bats' status needs a constant update.

The project, Eurasian Bridge 99, has been formed in order to locate and identify the bat populations in northwestern Turkey. Eurasian Bridge 99 focused on cave-dwelling bat species in the Çatalca-Kocaeli region and aimed to provide data on the bat species present in the region, their distribution, main roosts, and seasonal fluctuations in population sizes.

The project proceeded in three phases: (1) caves inventory, (2) summer/winter counts, and (3) data analysis. Besides collecting data on the bats' abundance and distribution, the fieldwork included caves mapping, habitat assessment, and training volunteers in basic field techniques.

Along with the fieldwork, workshops and seminars were organised in Boğaziçi University, University Speleological Society, Turkish Society for Protection of Wildlife, Yüzyıl high school, and the Forestry Faculty of İstanbul University. Preliminary data were presented in the annual exhibition organised by the Scientific and Technical Research Council of Turkey and on the conference in Poland. We hope that these activities will help to secure continuous monitoring of the bats and increase public concern on protection issues.

During the project, the interiors of 13 caves were explored and 9 bat species encountered. It has to be stressed that ten of the caves were never studied before. Many important maternity roosts and hibernation sites were identified. Although far from being complete, our data might prove useful in setting the right conservation program for the bats in Turkey whereas the distribution patterns analysed by us might add to better understanding of the region's ecology.

AIMS AND OBJECTIVES

The Aim of the Project Eurasian Bridge'99

The project Eurasian Bridge'99 aimed to provide data on the distribution of resident cave-dwelling bat species in a transition region between southeastern Europe and northwestern Anatolia. The results would help to set basis for conservation programs. By trying to found the first bat research group in Turkey, we hoped to secure continuous monitoring of the bat species and to increase public concern on environmental protection issues concerning bats.

Objectives of the Project

Fieldwork

The fieldwork of the project included:

- An inventory of caves and other possible bat roosts of the region;
- Mapping distributions of cave-dwelling bat species;
- Winter counts;
- Summer counts.

Scientific

The scientific side of the project included:

- Identification of bats species present in the region;
- Information about the current distribution of bats species;
- The results of winter and summer counts.

Training

Educational activities of the project included:

- Founding a new bat research group and training volunteers in basic field techniques;
- Workshops and seminars organised for Boğaziçi University students, University Speleological Society and other caving groups;
- Visiting other bat research teams in order to learn more about the recent field techniques and to discuss the findings.

Conservation

The project aimed to:

- Provide the primary data about the distribution of bat species at the transition region between Europe and Anatolia, which would enable the creation of accurate conservation programs for bat species in the future;
- Assess vulnerability of bats species present in the region;
- Identify roosts, that are the most crucial for the survivorship and well being of bat species;
- Compare the regional and international conservation status of bat species;
- Set basis for continuous monitoring in the future;
- Enable the entrance of the topic bat conservation into the agenda of the Turkish Union of Cavers.

BATS IN GENERAL

Natural History of Bats

Bats are taxonomically classified as order 'Chiroptera'. The order Chiroptera includes 17 families, 186 genera and 963 species, which are distributed all over the world except Antarctica. Only the rodents, with approximately 1700 species, out of approximately 4000 species of mammals, outnumber bats in terms of species richness (Altringham, 1996).

Chiroptera is divided into two suborders: the Microchiroptera (microbats) and the Megachiroptera (megabats). The Megachiroptera comprises only one family, Pteropodidae, 42 genera and 175 species. It includes fruit, flower, nectar and pollen eating bats, which live exclusively in the Old World. (Altringham, 1996). The Microchiroptera comprises 16 families, 144 genera and 788 species. The Microchiroptera are present in both the Old World and the New World (Altringham, 1996; Nowak, 1994).

Most of the Chiroptera inhabit the tropics. The three main zones in which the greatest number of species exists are the American tropical rain forests, southeast Asian rain forests and east African equatorial savannah. Venezuela is particularly famous for the specious bat fauna; 146 species inhabiting the country are almost twice as many as the species of the entire Palaearctic region (Findley, 1995).

European Bat Fauna

The European bat fauna includes 3 families (Rhinolophidae, Vespertilionidae, and Molossidae), 10 genera, and 31 species (Benda and Horacek, 1998). The families, genera and species are as follows:

Family RHINOLOPHIDAE - Horseshoe bats:

Genus: *Rhinolophus* (Lacepéde, 1799)

Rhinolophus hipposideros (Bechstein 1800) – The Lesser Horseshoe Bat

Rhinolophus ferrumequinum (Schreber, 1774) – Greater Horseshoe Bat

Rhinolophus euryale Blasius, 1853 – The Mediterranean Horseshoe Bat

Rhinolophus mehelyi Matschie, 1901 – Mehely's Horseshoe Bat

Rhinolophus blasii Peters, 1866 – Blasius's Horseshoe Bat

Family VESPERTILIONIDAE – Common Bats

Genus *Myotis* (Kaup, 1829)

Myotis daubentonii (Kuhl, 1817) - Daubenton's Bat

Myotis capaccinii (Bonaparte, 1837) – Long fingered Bat

Myotis dasycneme (Boie, 1825) – Pond Bat

Myotis brandtii (Everyman, 1845) – Brandt's Bat

Myotis mystacinus (Kuhl, 1817) – Whiskered Bat

Myotis emarginatus (Geoffrey, 1806) – Geoffrey's Bat

Myotis nattereri (Kuhl, 1817) – Natterer's Bat

Myotis bechsteinii (Kuhl, 1817) – Bechstein's Bat

Myotis myotis (Borkhausen, 1797) - Greater Mouse Eared Bat

Myotis blythii (Tomes, 1857) - Lesser Mouse Eared Bat

Genus *Nyctalus* (Bodwich, 1825)

Nyctalus noctula (Schreber, 1774) - Noctule

Nyctalus leisleri (Kuhl, 1817) – Leisler's Bat

Nyctalus lasiopterus (Schreber, 1780) – Greater Noctule

Genus *Eptesicus* (Rafinesque, 1820)

Eptesicus serotinus (Schreber, 1774) - Serotine

Eptesicus nilssonii (Keyserling et Blasius, 1839) – Northern Bat

Eptesicus bottae (Peters, 1869) – Botta's Serotine

Genus *Vespertilio* (Linnaeus, 1758)

Vespertilio murinus Linnaeus, 1758 – Parti-coloured Bat

Genus *Pipistrellus* (Kaup, 1829)

Pipistrellus pipistrellus (Schreber, 1774) – Common Pipistrelle

Pipistrellus nathusii (Keyserling et Blasius, 1839) – Nathusisus's Pipistrelle

Pipistrellus kuhlii (Kuhl, 1819) – Kuhl's Pipistrelle

Pipistrellus savii (Bonaparte, 1837) – Savi's pipistrelle

Genus *Plecotus* (Geoffrey, 1818)

Plecotus auritus (Linnaeus, 1758) – Common Long-eared Bat

Plecotus austriacus (Fischer, 1829) – Grey Long-eared Bat

Genus *Barbastella* (Gray, 1821)

Barbastella barbastellus (Schreber, 1774) - Barbastelle

Genus *Miniopterus* (Bonaparte, 1837)

Miniopterus schreibersii (Kuhl, 1817) – The Bent-Winged Bat

Family MOLOSSIDAE

Genus *Tadarida* (Rafinesque, 1814)

Tadarida teniotis (Rafinesque, 1814) – European Free-tailed Bat

CONSERVATION OF EUROPEAN BATS

Hibernating bats are very sensitive to disturbance, as arousal from hibernation can cause depletion of their fat reserves. Bats living in caves and mines are especially vulnerable to human disturbance (Richards and Halls, 1998) and consequently many sites of hibernation in North America and Europe are under strict protection (Stebbings, 1998; Nowak, 1994).

The traditional methods of bat conservation have focused on roost protection (Kunz and Racey, 1998). A comprehensive protection, however, should include both roost and habitat protection (Entwistle et al., 1997). Until recently tropical islands with high biodiversity and oceanic islands with many endemic species were in the centre of conservation efforts. But this approach is changing, and presently habitat protection also includes temperate regions, where some of the largest hibernating and maternity roosts are present. There is also trend to shift from the species centred protection (based on density or rarity of species) to more productive and cost effective protection of native area (Arita and Ortega, 1998; Marinho-Filho and Sazima, 1998; Pierson, 1998).

There are many legislation and treaties regarding the conservation of wildlife in general and bats in particular. The most important is the 'European Bats (Eurobats) Agreement' under the 'Convention on the Conservation of Migratory Species of Wild Animals'. The convention aims to form a direct action plan for the conservation of European bats. According to the Eurobats agreement, the signing countries have to take necessary actions for the protection of the 31 bat species of Europe. The details regarding this agreement, which Turkey is not a part of, are below:

European Bat Agreement

The Agreement on the Conservation of Bats in Europe, which came into force in 1994, at present, numbers fourteen European states among its Parties. The Agreement was set up under the Convention on the Conservation of Migratory Species of Wild Animals, which recognises that endangered migratory-species can be properly protected only if activities are carried out over the entire migratory range of the species.

The Bat Agreement aims to protect all 31 species of bats identified in Europe, through legislation, education, conservation measures and international co-operation with Agreement members and with those who have not yet joined.

In 1995, the First Session of the Meeting of Parties to the Agreement formed an Action Plan, which was to be translated into international action. They established an Advisory Committee to carry forward this Plan between the Meetings of Parties.

The most significant items for the Advisory Committee are monitoring and international activities. A pan-European observation study is to identify population trends and then to facilitate the timely introduction of measures to address any problems which the study's results might throw up. The study is based upon representative species, and consistent methods for observing them are to be used.

International protection measures for bats, above all, have to concentrate on those species that migrate across Europe, in order to identify and address possible dangers caused by bottleneck situations in their migratory routes. Therefore, the Advisory Committee is also to examine the available data about the migratory behaviour of representative bat-species.

The results of these studies are intended to lead to a comprehensive international program for the conservation of the most endangered bat-species in Europe.

REGULATIONS FOR SAFEGUARDING BATS IN TURKEY

Although not a signatory to Convention on the Conservation of Migratory Species of Wild Animals, Turkey has taken part in the Bern Convention and set some national regulations, regarding conservation of species including bats (but not directly), their roosts, and associated habitats. The duty of actual implementation of the obligations arising from these treaties (both legislative and administrative) has not been undertaken to its full extent though.

International Regulations

Bern Convention (Switzerland 1984)

As a member of the Council of Europe, Turkey became a signatory to the 'Convention on the Conservation of European Wildlife and Natural Habitats' (the "Bern Convention") in 1984. The convention places an obligation on Contracting Parties to "take appropriate and necessary legislative and administrative measures to ensure the conservation of the habitats of the wild flora and fauna species, especially those specified in the Appendices I [plants] and II [animals]" of the convention. According to the Appendix II, all the Microchiroptera species, but *Pipistrellus pipistrellus*, are under protection.

Also 18 species of İstanbul's threatened plants are listed in the Appendix I, and this places an international obligation on planners and land managers to take the necessary precautions to protect these plants and the places in which they grow.

In addition, through Resolution No. 3 (1996), the Convention places an obligation for the contracting parties to identify and protect 'Areas of Special Conservation Interest' (ASCIs), which will contribute to a pan-European network of protected sites, the EMERALD Network. In addition to protecting rare species, contracting parties are also obliged to protect examples of Endangered Natural Habitats, as specified in Resolution No. 4 (1996). Thirteen listed habitats occur within the province: at present no examples of any of these habitats receive protection.

National Regulations

The National Parks Law (1983)

The National Parks Law seeks to protect features of national and international importance, through the designation and management of national parks, nature parks, natural monuments, and strict nature reserves. The statute regulates or forbids forestry, development, hunting, agricultural activities which might damage or destroy the special interests of the site.

The Cultural and Natural Assets Protection Law (1983)

The Cultural and Natural Assets Protection Law seeks to identify features of sites of exceptional natural or cultural value, and to protect them for construction and other forms of physical interference, and gross changes in usage. The special sites area can be designated under one of three categories:

- city sit areas, reflecting social, economic, or complex of archaeological or historic features,
- architectural sit areas, for individual structures,
- natural sit areas, of high landscape or nature conservation value.

The Boğaziçi (Bosphorus) Law (1983)

The Bosphorus Law seeks to protect and develop the cultural, historical and landscape values of Bosphorus and adjacent hills through planning regulations which limit urban development within the area. The regulation aims to preserve forested and open undeveloped areas as green space, forbids the construction of industrial buildings (like fuel stores, shipyards, etc.), and severely regulates residential development.

Environment Law (1983)

The Environment Law provides additional legal and technical ways of protecting the environment, to ensure the wise use of land and natural resources; to prevent water, soil and air pollution; and to protect fauna and flora, for the health, cultural and living standards of future generations. In particular, the law places an obligation on developers to prepare Environmental Impact Assessments, for certain large and potentially damaging development activities.

The Council of Ministers is empowered to establish and declare threatened areas that have national or international ecological importance as 'Areas of Special Conservation Interest', with the aim of taking all necessary measures to ensure that the natural beauty of the area is conserved for the benefit of future generations.

BATS' STATUS IN TURKEY

Until the 1950s, mostly non-Turkish researchers conducted the bat studies in Turkey. Şadoğlu was the first Turkish author who wrote in 1953 an article on bats. In 1960's Çağlar and Kahmann were the most prominent figures in the Turkish bat fauna research. Between the 1960's and 1970's, German and Austrian zoologists made many important contributions to bats research. Starting with the 1980's, extensive research of Albayrak yielded many data of new species and roosts locations (Albayrak 1988, 1990a, 1990b, 1993). The most recent review of Turkish bat fauna was written by Benda and Horacek in 1998.

The Turkish bat fauna includes 32 species; one species of Megachiroptera (*Rousettus aegyptiacus*) and 31 species are Microchiroptera. Out of the European continental bat fauna, only *Myotis dasycneme* and *Eptesicus nilssonii* are absent in Turkey. On the other hand, the Turkish bat fauna includes *R. aegyptiacus* and *Otonycstris hemprichi* species that are absent in Europe.

Out of the 44 species that form the Middle Eastern bat fauna, 24 are present in Turkey. Based on the percentage of similar species within the European and Middle Eastern bat fauna (94 % and 61 % respectively), Benda and Horacek (1998) concluded that the Turkish bat fauna is similar to the West Palaearctic arboreal.

There are many bats' distribution borderlines in Turkey. The temperate zone species that reach their maximum abundance in Europe and Siberia, have south and southeastern distribution borders here. The species *M. bechsteinii*, *M. mystacinus*, *M. brandtii*, *M. daubentonii*, *V. murinus*, *P. nathusii*, *N. leisleri*, *N. lasiopterus*, *B. barbastellus and P. auritus*. *M myotis* and *M. capaccinii* reach their eastern borders in Turkey. The Rize-Erzurum-Diyarbakır-Antalya is a borderline for *M. myotis*, whereas Hatay is an eastern border for *M. capaccinii*. *R. aegyptiacus*, *E. bottae* and *O. hemprichi* also reach their north and northwestern borders in Turkey (Benda and Horacek 1998).

Benda and Horacek (1998) divide Turkey into three zones of bat fauna.

1) Northwestern Turkey,
2) Southeastern Turkey,
3) Central and eastern Anatolia.

Whereas southeastern and northwestern Turkey show distinctive differences in terms of species, central and eastern Anatolia is characterised as a transition zone between them. Eastern Anatolia is especially rich in bats as 22 of 31 species comprising the Turkish bat fauna is found there.

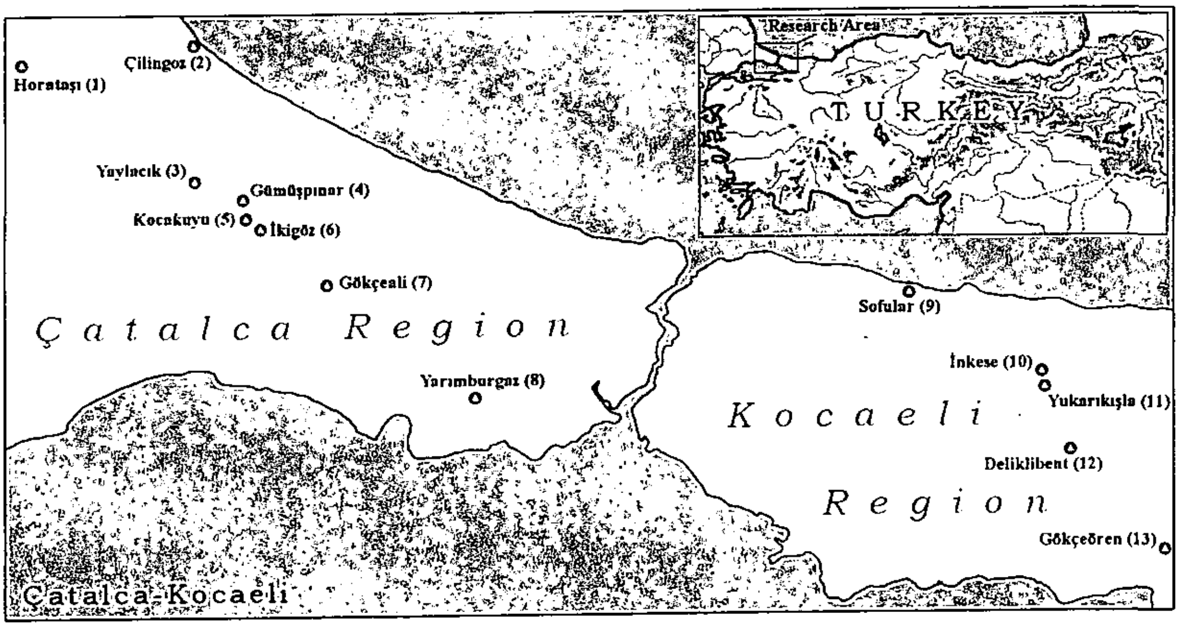
PROJECT AREA: ÇATALCA - KOCAELİ REGION

The Çatalca-Kocaeli region surveyed in the project Eurasian Bat Bridge '99, is situated in Northwestern Turkey, and extends 100 kilometers eastwards and westwards from the Bosphorus. The research was conducted in 13 roosts situated in 6,000 km^2 area (Map 1). The rough coordinates of the project area are:

Longitude E/W: 29

Latitude N/S: 41

The area acts as a transition region between southeastern Europe and Middle East. It is inhabited by many of the migratory and resident bat species throughout the year.



Map 1. Map of the research area and the location of surveyed roosts.

The rapid urbanisation of the region poses a serious threat to the wildlife. Because of the continuous growth of Istanbul on both sides of the Bosphorus, natural grasslands and forests are being replaced by industrial, agricultural and residential structures. As a result, the habitats of bats (and other species) are under direct threat of pollution and depletion.

Each year İstanbul's population grows by up to half a million individuals and today the city houses perhaps 13 million inhabitants. As such, İstanbul is Europe's fastest growing conurbation, belonging to the ranks of the world's great mega-cities.

High population translates into huge demands for housing, industry, jobs, roads and other services – and above all, land. In satisfying this demand, huge swathes of countryside – verdant forests, internationally important heathlands and sand dunes – are destroyed forever. With their loss, common species of plants and animals become rare, and rare species approach extinction. If the growth of the city remains unchecked, whole landscapes will have been swept away, and certain plant species will become extinct.

Biodiversity of the Area

With a history dating back over 26 centuries, man's agricultural and forestry activities in the countryside surrounding the city have changed the landscape in a multitude of ways. Yet rather than being wholly destructive, many of the older traditional management practices have created a varied and wildlife-rich landscape, not so very different from other parts of Europe. Traditional management practices such as coppicing and grazing of domestic stock have actually increased the diversity and abundance of plant and animal life around the city. Accordingly it is essential that these age-old rural management practices continue, albeit in a fully regulated manner.

Five habitats within the province are of high national or even international importance to nature conservation:

Grasslands

Flower-rich limestone grassland covered much of the southern part of European İstanbul, but has largely been converted to arable land, today growing wheat or sunflowers. Yet the few remaining areas are immensely rich in rare plant species, and an abundance of insect life. These habitats were prevalent across approximately 122,500 hectares of the region, yet today; it is estimated that only 12,500 hectares retain their high conservation interests.

Forests

The forests of İstanbul are the most widespread of the city's valuable habitats, rich in forest flowers, and providing an undisturbed habitat for the city's wild boar and jackals. Much of the city's forests are coppiced on a 20-year cycle to provide fuel wood and material for charcoal production. These coppice forests are of immense importance as a cultural landscape, and represent one of the most intact and largest examples of sustainable charcoal and coppice production systems surviving in Europe today. The most widespread habitat in the province, yet still 2,200 hectares have been destroyed over the last ten years.

Heathlands

Much of the southern and eastern part of the province was covered in heathland, dominated by low shrubs principally from the heather family (Ericaceae). Whilst they have been severely damaged, the remaining fragments are the most important in eastern Europe and the eastern Mediterranean region. This is the richest habitat in the province for rare plant species. Extensive heathlands covered approximately 95,000 hectares of the southeastern parts of the province. Today it is estimated that 85% has been destroyed: only six areas of 2,000 hectares or more survive. Afforestation, conversion to arable production, and urban expansion pose the principle threats to this most rare of habitats.

Sand dunes and other coastal habitats

Scattered at 15 spots along the coast, the sand dunes bordering the Black Sea are the most important, and represent the second richest habitat for rarer plant species in the province. In addition, some of the rocky coastline, and offshore islands are particularly important for breeding populations of seabirds (e.g. Şile Islands). Historically 15 sand dune systems were present along İstanbul's Black Sea shores, covering a total of 5,661 hectares. Today just 1,182 hectares survive – a loss of 79%, largely since 1960.

Wetlands

There are wetlands at the Büyükçekmece, Küçükçekmece and Terkos lakes in European İstanbul, and at Riva and Ağva in Asian İstanbul. These sites are rich in aquatic and marsh plant life (indeed Terkos has the richest freshwater flora of any lake in Turkey), and are important for their birdlife. Due to their importance as water supply reservoirs, the main natural water bodies in the province have survived largely intact: notably examples include the lakes of Terkos, Büyükçekmece, and Küçükçekmece, together with reedbeds of the Riva river valley. However destruction of flooded forests around the Terkos lake and the reclamation of reedbeds at the Küçükçekmece lake continue to cause considerable damage.

The wide diversity of unusual habitats, combined with the province's position between two continents, and a climate influenced by both the Black Sea and the Sea of Marmara, has allowed the development of an rich flora. The province covers just 511,000 hectares, yet supports an approximately 2,000 species of plants.

Of particular importance to nature conservation are the province's rarer species. Over 270 species listed in the national Red List as rare and/or threatened occur within the province. Of these some 43 species are more abundant here than anywhere else on the earth.

The richness of the flora is probably a result of the following unique set of conditions that prevail in İstanbul:

- variety of soils,
- varying climate due to its position between the two seas, from the damp cool climate of the Black Sea coast to the warmer Mediterranean climate of the Sea of Marmara,
- position between the vastly different floras of two continents, Europe and Asia,
- a long history of traditional land management, which has diversified and enhanced the vegetation and flora.

Urbanisation

The effects of urbanisation on the province's rural environment are immense. Tens of thousands of new houses are constructed annually, vast industrial complexes are under construction, demands for building aggregates soar, and each year – as result of increased wealth and car ownership – vast numbers of people flood into the countryside at weekends to swim and picnic.

Effective planning needs to take account of the natural heritage that encircles the city. Without a concerted effort to protect these areas now, many are likely to be completely destroyed – or altered beyond all recognition – within the next few decades. Not only will this represent an irreplaceable loss of features of international nature conservation importance, but it will also result in the loss of rare landscapes and open areas, so valuable as current and potential outdoor recreational areas.

The major problems threatening İstanbul's green places are as follows:

Urban expansion

The population of İstanbul in 1985 was 5,842,985 and increased to 9,198,809 in 1997, a growth of 57% in 12 years. At the end of 1997, 15% of the total population of Turkey was residing in Istanbul. Indeed the city is expected to house over 17 million inhabitants by the year 2010. The loss of natural areas is severe. For example, the expansion of the city on the European side of the Bosphorus has increased 90% in the last ten years; whilst suburbs such as Gaziosmanpaşa in the European half of the city have increased by 65% in the past seven years. In the Asian half of the city, the population of Sultanbeyli, has increased by 2,100% between 1985 and 1990.

Mineral extraction

In İstanbul, 604 mineral mines (covering a total of 1542 hectares) and 102 quarries (over 300 ha) have been given permission to operate. Approximately 60% of the permissions have been given during or after the 1980s. It is suspected that the overall area subjected to mining within the province is considerably greater than this figure, presumably the result of many illegal mining operations.

Afforestation

Tree planting and afforestation are often good activities for the environment, but in a few instances they can cause considerable damage. Some open habitats (like grasslands, heathlands, and sand dunes) are rich in rare plants and animals, but these suffer if subject to tree planting (the growing trees shade out the rarer, shorter-growing plants). This is a particular problem around İstanbul, and, at the present time, afforestation can be regarded as the second most damaging activity to sites of nature conservation importance after urban spread.

Approximately 42,000 hectares of land have been afforested within the province since the 1950s, resulting in the loss of heathlands, grasslands and sand dunes (such as the dunes at Terkos). This has been exacerbated in recent times by the introduction of amendments to the Forestry Law (notably amendment, 20105 of 11 March 1989), which seeks to expand the area of plantation forest in the province by making available state lands to private and corporate bodies, for purposes of afforestation.

Deforestation

The loss of forests is of considerable concern to nature conservationists. Most of the loss occurs as forests are cleared for agricultural land or to make way for housing. Forest fires also pose a considerable threat: over the past ten years 5,799 hectares of forest have been lost to fire, in 972 separate incidents (involving mainly planted pines).

Water supply

In the Istanbul province approximately 920 million m^3 of water from ten sources is available annually (730 million in dry seasons). Predictions suggest that by the year 2010 the annual demand for water will rise to 1.7 billion m^3.

The construction of reservoirs causes considerable destruction of wildlife–rich habitats, including heathland and forest. Two schemes currently being investigated or under construction (the Istranca and Melen River schemes) have resulted/will result in the loss of substantial areas of forest along the route of the water supply line and at reservoirs sites. Furthermore, they are both likely to cause serious secondary environmental problems on flooded forest and wetland ecosystems downstream of the dammed rivers (e.g. at İğneada and Karasu).

The protection of water catchments from development can help the conservation of wildlife-rich areas (e.g. around the Alibey and Ömerli reservoirs), and combined action to protect water catchments for water quality and wildlife could represent a major mechanism for conserving İstanbul's wildlife heritage.

Agricultural intensification

The ploughing of grasslands and heathlands, the application of pesticides and fertilisers damage and destroy the wildlife and valuable sites. Fragmentation of species- rich wildlife habitats isolates populations, which become more susceptible to extinction, with fewer prospects for re-colonisation from nearby sites.

Loss of traditional management practices

People have been managing the countryside surrounding İstanbul for many centuries. Far from being destructive, man's activities such as coppicing, charcoal making, pollarding of individual trees, and grazing and cutting of pastures and meadows has actually fashioned the diverse, visually attractive and species-rich landscape present around the city today. Many of the rarest plants and animals are wholly dependent on mankind for their survival – rare crocuses require light grazing to maintain their preferred short grassy habitat, whilst many butterflies, lilies and cyclamen rely on coppicing to maintain open conditions within their woodland habitat. Cessation of such activities can lead to serious declines, and even extinction.

Geomorphology

Çatalca Region

The Çatalca peninsula has a dominant plateau character. The main mountainous areas are the skirts of the Istıranca Mountains that penetrate into the Northwest of the region. Black Sea and Marmara Sea that surround the peninsula have adjacent coastal zones that have high altitude due to the plateau character. The plateau starts after the narrow coastal zone that ends by steep cliffs. Wider coastal zones are present where the rivers that originate from the central plateau reach the sea. Small plains are present within these wider coastal zones. There are bays at the mouths of valleys.

Kocaeli Region

Although Kocaeli peninsula has a geomorphology dominated by plateau, it also exhibits a mountainous topography. Generally, the southern zones are higher than the north, and the eastern zones are higher than the west. The main points of high altitude are Kayışdağı, Aydosdağı, Kayalıdağ, Serçetepe, and Çenedağ from the west to the east, which are located more towards the south of the peninsula. The coastal zones are similar in character to Çatalca, with cliff forming steep coasts.

Whereas the longer rivers of the region end the Black Sea, the shorter ones end in the Marmara Sea, dividing the Kocaeli peninsula into two parts. The effect of the Black Sea is more pronounced at the north and it is negligible in the south.

Climate

Among abiotic factors that influence climate in the Çatalca-Kocaeli region, precipitation and temperature are the most important ones. The general climatic properties for the two regions are as follows:

Çatalca Region

The general climate of Thrace is similar to that of the Mediterranean. The most of the annual precipitation of 600-800 mm takes place in winter. However, due to the effect of the Black Sea, in the Çatalca region, the rate of summer precipitation is higher in comparison to areas where typical Mediterranean climate is prevalent. The Çatalca region has a low percentage (25%) of heavy rains. The temperature fluctuations do not have a substantial impact on vegetative succession. Frost in winter prevents Mediterranean plant species from penetrating into the central areas.

One of the important factors affecting the growth of vegetation is the difference between precipitation and evapotranspiration rates. From April to September, when evapotranspiration is higher than the precipitation, vegetation faces a water shortage balanced by water stored in soil. But in July, August and September there is a severe water scarcity.

Kocaeli Region

The climate of the Kocaeli Peninsula shows a transitory character between the Black Sea and Mediterranean climate. Towards the north, as the influence of the Black Sea climate dominants, the winter precipitation decreases and the summer precipitation increases.

The greater influence of the Black Sea results in higher annual precipitation rates for the Kocaeli region (800-1000 mm) in comparison to the Çatalca region. Within the peninsula, the western areas have the lowest annual precipitation, and the plateau that covers most of the peninsula has the highest precipitation. The south and western parts of the peninsula have higher percentage of heavy rain compared to the north and east. July and August are the months of water deficiency for plants.

The peninsula shows a homogenous character in terms of the average temperature. The average temperature for both the Black Sea and Marmara coasts, and the central parts is 5 to 6°C in winter. A difference in maximum winter temperatures does not exceed 2-3°C within the peninsula. The northern zones are generally colder than the south (with greater number of frosted days), causing higher abundance of more resistant plant species in the northern areas. The average summer temperatures varies between 20 and 24°C; a difference in maximum summer temperatures is ~ 4°C and does not affect the distribution of plant species.

Habitats

Çatalca Region

The humid forest zone predominates the Istıranca mountains, especially the northern faces, which comprise the highest topography of the region. The Istıranca mountains due to their altitude and effects of the Black Sea's humid climate, are one of the regions with the highest precipitation rates in Turkey. The dominant species of the humid forest zone of the Çatalca peninsula is a beech tree (*Fagus orientalis*). There are also various oak species (*Quercus dschorochensis*, *Q. frainetto* and *Q. cerris*) surrounding or staying between the beech aggregations.

The precipitation rates decrease towards southwards, resulting in the dry forest zone at the southern slopes of the Istıranca mountains. The dry forest continues southwards until about 10 km from the coast of the Marmara Sea. Although in the dry forest zone there is a lower precipitation rate than in the humid forest zone, the rate is still much higher than in the steppe zone to the west.

The dry forest zone is composed of deciduous oak forests composed of a rich variety of eight oak species that shed their leaves in summer. The other abundant elements are two horn beech species (*Carpinus orientalis* and *C. orientalis*).

Kocaeli Region

Habitat morphology of the Kocaeli peninsula is somehow similar to that of the Çatalca peninsula (Dönmez 1990). Here, forests (humid and dry), maquis, pseudomaquis, and coastal vegetation are the main vegetation types. Dönmez (1979) identified two habitat zones in the peninsula: (1) a humid forest zone, including pseudomaquis, and (2) a dry forest zone, including maquis (mainly *Arbutus unedo*, *Laurus nobilis*, and *Phillyrea latifolia*). Maquis, composed of evergreen species, are common in coastal regions where the native forest cover deteriorated. Maquis that fills up the destroyed parts of forests and are mixed with species that shed their leaves in summer are called pseudomaquis.

The humid forest zone covers a greater area than the dry forest zone. Although these two forest zones accommodate different tree species, they are both partly replaced by maquis composed mainly by *Arbutus unedo*, *Laurus nobilis*, and *Phillyrea latifolia* species (Dönmez 1979).

Within the Kocaeli peninsula, on the west from the Gökdere valley - north of the Karakaya hill - Ağva line, two oak species, *Quercus pedunculiflora* and *Q. cerris,* and chestnut, *Castenae sativa,* are dominant; on the east from the line, a beech species, *Fagus orientalis*, is dominant. The difference arises from the combined effects of the climate, precipitation, and soil types.

Dry forests in the southern part of the peninsula (south of the Alemdağ and Aydos mountains) are promoted by the higher average temperature and higher evaporation rates. The dry forest zone is composed of oak species, tolerant to dry climate. Dominant species are *Q. infectoria* and *Q. frainetto*.

METHODOLOGY OF THE RESEARCH

Fieldwork

Our fieldwork started with a preparation of an inventory of caves of the Çatalca-Kocaeli region. We analysed the archives of Boğaziçi University Speleological Society, interviewed Turkish cavers, contacted local informants, and organised three fieldtrips to locate recorded caves and to search for new ones. Among 20 caves included in the final list, 13 accommodated bats' roosts. The list of the caves with bat species included Çilingoz, Deliklibent, Gökçeali, Gökçeören, Gümüşpınar, Horataşı, İkigöz, İnkese, Kocakuyu, Sofular, Yarımburgaz, Yaylacık, and Yukarıkışla (Table 1). After consulting the available records, we found that only three caves were previously studied for the presence of bat species. The caves were studied during 30 fieldtrips in two time periods. The first 22 fieldtrips took place between March and August 1999, followed by eight fieldtrips conducted in February and March 2000. An additional fieldtrip, with the aim of training potential bat volunteers, was organised in November 1999.

Species Identification and Population Census

The species were identified by analysing differences in their morphological characters. Bats were taken by hand, if possible, or captured by a hand-net. The forearm length was used as a dominant diagnostic measurement. The measurements were made by a Vernier scale with a precision of 0.1 mm. A heterodyne bat detector (Batbox 3) was used for identification of flying horseshoe bats.

Single individuals and clusters of less than 30 individuals were counted directly. Bigger clusters were counted by estimating a number of individuals present in the area illuminated by a torch and then by multiplying it by the number of areas needed to cover the whole cluster.

The diagnostic details for each genera and species are as follows:

Rhinolophus

The most striking feature of this genus is the leaf-like skin process surrounding the nasal region through which echolocation calls are emitted. Their echolocation calls are characterised by a constant frequency component that ends with a terminal FM buzz.

Rhinolophus ferrumequinum

R. ferrumequinum is the largest of the European horseshoe bats. Its forearm length is 54-61 mm. The dorsal hair is grey-brown to smoky grey with a reddish tinge; the ventral hair is grey-white to yellowish white. The juveniles are more ash-grey on the back. The wing membranes and ears are light grey and brown. Individuals of *R. ferrumequinum* can wrap themselves completely inside their wing membranes. The upper connecting process of the nose (ucp) is short and rounded; the lower connecting process (lcp) is pointed. *R. ferrumequinum* emits a relatively low frequency call when compared to other rhinolophids, between 77-81 kHz.

Rhinolophus hipposideros

R. hipposideros is the smallest horseshoe bat. Its forearm length changes between 32 and 42.5 mm. The colour of the dorsal side is brownish smoky grey (without a reddish tinge); the ventral side is grey to grey-white. The juveniles are dark-greyer on the back. The wing membranes and ears are light grey and brown. It also can wrap itself completely inside its wing membranes. The ucp is short and round, the lcp is short and pointed. The echolocation frequency changes between 105 and 111 kHz.

Rhinolophus euryale

R. euryale is one of the three medium sized horseshoe species. Its forearm length is 43-51 mm. Another measurement that is made for identification of the medium sized horseshoe bats is the measurement of the first and second phalanx of the fourth finger. The first phalanx is 6.6-8.5 mm and the second phalanx is 17.9-19.2 mm. The ventral side is grey-white to yellowish white; the dorsal side is grey-brown with a pinkish tinge. The boundary between the two sides is indistinct. The juveniles are more grey coloured. The bare parts of the face (horseshoe and lips) are light brownish. The ears and wing membranes are light grey. A few dark hairs are present around the eyes. The third to fifth fingers at rest are bent 180° at the joint between first and second phalanges and hence it cannot wrap itself completely in the wing membranes. The ucp is pointed and it slightly curves downwards and protrudes more than the rounded lcp. The lancet tapers off to a blunt point evenly.

Rhinolophus mehelyi

R. mehelyi is the other medium sized cave-dwelling horseshoe bat that was recorded within the caves of the region. Its forearm is 50-55 mm. The first phalanx of the fourth finger is 7.7 mm and the second phalanx is 19 mm. The dorsal side is grey-brown; the ventral side is almost white. The border between the two sides is distinct. The ears and wing membranes are grey-brown. Conspicuous dark spectacles of grey-brown hairs exist around the eyes. It cannot wrap itself completely in the wing membranes because of the reason similar to *R. euryale*. The ucp is blunt and slightly longer than the lcp. In contrast to *R. euryale*, its lancet gets thinner in a convex curving manner towards the tip. Its echolocation frequency changes between 105 and 112 kHz.

Myotis

The ears that pass the height of the head and absence of nasal ornamentation are the most distinguishing features of this genus, used for distinguishing it from *Miniopterus* and *Rhinolophus* genera. Other than the forearm length, the length of spur on the tail membrane, and the presence/absence of bristles on the free (spurless) end of the tail membrane are used for identification.

Myotis daubentonii

M. daubentonii is a medium to small sized mouse-eared bat. Its forearm is 33-42 mm. Its spur attains one third of the length of the tail membrane. At three quarters of the spur there is a distinct break. No hair exists on the free end of the tail membrane. The dorsal hair is brown-grey to dark bronze; ventral side is silver grey with a brownish tinge. The border between the dorsal and ventral fur is distinct. The juveniles are darker. It muzzle is rufous.

The ear and wing membranes are dark grey-brown. It hunts using FM signals, sweeping a range between 78 and 25 kHz, with a peak at 45 kHz.

Myotis capaccinii

M. capaccinii is another medium sized mouse-eared bat. Its forearm length is 38-44 mm. The spur attains one third of the length of the tail membrane. At two thirds to three quarters of the tail membrane, there is a break acting as a spur tip. The tail membrane has dense, dark hair both above and below that reaches the spur region. The dorsal fur is light smoky grey with a slight yellowish tinge. The ventral fur is light grey. The border between the dorsal and ventral sides is indistinct. The ears and wing membranes are grey-brown. It has a reddish brown muzzle. Its feet are bigger than the other medium-sized *Myotis*. The tail membrane is covered with dense and dark hairs above and below, which is absent in the other *Myotis* species.

Myotis emarginatus

M. emarginatus is a medium sized mouse-eared bat. Its forearm length is 36-42 mm. Its spur attains one half the length of the tail membrane. The free margin of the tail membrane has sparse bristles. It has a tri-coloured dorsal fur whose base is grey, middle is straw yellow and top is rufous brown. The ventral side is yellowish grey. The ear and wing membranes are dark grey-brown. Its muzzle is brown. On its ear there is a notch almost perpendicular to the ear, at a distance of about two thirds from the base.

Myotis myotis

M. myotis is one of the largest species belonging to the genus *Myotis*, and the largest one in Europe. Its ears are long and broad; the grey-brown muzzle is short and wide. The tragus reaches one half of the length of the ear. The dorsal fur is light grey-brown with a rusty tinge, the ventral fur is whitish grey. The ear and wing membranes are grey-brown.

Myotis blythii

M. blythii is slightly smaller than *M. myotis*. Its ears are narrow and smaller. Its light grey muzzle is also narrower and pointed. The tragus is one half the length of the ear. Its dorsal fur is grey with a brownish tinge; its ventral fur is greyish white. The ear and wing membranes are grey-brown.

Miniopterus

Miniopterus schreibersii

Ears that do not exceed the height of the head are the most important feature distinguishing *M. schreibersii* from the mouse eared bats. Its tragus is bent at the tip. Its dorsal fur is grey-brown to ash-grey, sometimes with a lilac tinge. Its underside is lighter grey and the muzzle is grey-brown.

Habitat Assessment

The habitat assessment was made within an area of approximately 3 km radius around each cave. It included the habitat types known to be particularly important for bats (Dönmez 1979a, 1979b; Fenton and Bell, 1979; Gaisler and Kolibac, 1992; Rachwald, 1992; Ekman and Dejong, 1994; Entwistle et al., 1997; Carmel and Safriel, 1998; Racey, 1998). A DAFOR scale was used for defining relative amounts of land coverage for the different habitat types (Fowler and Cohen, 1996). The scale was defined as follows:

1... The habitat type is rarely present
2... The habitat type is occasionally present
3... The habitat type is frequently present
4... The habitat type is abundant
5... The habitat type is dominant

Important Habitat Types for Bats

Woodland (Coniferous): Forest composed of tree species that do not shed their leaves in winter.

Woodland (Deciduous): Forest composed of tree species that shed their leaves in winter.

Woodland (Mixed): Forest composed of both coniferous and deciduous tree species.

Wet Woodland: Forest composed of deciduous trees, which are rooted in soil covered with water.

Coastal Area: Area that has an open sea interface and/or a beach (including rocky, sand and shingle beaches and sand dunes).

Woodland Ecotone-Clearing: Openings within broad-leaved deciduous trees which are uncluttered enough for bats to forage in.

Woodland Ecotone-Edge: The interface between grassland/moorland and tall scrub/woodlands.

Urban: Areas of human settlement.

Ditches: Open linear drainage features.

Single Trees: Plantations of single trees.

Treeline: a line of at least three single trees less than two canopy widths apart and greater than four meters high.

Hedgerow: linear woody vegetation less than four meters high and five meters wide.

Lake and Reservoir: Standing water greater than a quarter hectare (artificial or natural)

Pond: Standing water less than a quarter hectare (artificial or natural)

Bog: An area of wet and soft land, improper for agriculture of any kind

River: Running water bodies greater than two and a half meters wide

Stream: Running water bodies less than two and a half meters wide

Moorland: Land, which is covered with rough grass or low bushes and is not proper for grazing or agriculture

Pasture: Grassland used solely for grazing; improved or unimproved

Meadow: Grassland used for hay or silage production, improved or unimproved

Arable Land (Traditional): Land used for agriculture, less than a quarter hectare in area

Arable Land (Intensive): Land used for agriculture, greater than a quarter hectare in area

Tall scrub: underdeveloped broadleaved tree formations three to twelve meters high.

Maquis: low bushes typical of Mediterranean climate

Riparian treeline: Treeline located at the fringe of a river or stream

Riparian hedgerow: Hedgerow located at the fringe of a river or stream

Statistical Analysis

The spatial pattern of bats' distribution (random, clumped, or uniform) was measured by computing the Green's index (GI)

$$GI = \frac{\left(\frac{s^2}{\bar{x}}\right) - 1}{n-1}$$

where n, x and s^2 are the sample size, mean and variance. For patterns varying between random and maximally clumped, GI changes between zero and one.

Species abundance relationship was described by the Hill's diversity numbers: N0, N1, and N2.

$$N0 = S \qquad N1 = e^{-\sum_{i=1}^{S}(p_i \ln p_i)} \qquad N2 = \frac{1}{\sum_{i=1}^{S} p_i^2}$$

where S is the total number of species and p_i is the proportional abundance of the ith species. N0 indicates the number of all species in the sample, N1 refers to the number of abundant species, and N2 refers to the number of very abundant species. Evenness of the distribution was measured by the modified Hill's ratio (E5)

$$E5 = \frac{N2 - 1}{N1 - 1}$$

E5 approaches zero as a single species becomes very dominant in a community.

Interspecific association was tested by computing the chi-square statistics for each pair of species. A variance ratio was used to test for simultaneous interaction between all species.

The caves were classified by means of association analysis. We used a divisive and hierarchical technique along with the chi-square statistics to reduce the within-group heterogeneity. In cluster analysis we used the chord distance (CRD) and the flexible strategy. CRD between any two caves was computed as

$$CRD_{jk} = \sqrt{2(1 - c\cos_{jk})} \qquad c\cos_{jk} = \frac{\sum_{i-1}^{S}\left(X_{ij}X_{ik}\right)}{\sqrt{\sum_{i}^{S} X_{ij}^2 \sum_{i}^{S} X_{ik}^2}}$$

where S is the total number of species and X_{ij} represents the abundance of the ith species in the jth cave. The flexible strategy was used to calculate distances between groups of caves. It utilized the linear combinatorial equation

$$D(j,k)(h) = \alpha D(j,h) + \alpha D(k,h) + \beta D(j,k)$$

where α and β are parameters and the distance between the new cluster (j,k) formed from the jth and kth caves and a third hth cave are calculated from the chord distances D(j,k), D(j,h), and D(k,h).

To arrange the cave in relation to each other in terms of the species' presence, an ordination of the caves into a reduced species space was used. The ordination was based on correspondence analysis, data were double transformed and an eigenanalysis approach used.

CAVES OF THE ÇATALCA -KOCAELİ REGION

During the fieldtrips, 13 caves were surveyed (Table 1).

Table 1. The list of surveyed caves and their GPS coordinates.

Region	Caves	GPS Coordinates
Çatalca region (European side)		
	Yaylacık	601792-4579252
	Kocakuyu	610359-4571618
	İkigöz	610606-4569865
	Gökçeali	621552-4564047
	Yarımburgaz	646370-4548757
	Gümüşpınar	608149-4573881
	Horataşı	576626-4594573
	Çilingoz	601922-4597626
Kocaeli region (Asian side)		
	Sofular	710686-4562364
	İnkese	730852-4548433
	Yukarıkışla	730508-4548563
	Gökçeören	752515-4526380
	Deliklibent	734768-4537584

Yaylacık Cave

City: İstanbul
District: Çatalca
Locality: Yaylacık Village
GPS Coordinates: 0601792 – 4579252
Cave Type: Horizontal & Active

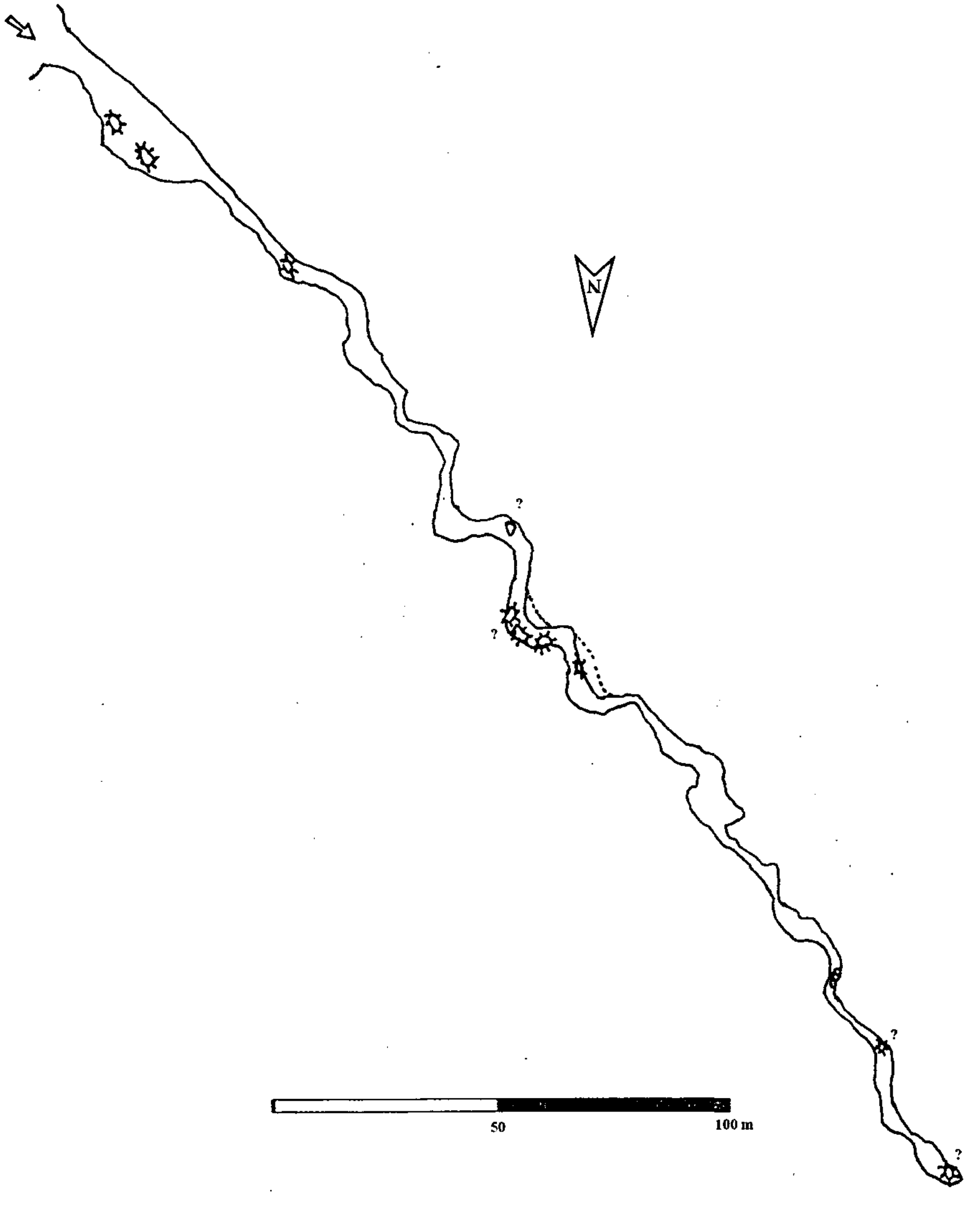
Location

The Yaylacık cave is situated 30 km at northwest of Çatalca. It can be reached via the Çatalca-İhsaniye-Gümüşpınar road. Approximately 7 km after Gümüşpınar, a road to the left goes through Yaylacık village. Approximately, 1 km after the village, the road passes through an elevated field. On the left, the field inclines towards the arable land, and on the right, there are charcoal workshops. The cave entrance is located at the southern end of this slope, inside thick bushes.

Description

The Yaylacık cave is a long active cave (approximately 500 m), which proceeds horizontally. It is composed of a single gallery with a low ceiling of 1.5 m and a width of about 2 m. The entrance is composed of a chamber, where water runs out on the left, and accumulated sand forms 1.m high platform on the right. Close to the end of the cave, the gallery crosses two relatively large dome chambers that act as warm air traps. Here, the ceiling height reaches almost 8 m. At the end of the main gallery, two narrow shafts are connected to the low ceiling. Unexplored as yet, they might lead to concealed chambers or to unknown exits. The end point of the cave is closed by accumulated sand and gravel. Strong air current blows from the narrow hole with 20 cm height. Although the cave seems to proceed more, one cannot pass through this hole.

Map 2. Map of the Yaylacık cave.



Kocakuyu Cave

City: İstanbul

District: Çatalca

Locality: Pınarca Village

GPS Coordinates: 0610359 - 4571618

Cave Type: Inclined & Fossil

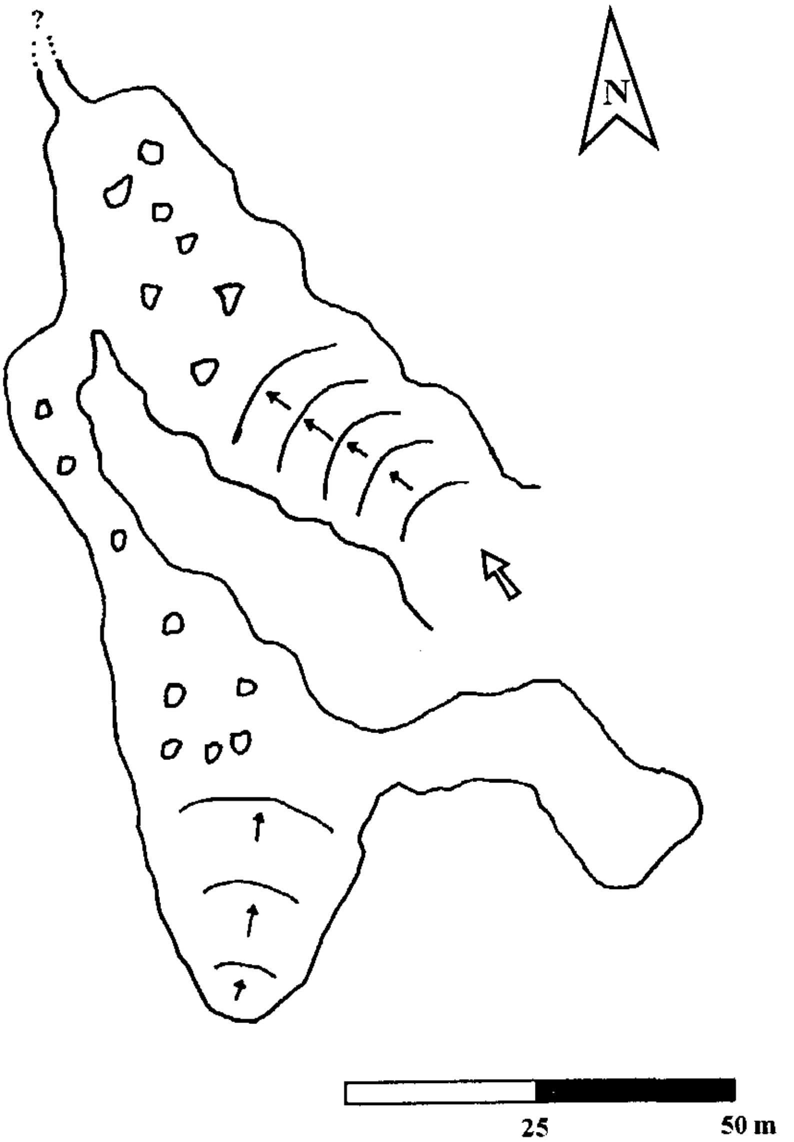
Location

The Kocakuyu cave is situated 18 km at the northwest of the Çatalca district and 3 km at the north of the Pınarca village. It can be reached by the stabilised dirt road leading from Pınarca to Gümüşpınar, which at its third kilometer passes through the old limekiln. At the western edge of the limekiln, electric posts line up the edge of the scrub. Cave entrance is concealed inside the scrub, situated between the two posts. A recently constructed (autumn 1999) tractor road passes just nearby the entrance. A rope or a ladder (3 m) is needed to descent the vertical pitch at the cave entrance.

Description

The entrance of the cave is a pothole of 3 × 5 m. The cave descends for approximately 40 m with a 30° slope till the end of the first gallery. At the bottom pitch, there are attractive travertine formations on the walls. Water, leaking from the crevices, keeps these formations active. Fallen rocks, debris, and guano of roosting bats cover the cave's floor. At the middle of the descent, on the left side, a crack passage leads to the second gallery marked with distinctive guano mounds. At the end of the second gallery, there is a concealed crack that leads to a smaller third gallery. In the third gallery, there are blocked chimneys and other interesting natural formations. At the end of the first and the third galleries, there are very narrow passages leading into small tunnels. One of the tunnels leads to another gallery, 2 m wide and 6-15 m high. A siphon blocks the rest of the cave, most probably, connecting the Kocakuyu cave to the İkigöz cave. Findings of the two cave diving expeditions (1990 and 1992) which explored the İkigöz cave, passed several sinks, and mapped 5 km of an underground cave system, seems to confirm this suggestion. It is interesting that although no others, except for the siphons, entrances to the underground cave system connecting these two caves are known, some bats were seen there. Naturally, there has to be a hidden passage from the surface. As there are several very large galleries within this almost unexplored system, there might be also large, unknown bat roosts.

Map 3. Map of the Kocakuyu cave.



İkigöz Cave

City: İstanbul
District: Çatalca
Locality: Pınarca Village
GPS Coordinates: 0610606 - 4569865
Cave Type: Horizontal & Active

Location

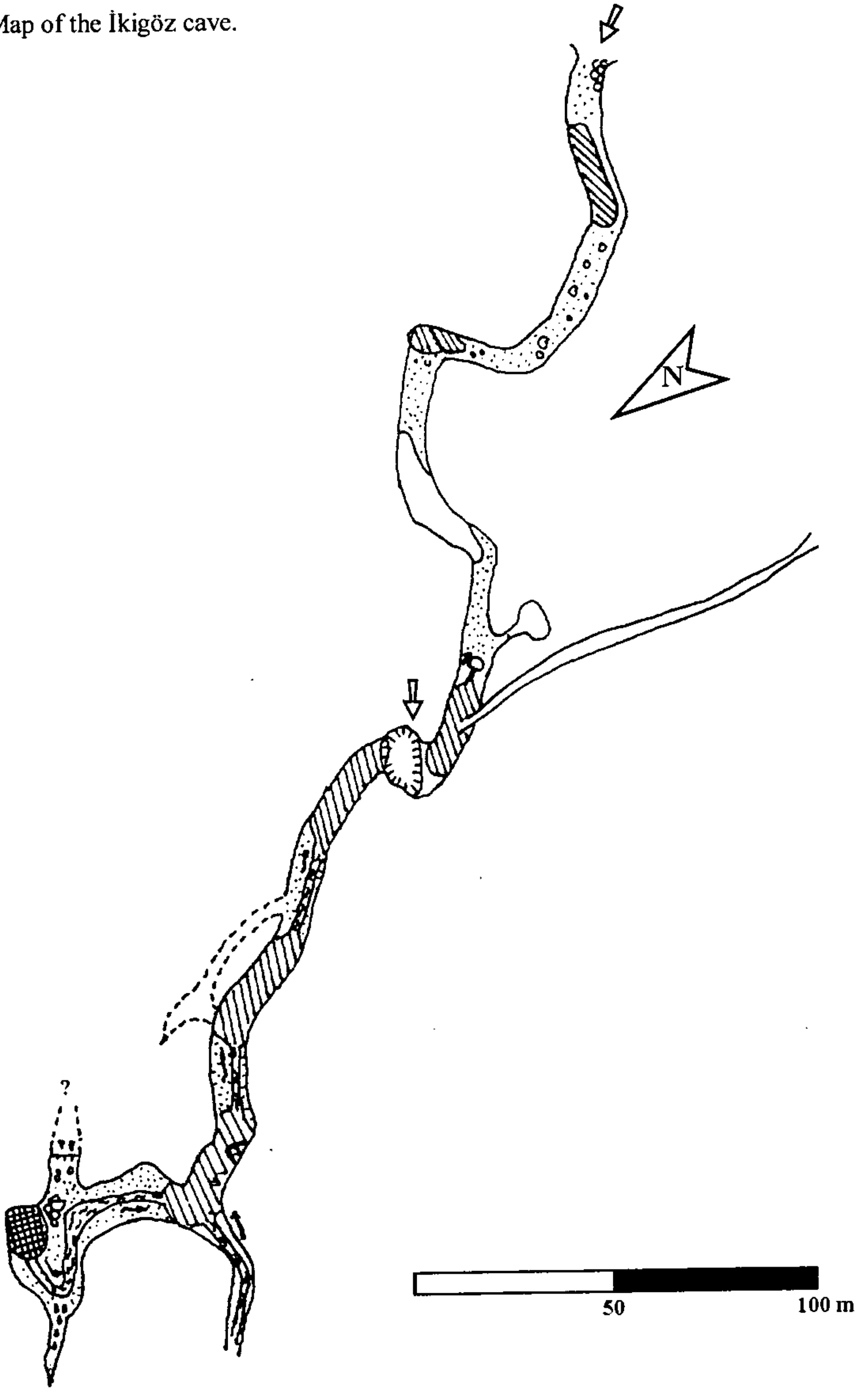
The İkigöz cave can be reached by following upstream the brook passing through the Pınarca village (see the Kocakuyu cave). The water exit from the İkigöz cave is approximately 150 m northwest from the Pınarca village.

Description

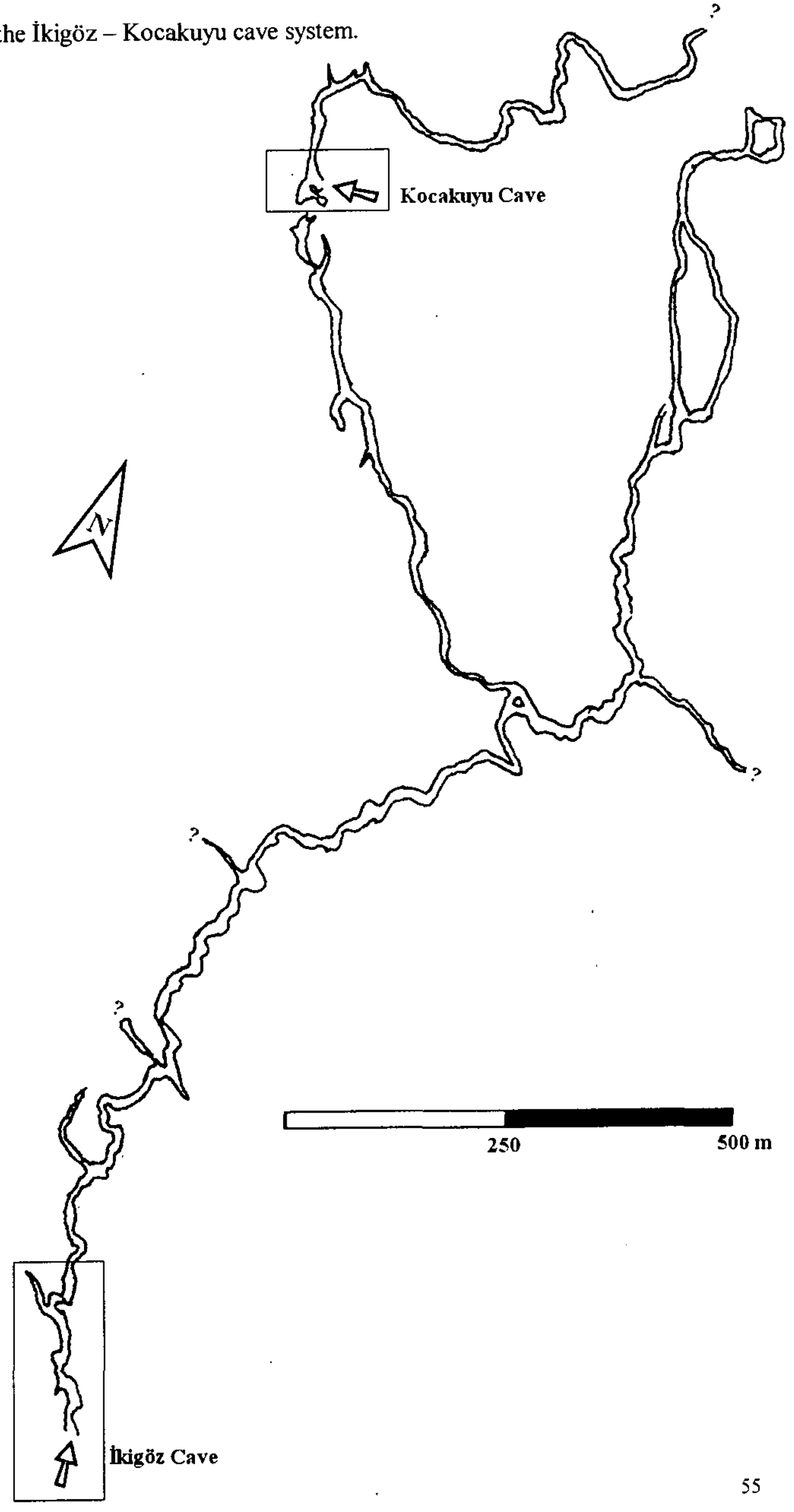
The accessible part of the İkigöz cave is an active gallery, 130 m long and 1,5-2 m high. A stream flows through the gallery. Except for a few sand dunes, the cave's floor is from 0.5-1 m under water. At the end of the gallery, a collapsed chimney forms another entrance to the cave. Two entrances gave the cave its name 'İkigöz' ('two-eyes' in Turkish). The underground stream passing through the cave system is the main drainage system of the area. It had been used as an important water source in the past. There are reminds of the ancient water dike connected to the cave, 2.5 m above the chimney. After passing the chimney, it is very hard to proceed further into the cave. The water, under a low entrance, forms a sink in winter months. In summer, the water level drops and enables a low passage (half a meter), which can only be passed by crawling in water. From this point on, the cave continues for another 100 m and reaches an inclined chamber, which has a permanent sink at its end.

In 1990 and in 1992, two expeditions of cave divers explored the cave system concealed behind the sink. The cave system is approximately 5 km long and includes numerous branches, passages, and galleries. Some of the galleries are very large, reaching a width of 15 m and a height of 20 m. As some bats were seen in the galleries, there have to be concealed cracks or chimneys leading to outside but undiscovered as yet. The galleries, because of their size and isolation, might provide excellent roosts for and host large colonies of bats. One of the branches of the İkigöz cave system is located very close to the Kocakuyu cave, implying that both caves might be a part of the same cave system. As some of the sinks remain unexplored, there is a possibility that these two caves might be directly connected to each other.

Map 4. Map of the İkigöz cave.



Map 5. Map of the İkigöz – Kocakuyu cave system.



Gökçeali Cave

City: İstanbul

District: Çatalca

Locality: Gökçeali Village

GPS Coordinates: 0621552 - 4564047

Cave Type: Horizontal & Fossil

Location

The Gökçeali cave is situated 7 km at the north of Çatalca. It is located within the Gökçeali military zone, which is established at the south end of the village. The road, which goes around the zone, leads to an artificial pond and a small military cafe. The hollow entrance of the cave is approximately 50 m on the right of the cafe. In order to access the cave, a permit has to be taken from the military quarters.

Description

The cave is composed of two large chambers. The entrance chamber is a large hollow, 15 x 7 x 6 m, which is directly affected by the changing outside conditions. From the first chamber, the cave ascends ~2 m and reaches to the inner chamber, 12 x 8 x 6 m. The cave floor is covered with debris and huge amounts of guano. Fallen rock blocks and debris, covered with guano, forms a small hill at the center of the chamber. As the only entrance is at a lower elevation, this dome chamber acts as a warm air trap. Therefore the average temperature stays higher than the ambient temperatures outside.

Yarımburgaz Cave

City: İstanbul
District: Halkalı
Locality: Altınşehir
GPS Coordinates: 646370 - 4548757
Cave Type: Horizontal & Fossil

Location

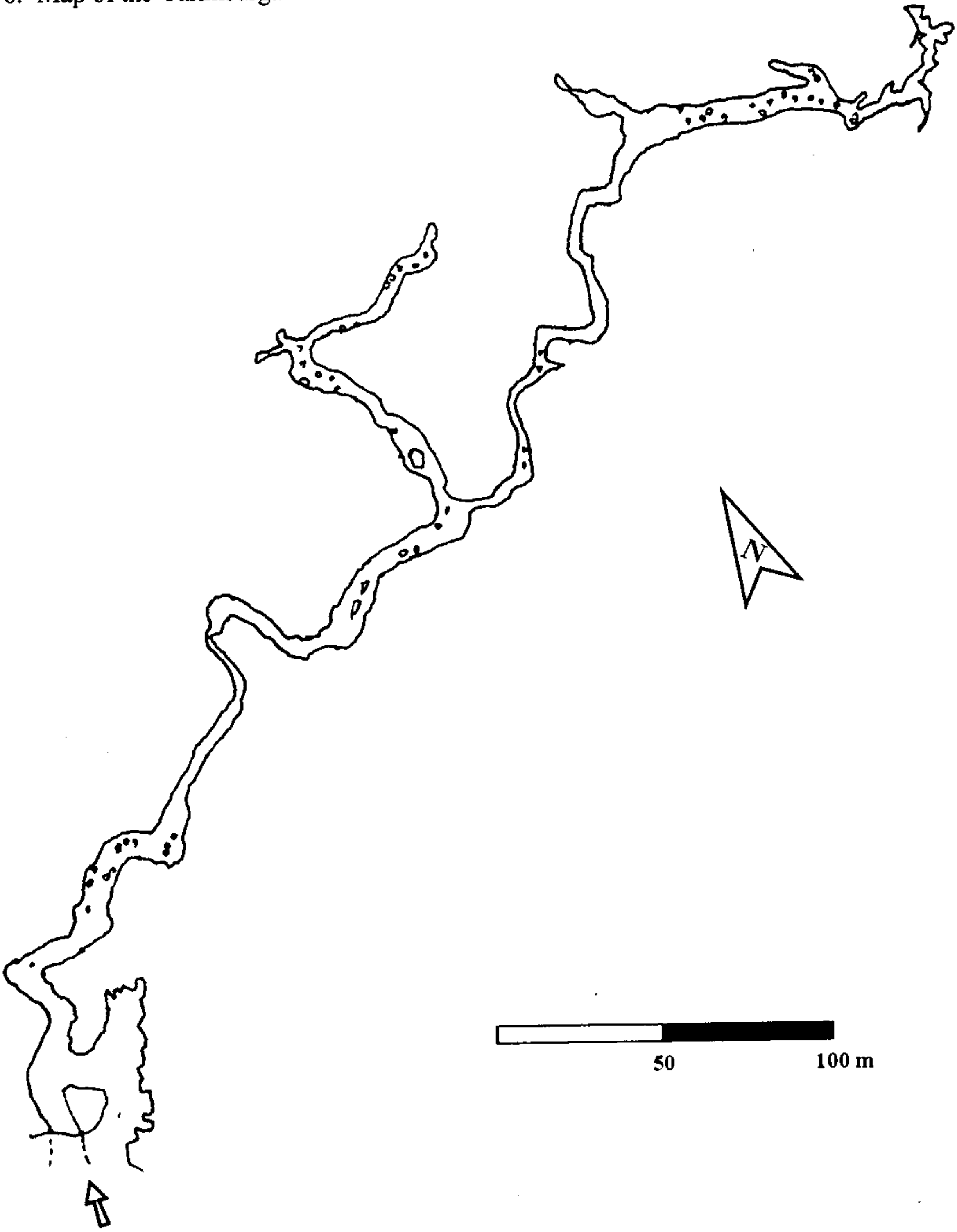
The Yarımburgaz cave is situated 20 km at the west of İstanbul; at the northern edge of the Küçükçekmece lagoon. The cave's locality can be reached from the İstanbul – Halkalı road. The cave is approximately 2 km close to the Altınşehir settlement. One can reach the cave easily by following the signs.

Description

Yarımburgaz is one of the largest caves of the project area. It proceeds approximately 1 km towards northwest. The cave has two large entrances, one situated on top of the other. The largest chamber of the cave is located just after the entrance (40 m x 30 m x 20 m). There are the remnants of a prehistoric church situated in the upper part of the chamber. The entrances are gated in order to protect the archaeological remnants against the treasure hunters and other intruders. However, the gate locks are constantly broken, and the access into the cave is always available. The main gallery proceeds for 100 m, with 7 m width and 7 m height. Further on, the gallery gets narrower and lower to 3m width and 1.5-2 m height. In the first half of the main gallery, there are prehistoric pictures carved on the walls. The gallery gets relatively larger at two more places, close to the middle, and at the end section of the main gallery. In the middle part, there is a side branch to the left, which proceeds for approximately 100 m.

The cave had lost most of its natural conditions due to human interference. Some parts of the main gallery are digged into water arches in order to simulate an underground river during the production of an action film. Moreover, it is constantly being disturbed by intruders.

Map 6. Map of the Yarımburgaz Cave.



Gümüşpınar Cave

City: İstanbul
District: Çatalca
Locality: Gümüşpınar Village
GPS Coordinates: 0608149 - 4573881
Cave Type: Horizontal & Fossil

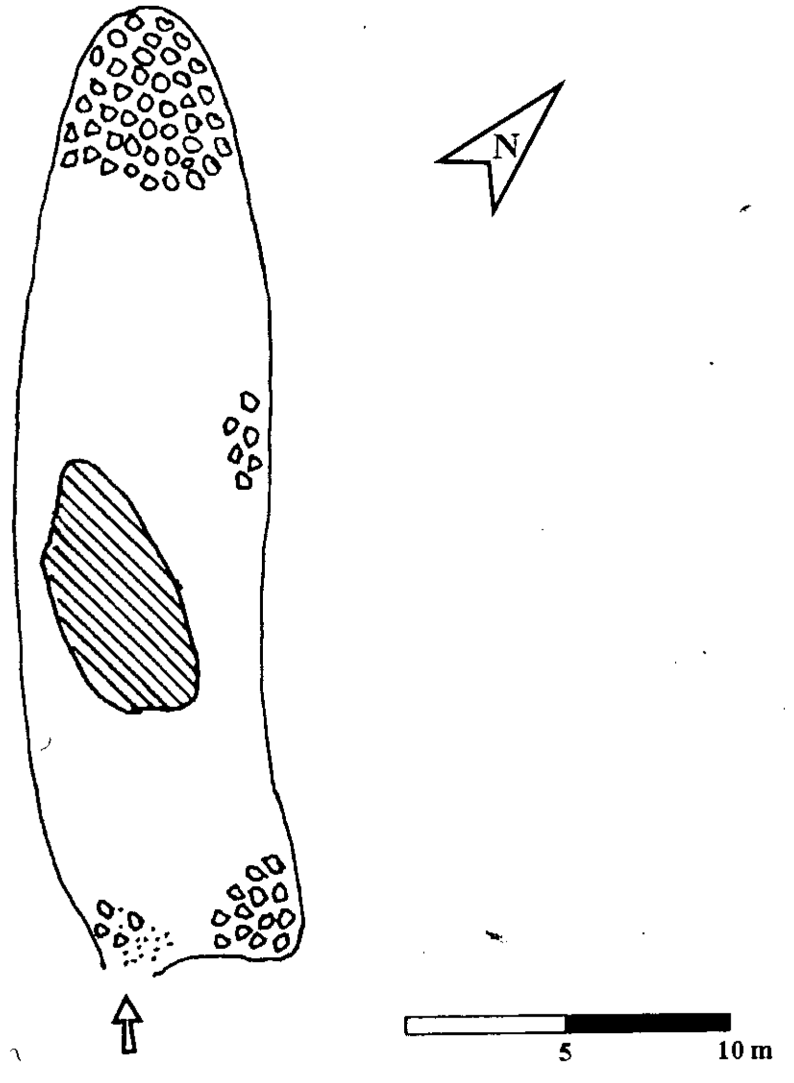
Location

The cave is located near the Gümüşpınar village, which is at 25 km northwest of Çatalca. The cave locality can be reached from the Çatalca – Subaşı – Gümüşpınar road. Just before the village, there is a side road to the right, which leads ~100 m to an old fountain and a fish farm. Behind the farm building, there is a path, which climbs the hill and leads to the cave. The entrance is concealed under the tree group.

Description

The entrance of the cave is a small crack, which is 1.5 m wide and 0.5 m high. The cave is composed of a single fossil chamber (29 m x 9 m x 3 m). There are a few travertine formations on the walls and the ceiling. The cave is used for dumping garbage by the surrounding shanties.

Map 7. Map of Gümüşpınar cave.



Horataşı (Kalaslı) Cave

City: Tekirdağ

District: Saray

Locality: Aycacık Village

GPS Coordinates: 0576626-4594573

Cave Type: Horizontal & Fossil

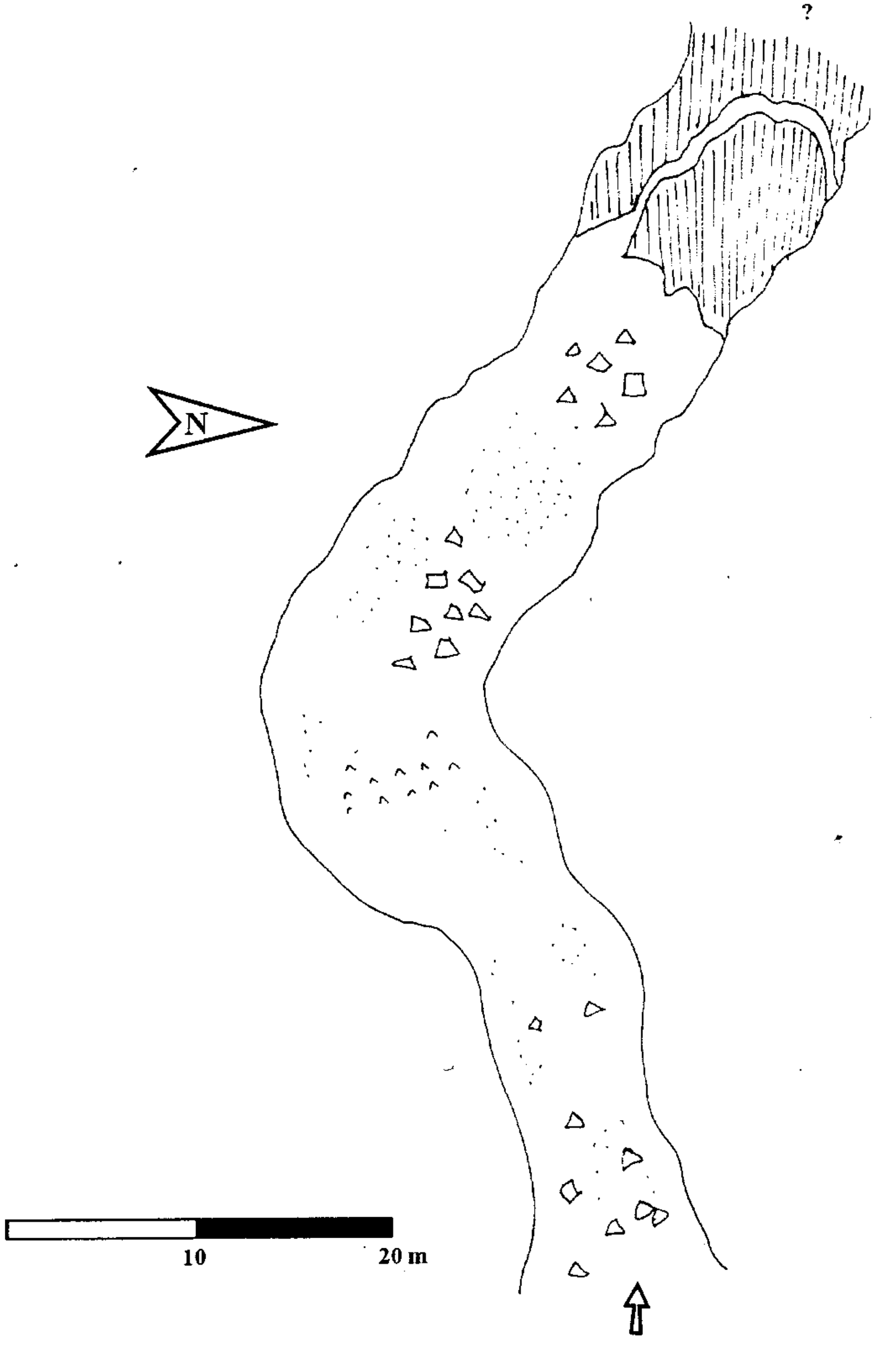
Location

The Horataşı cave is located 8 km at the northwest of the Saray district; on the northern slope of the Yanosman hill and adjacent to the Ayvacık (Ergene) brook. The cave can be reached from the Saray – Vize road, or from the Saray – Ayvacık road. At the fifth kilometer from Saray, there is the Kavacık village. A stabilised road, which connects the Kavacık and Ayvacık villages, passes through the Ayvacık brook in front of the cave. The cave entrance is located 10 m above the riverbed. Approximately 30 m to the right from the Horataşı cave's entrance, there is a small cave, Küçük Kalaslı.

Description

This mostly fossil cave is relatively warm and humid with a few small ponds formed in by the water dropping from the ceiling. Its total length is 65 m, and its deepest point relative to its entrance is –3 m. The cave has a meander profile, which is obstructed at the end by three columns. Rock blocks, debris, soil and guano cover the cave's floor. There are numerous stalagmites, columns, and travertine speleothems. The most spectacular forms are the curtains, speleothem of dripstone in the form of a wavy or folded sheet hanging from the cave's walls and ceiling. The width of the cave varies between 6 and 10 m, whereas the ceiling height changes between 0.5 and 5 m. A final section of the cave is a collapsed hollow with a subsidence of approximately 4 m. Here, there are many small ponds and the floor is covered by a thick layer of guano. The nearby cave, Küçük Kalaslı, is a part of the same cave system. It is a traverse tunnel of 17 m length. It has two entrances – one partly blocked by rocks. A thick layer of soil and debris cover the cave's floor. The cave's width varies between 4 and 10 m, and the ceiling height between 1-2 m. This cave has a strong air current that keeps it drier than the Horataşı cave.

Map 8. Map of Horataşı cave.



Çilingoz Cave

City: İstanbul

District: Çatalca

Locality: Yalıköy

GPS Coordinates: 0601922 - 4597626

Cave Type: Horizontal & Active / Fossil

Location

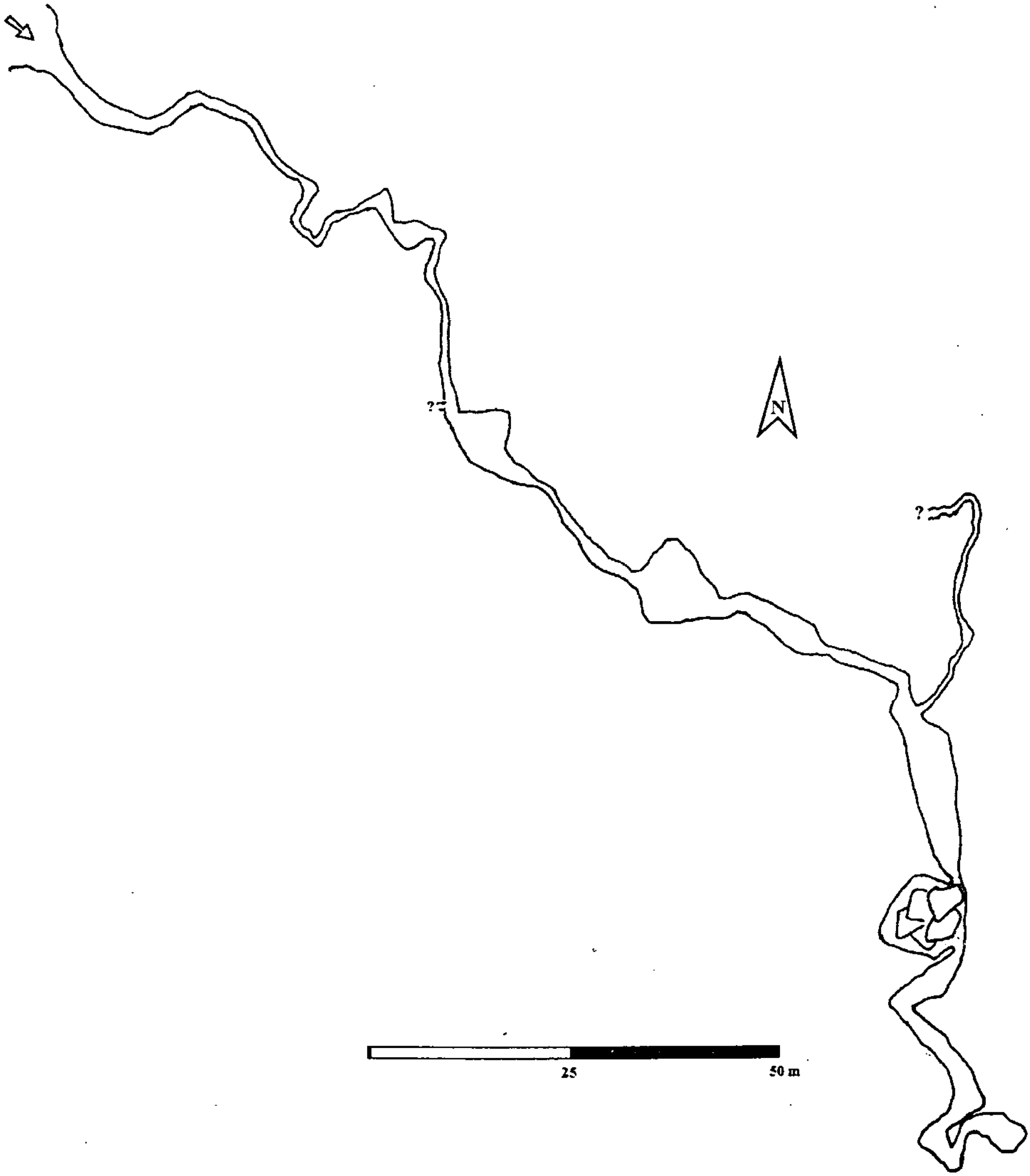
The Çilingoz cave is located at 46 km northwest of Çatalca, and ~10 km northwest of Yalıköy village, along the coastline. It can be reached via Çatalca – Subaşı – Ormanlı – Yalıköy road. In Yalıköy, a stabilised side road to the left, leads to Çilingoz coast. The cave is located inside the rocky formation at the east end of the beech, ~20 m behind the rocks.

Description

The Çilingoz cave is one of the largest caves of this research. It is approximately 600 meters long, and it is composed of a long gallery, which is partially active, and two small side galleries. The ceiling height is well over 8 m in most of the places, occasionally dropping down to 3 meters, particularly close to the end of the cave. The main gallery transects through 3 large domes, where the ceiling is covered with various stalactites. There is a bit of water running down the main gallery, most probably much more active during the winter. There are plenty amount of guano hills throughout the main gallery. By the summer, these mix with the left water, and occasionally forms mud lakes.

There are two entrances, one situated on top of the other, directly faces the sea, therefore the first 20 meters of the main gallery is under direct effect of the outside conditions.

Map 9. Map of the Çilingoz cave.



Sofular Cave

City: İstanbul
District: Şile
Locality: Sofular Village
GPS Coordinates: 0710664 – 4562395
Cave Type: Horizontal & Fossil

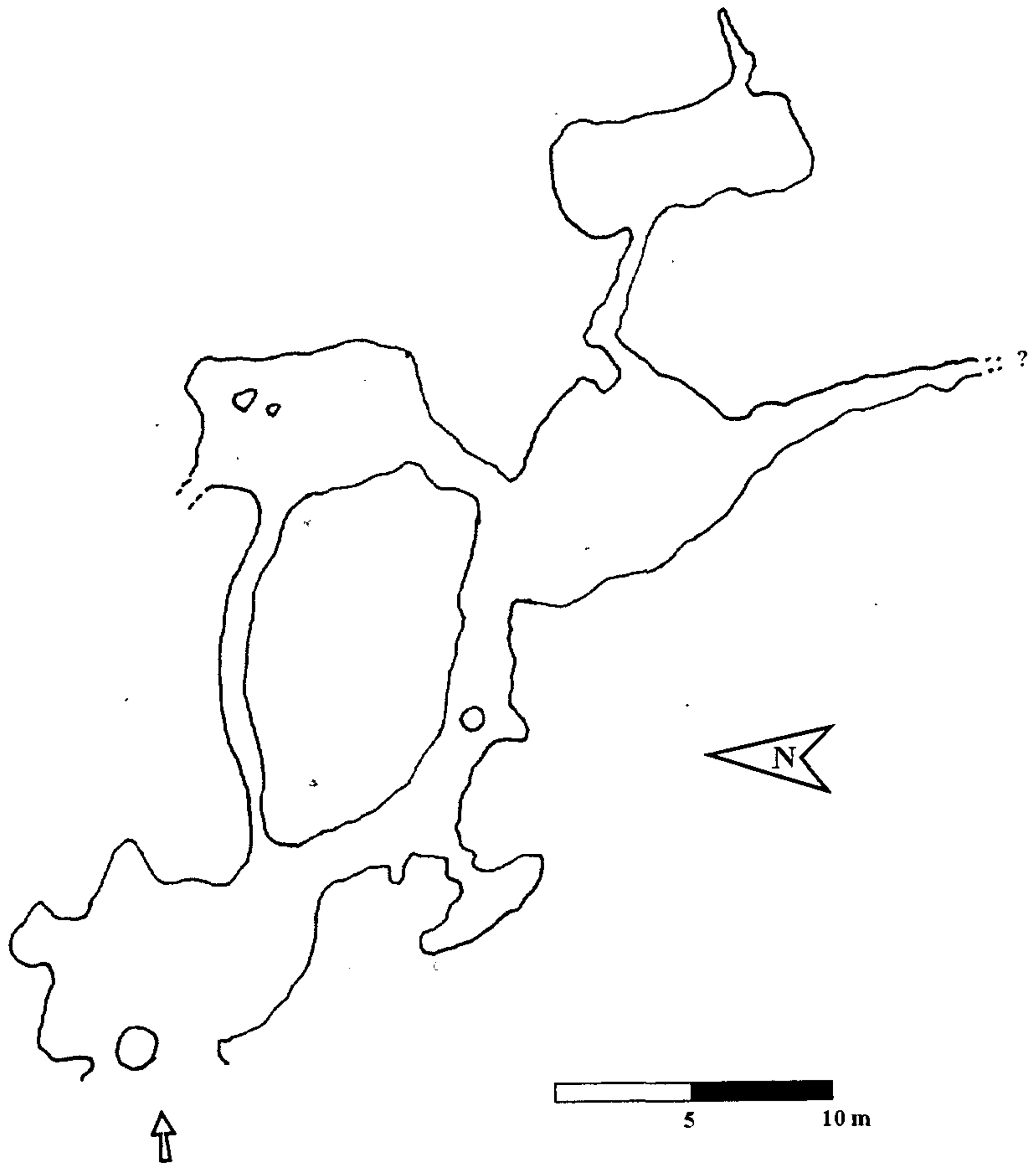
Location

The Sofular cave is situated at the north of the Kızılca and Sofular villages (12 km west of the Şile district). It can be reached by a dirt road that leads from the Sofular village to the seashore. The cave is located inside the rocky formation at the east end of the beach, approximately 50 m inland from the sea line and approximately 200 m towards the east from the Sofular stream entering the Black Sea.

Description

The Sofular cave is a karst formation (a cave formed inside the limestone by the effects of underground waters). The cave is approximately 100 m long. Its entrance chamber is a large hollow, 20 × 8 × 4 m, which is directly affected by the changing environmental conditions such as naval winds or precipitation. The chamber forks into three branches. The right branch is the main gallery. The middle branch is 12 m long and leads to the main chamber through a very narrow crevice. The left branch is a small cavity. The main gallery, which continues for 20 m, gets steadily wider and lower until it reaches the main chamber. The main chamber, 15 × 10 × 4 m, forks further into three new branches. The left branch is a large side gallery, 10 × 5 × 10 m, which ascends 2 m above the main chamber. A bat colony roosts seasonally inside the gallery. It also contains large deposits of guano. The middle branch leads into a smaller chamber, 15 × 5 × 7 m, with coarse stalactites and stalagmites. The right branch is the continuation of the main gallery, which gradually widens and lowers to 10 × 3 × 0.6 m. Although there are water droplets on the walls, and the humidity is relatively high, the Sofular cave is a fossil cave, which completed its main formation process.

Map 10. Map of Sofular cave.



İnkese Cave

City: İstanbul

District: Şile

Locality: Sortullu Village

GPS Coordinates: 0730773 – 4548528

Cave Type: Horizontal & Active + Fossil

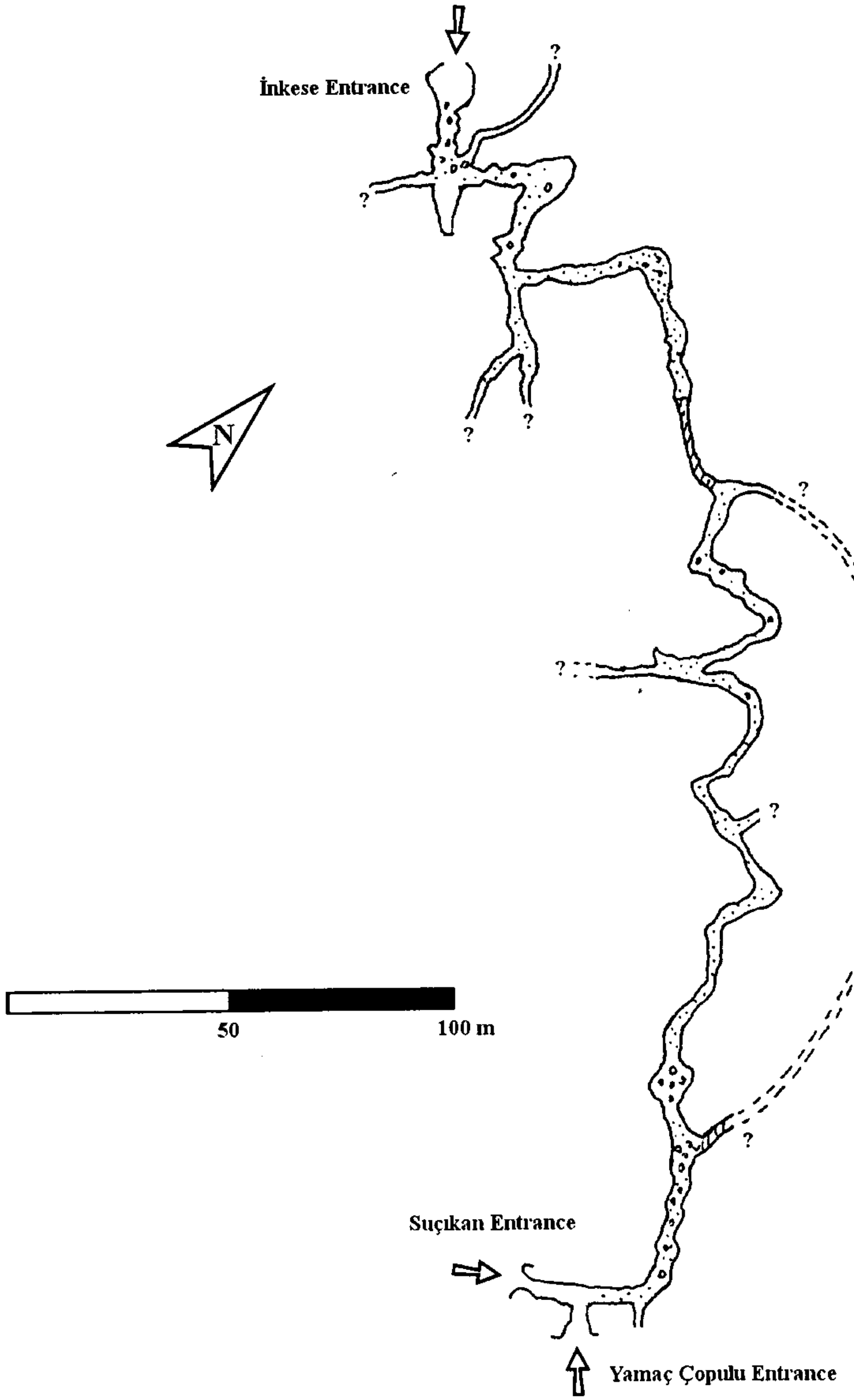
Location

The İnkese cave is situated at the southeast of the Şile district - 1.5 km at the south of the Sortullu village and 3 km at the northwest of the Hacıllı village. The cave can be reached by taking initially the Şile–Ağva road, and then changing it for the road leading to the Osmanköy village. After passing through the Osmanköy and Sortullu villages, just at the entrance to the Hacıllı village, there is a dirt road on the right. The road goes around the Doğanyuvası Hill and passes very close to the entrance of the İnkese cave. The İnkese cave is located inside a low basin, approximately 350 m above the sea level, and is connected to the Suçıkan cave, both caves forming the İnkese-Suçıkan caves system.

Description

The İnkese-Suçıkan caves system is a karst formation, situated on the branch of the Göksu stream, the main stream of the area. The stream enters the caves system in İnkese, from the west-northwest at 250 m (altitude), and exits towards east-southeast in Suçıkan at 170 m. The entrance to the İnkese cave is a pothole of 10 m in diameter. It is situated at the south end of a doline of 200 m in diameter. İnkese is a horizontal cave with slight descends at waterfall points. The cave has an active gallery and a higher fossil gallery, which leads to the Suçıkan cave. The İnkese entrance descends 3 m and leads to a big chamber, 24 × 9.5 × 13 m. Because of the several artefacts and the ancient carved stairs found here, it is believed that the chamber was used as a church in the past. On the right, 8 m above the old carved stairs, there is a 12 m long fossil corridor. At the left of the big chamber, the stream enters the cave, and runs through the main active gallery. The gallery continues for approximately 250 m, its ceiling lowering from the initial 8 m to the final height of 1 m. After the first 18 m, there is a right fossil branch, 27 m long. At the end, the gallery divides into two branches. There is a water sink in the left branch. In the right branch, there is a fossil gallery, approximately 100 m long. It passes through the Yamaç Çopulu pothole, 2 × 3 × 4 m, which intersects the cave as a collapsed chimney. The gallery continues for 50 m more in a relatively active gallery (3 m wide and 12 m high), and ends at the Suçıkan entrance. Except for the fossil gallery which connects İnkese and Suçıkan caves, the cave system is still active in its formation process.

Map 11. Map of the İnkese cave.



Yukarıkışla Cave

City: İstanbul

District: Şile

Locality: Sortullu Village

GPS Coordinates: 0730508 - 4548563

Cave Type: Horizontal & Fossil

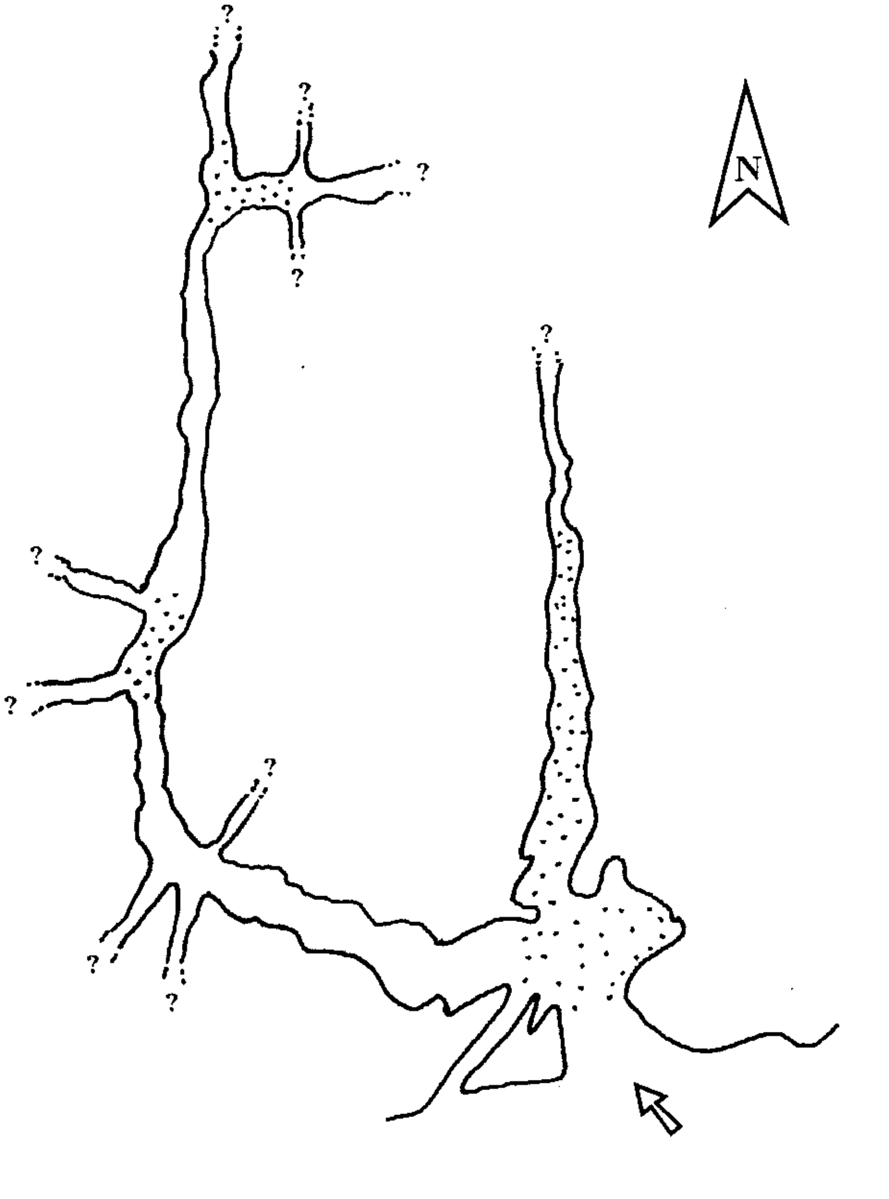
Location

The Yukarıkışla cave is situated ~200 m at the west of the İnkese cave. The entrance, located inside dense shrub, can be reached by a path, which starts from the western edge of the woodland clearing around the İnkese cave's entrance.

Description

Yukarıkışla is a fossil cave, which is composed of two horizontal galleries. Its entrance is 2 m wide and 1.5 m high. The right gallery, which is ~15 m long, starts with 1 m width & 1 m height, and gradually gets narrower until it is impassable. The left gallery is relatively longer (~40 m), and it proceeds with a 3 m height and 1.5 m width, between the collapsed rock blocks. After the first 20 m, the gallery ascends ~2.5 m, and proceeds as a fossil tunnel, which is 30 cm high and 1.5 m wide. Although bats were observed flying through this tunnel, no further investigation could be accomplished.

Map 12. Map of the Yukarıkışla cave.



Gökçeören Cave

City: Kocaeli

District: Gebze

Locality: Village

GPS Coordinates: 0752515 - 4526380

Cave Type: Horizontal & Active / Fossil

Location

The Gökçeören cave is located close to Hacıoğlu village, which is at 15 km north of İzmit. In order to reach the cave locality, one leaves İstanbul – Ankara highway (T.E.M) from the Kandıra exit. On the İzmit – Kandıra road, there is poplar afforestation and a subsequent small village on the left, approximately 5 km after the T.E.M exit. One has to take the side road to the left, which is at the end of the poplar field. Approximately 2 km further, an earthen road to the right goes nearby a small dam and through Hacıoğlu village. After passing the village, a truck road proceeds on the right slope of a valley. Approximately 4 km further, where the road descends to the riverbed, a side path to the left leads to a small opening by the brook. A trail across the brook, climbs ~15 m and reaches the cave entrance.

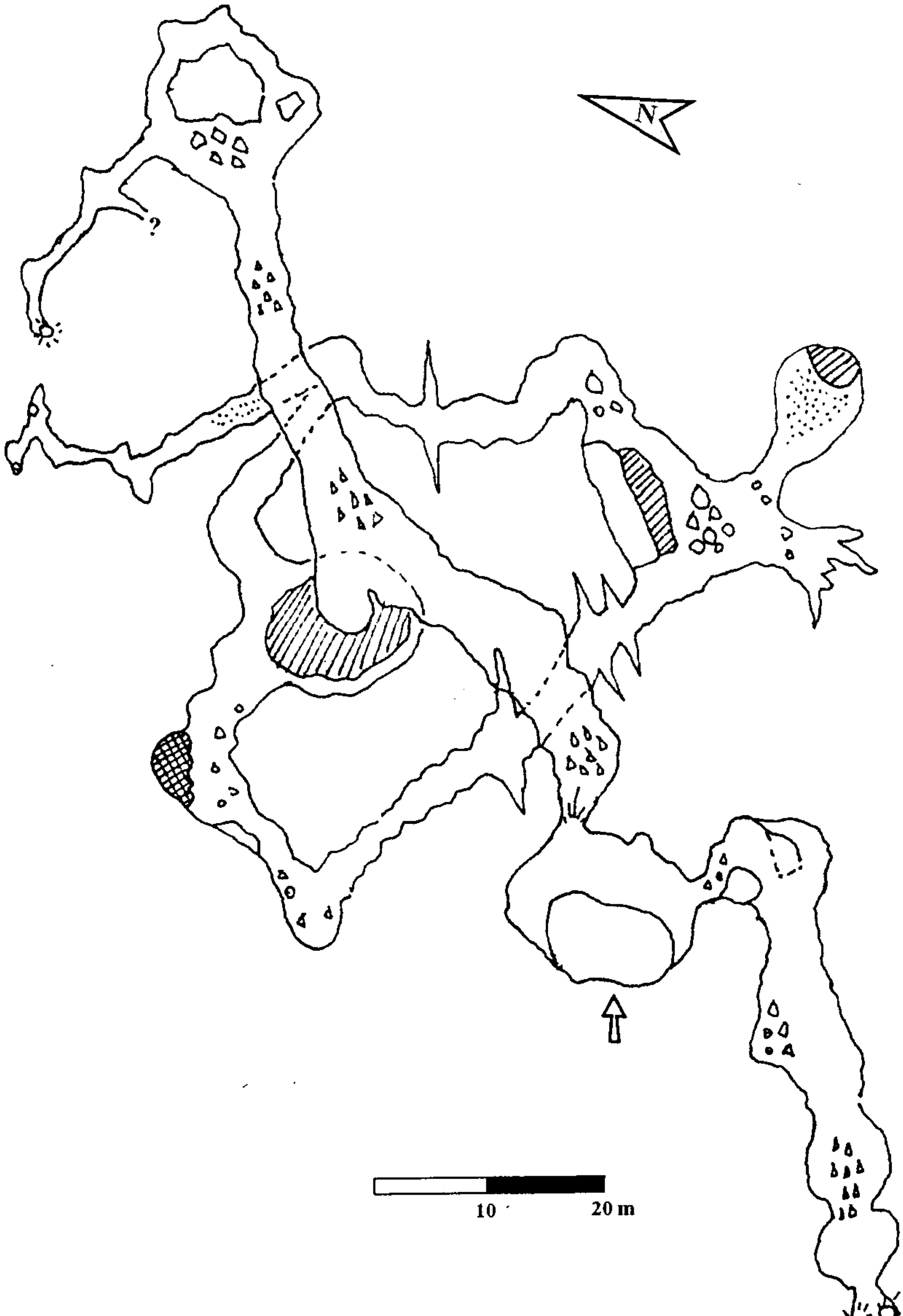
Description

The Gökçeören cave has quite a complex system. It is composed of an upper fossil and a lower active gallery, which is 200 m long in total. The entrance pothole, which is 3 m high, is close to the middle of the upper fossil gallery, and it divides the cave system into two sections. The right section is a 30 m long fossil gallery. Here, the floor is covered with collapsed rocks and debris, and the ceiling height is changing between 2.5- 1.5 m.

The left section is a relatively larger gallery (40 x 4 x 4 m), which is connected to the lower gallery through a crack. At the end of this gallery, there is a higher chamber (9 x 8 x 9 m), to which a 15 m long tunnel, and a 20 m long circuit is connected. On the ceiling of this chamber, there is also a chimney, from which long tree roots are suspended into the cave.

At the middle of the second section, one can pass from the higher fossil gallery to the lower active gallery via a crack on the left. The lower gallery is a circuit which is ~70 m long. It crosses a chamber on the left, where the ceiling height reaches 9 m. There are three sinks in the lower active gallery, and one of them is situated at the end of this chamber. The other two sinks are situated ~30 m further. The last one is an active sink, and it drains the underground water to the outside brook.

Map 13. Map of Gökçeören cave.



Deliklibent Tunnel

City: Kocaeli

District: Gebze

Locality: Kozluca Village

GPS Coordinates: 0730508 - 4548563

Cave Type: Horizontal & Artificial

Location

The Deliklibent tunnel is ~15 km at the north of Gebze, between the Çalköy and Alihocalar villages. Çalköy can be reached from the Gebze - Mollafeneri – Cumaköy road. In Çalköy, the road to Alihocalar has to be taken. At the 3rd kilometer of the road, a path to the left goes over the ridge, through which the tunnel runs. The second path on the right, descends down to the field, and leads to the entrance of the tunnel. The other entrance is at the other side of the ridge.

Description

Deliklibent is an old, human-made tunnel, which was built for transferring water from the stream, to the other side of the ridge with the help of a mill. Its total length is ~60 m. The first 30 m of the tunnel is 4 m high and 0.5 m wide. The other half is lower; 1 m high, and 0.5 m wide. There is ~30 cm high muddy water on the ground

MICRO-HABITATS AROUND THE CAVES

Yaylacık Cave

Tall scrub comprises the most dominant vegetation around the cave. Meadow is the next most abundant habitat type. There is a riparian treeline along a stream. There are treelines present in some distance from the stream. Edges are present along the tall scrub/meadow interface. There is a small village whose inhabitants practice traditional agriculture. Single fruit trees are seen within the village.

Kocakuyu & İkigöz Caves

These two caves constitute the two ends of one bigger cave formation, which is cut at intervals by siphons. Therefore the habitat around them is described together. The tall scrub constitutes the most abundant vegetation type within the area. Next, deciduous woodland, meadow, and arable land on which intensive agriculture is done are the most frequent habitat types. There are also woodland clearings and riparian treeline along a stream. Sub-urban areas in which traditional agriculture is done, edge, and single fruit trees are present in the vicinity.

Gökçeali Cave

The most frequent types of habitat are deciduous woodland, tall scrub, and intensive arable land. Traditional arable lands, coniferous woodland (artificial), maquis, pasture, single trees and extensive tree lines are also present. Riparian vegetation around a stream is composed of hedgerow and forms treelines. There is an artificial pond nearby. Edges exist at the tall scrub/deciduous woodland and pasture interfaces.

Horataşı Cave

The deciduous woodland, tall scrub and meadow are the most abundant habitat types. The deciduous woodland has several clearings, and edges are caused by the presence of meadow next to the deciduous woodland and tall scrub formations. There is a stream with treelines on its fringe. A treeline aggregation is also notable away from the stream. A bog, situated about 50 m from the mouth of the cave, is full of insects. There are a few small ponds in the vicinity. Fields where traditional agriculture is done are occasionally present.

Çilingoz Cave

The cave and its habitat are located in a valley covered with deciduous, coniferous, and mixed forests. Quercus was the most dominant tree genus there and Carpinus, Fagus and Pinus were the most abundant genera. The pseudomaqui elements cover the areas from which oak, beech and pine trees were removed. There are also tall scrubs, moorland, meadow, woodland clearings and edges. Riparian hedgerow and treeline are present along a stream. There is a small water reservoir. An artificial sub-urban area is used as a recreational site in summer.

Sofular Cave

The habitat around this cave is the richest in the Kocaeli region. Both, coniferous and deciduous woodlands are present. Maquis are present in places where the woodland was destroyed. The mouth of the cave faces a coastal zone. Pasture and heathland are occasionally present. A stream that runs through the coastal zone and reaches the sea, has a treeline and hedgerow on its banks. Edges and woodland clearings are formed between woodlands and pasture.

İnkese and Yukarıkışla Caves

Tall scrub is the dominant habitat type around these caves. Single trees, heathland and pasture cover a large area. Deciduous woodlands are present occasionally. There are hedgerows and riparian treelines along a stream that flows into the cave. Edge exists mainly between pasture and tall scrub.

Gökçeören Cave

Tall scrub comprises the most abundant habitat type of the region. Pasture, maquis and a water reservoir nearby cover the next largest area. There is a stream with riparian treeline and hedgerow. Treelines and single trees are frequent. There are two villages nearby the cave whose inhabitants practice both traditional and intensive agriculture. Edges are formed between tall scrub and pasture.

Deliklibent Tunnel

Tall scrub and agricultural land (intensive) cover the largest area around the cave. Maquis and pasture are abundant. An urban area is present nearby. Riparian hedgerows and treelines are present by a stream. Extensive edge is notable at the tall scrub-pasture interface.

CAVE-DWELLING BATS OF THE ÇATALCA – KOCAELİ REGION

In this section, the general characteristics and niche preferences of the ten cave dwelling bat species that inhabit Çatalca-Kocaeli region are described.

Genus *Rhinolophus* (Lacepéde, 1799) – Horseshoe Bats

Out of 69 existing species of this genus, five are found in Europe. They inhabit both caves and human-made structures. Their wings have low aspect ratios allowing them to exploit cluttered environments while exhibiting manoeuvring flight (Schoeber and Grimmberger 1997; Schnitzler and Kalko, 1998). The females of this genus have two false teats that develop after reaching maturity and to which the newly born offspring can cling with their mouths. The juveniles stay within the wing membranes of their mothers, which can be partially or completely wrapped around their body. The ears, which lack a tragus, can move independently of each other in order to receive the reflected echolocation signals emitted through the nose (Schoeber and Grimmberger 1997).

Four horseshoe bat species that were recorded in the survey area are *Rhinolophus hipposideros*, *R. ferrumequinum*, *R. euryale* and *R. mehelyi*.

Rhinolophus hipposideros (Bechstein, 1800) – The Lesser Horseshoe Bat

R. hipposideros is the horseshoe bat with the northernmost distribution. It inhabits relatively warmer regions in mountains, forests, limestone formations and sometimes houses. It can be classified as a house bat at the northern latitudes and as a cave bat at the southern latitudes. In winter, from September to late April, *R. hipposideros* hibernates at 6-9°C without forming clusters and at high relative humidity (up to 100%). The females mature at the end of the first year, and mating takes place in autumn. The young are given birth from mid-June to early July. In summer, the females form maternity colonies of 10-500 individuals that disband in August. *R. hipposideros* is frequently found together with *M. myotis* and *M. emarginatus* in the roosts.

R. hipposideros is a non-migratory species and does not move more than 5-10 km between the winter and summer roosts. Due to its small size, it is a relatively fast flier hunting in open forests, preying on small moths, mosquitoes, crane flies, beetles and spiders. Although its dominant strategy is gleaning, it can also hunt by aerial hawking and by pouncing on ground.

Rhinolophus ferrumequinum **(Schreber, 1774) – Greater Horseshoe Bat**

R. ferrumequinum inhabits warmer regions with trees and shrubs (where running or standing water is available), karst formations and houses. Similarly to *R. hipposideros*, it is a house bat in the north, and a cave bat in the south. It rarely forms clusters, preferring temperatures between 7-10°C in winter. Hibernation takes place from September/October to April. The females and males reach maturity at two years. Mating usually occurs in autumn, but also during hibernation period. The young are born between June to mid-July in the summer roosts, which are occupied by both the males and females. They are ready for flight at 3-4 weeks and are totally independent at 7-8 weeks, about mid-August when the maternity colonies disband. It is found frequently together with *R. euryale* and *M. emarginatus*.

R. ferrumequinum is a permanent resident, migrating at most 20-30 km between summer and winter roosts. It is a relatively slow flier, foraging and hunting around open tree stands, rock faces, and gardens, preying on June beetles, carrion beetles, grasshoppers, and moths by gleaning or perching.

Rhinolophus euryale **(Blasius, 1853) – The Mediterranean Horseshoe Bat**

R. euryale has a southern range bordered by the Balkan's and Mediterranean Sea, and a northern range of Austria, Slovakia and Southern France. It is a cave bat, which forms maternity roosts of 50-400 females in summer. Winter roosts are caves or tunnels in which the temperature is around 10°C. It hibernates singly or maintaining body contact with con-specifics. It is a sedentary species, frequently found together with *M. emarginatus* and *M. schreibersii*.

R. euryale forages on hillsides, within relatively dense tree or shrub cover that have a fresh water supply nearby. Using its slow, fluttering flight, it can hover and feed on moths and other insects.

Rhinolophus mehelyi **(Matschie, 1901) – Mehely's Horseshoe Bat**

The information about the distribution of this species in Europe is sketchy. *R. mehelyi* is a cave bat, which roosts in karst formations that have access to water. It forms maternity colonies of up to 500 females. It hunts on warm mountain slopes, among shrubs and trees, using a similar flight style to the *R. euryale*. *R. mehelyi* feeds on insects and moths. It is frequently found together with other horseshoe bats, *M. blythii* and *M. schreibersii*.

Genus *Myotis* (Kaup, 1829) – Little Brown Bats

This genus comprises 90 species, 10 of which inhabit Europe. They use FM frequency signals for echolocation and have a relatively low wing aspect ratio that makes it possible to exploit cluttered environments. They use forests as well as caves and human-made structures as roosts.

Myotis daubentonii **(Kuhl, 1817) - Daubenton's Bat**

M. daubentonii is present almost everywhere in Europe except for Northern Scandinavia and North Scotland. It is mainly a forest bat that spends the winter in caves or human made structures. Its temperature preference for hibernation, which takes place between late September to late April, is 0-6°C. It is occasionally found in temperatures below 0°C. *M. daubentonii* also likes high humidity. Some winter roosts contain up to 1000 individuals. Females mature at the end of the first year. Mating starts in September and continues during the winter. The young are usually born in the 2nd half of June. Maternity roosts that have been recorded to contain 200 individuals disband in August. *M. daubentonii* is a partial migrant that can travel around 100 km between summer and winter roosts.

M. daubentonii is a fast and agile flier; hunting 5-20 cm above water and around trees, feeding mainly on mosquitoes, crane flies and moths.

***Myotis capaccinii* (Bonaparte, 1837) – Long fingered Bat**

M. capaccinii inhabits the Mediterranean and Balkan countries in Europe. *M. capaccinii* maternity colonies are within caves, consisting of up to 500 females. In winter it is usually found in crevices or in caves. It prefers forested and shrubby landscapes near water, feeding especially on flying insects caught above the water surface.

***Myotis emarginatus* (Geoffrey, 1806) – Geoffrey's Bat**

M. emarginatus inhabits Central and Southern Europe. Its nursery roosts are attics of houses in the northern latitudes of the temperate zone, and caves and mine galleries in the southern latitudes. *M. emarginatus* hibernates between October and April. Its winter roost temperature preference is 6-9°C, the number of the roosting individuals changing between 20-2000 individuals. Most hang singly, and they are rarely seen in clusters or crevices. Mating takes place mainly in autumn. The young are given birth from mid-late June to early July. The maternity roosts disband in September. It is frequently found together with horseshoe bats in roosts. *M. emarginatus* is mainly sedentary, its movements between summer and winter roosts being less than 40 km.

M. emarginatus feeds mainly on brown lacewings, diptera, hymenoptera, moths and caterpillars taken from branches, leaves or ground.

***Myotis myotis* (Borkhausen, 1797) - Greater Mouse Eared Bat**

M. myotis has been recorded in entire Europe except Ireland, Denmark and Scandinavia. It is a warmth loving species. In summer it chooses roosts with temperatures near 45°C, in winter the temperature range is 3-12°C. It can be found both hanging singly or in clusters (100-4500 individuals), inhabiting holes in the walls, ceilings of caves and although rarely, narrow cracks. It hibernates from September to April. Breeding starts in August, but it can also take place in winter, during hibernation period. One male usually has a harem composed of a few females. Females give birth around early June.

M. myotis is a partial migrant with a range of about 50 km. *M. myotis* prefers light wooded areas, meadows, open stands of trees, forested habitat, parks, fields and towns. It has a slow, fluttering flight about 5 to 10 m from the ground. *M. myotis* feeds on carabid beetles, cockchafers, dung beetles, moths caught in flight, and non-flying beetles, spiders, grasshoppers and crickets taken from the ground.

***Myotis blythii* (Tomes, 1857) - Lesser Mouse Eared Bat**

The information on the distribution and habits of this species is sparse. In winter, it usually hangs singly, preferring temperatures between 6-12°C. Maternity colonies of *M. blythii* (composed of up to 5000 individuals) are located in caves, usually with *M. schreibersii*, *M. myotis* and horseshoe bats. Mating takes place in fall, and sometimes also in spring. The males can have harems. It is a partial migrant similar to *M. myotis*.

M. blythii prefers to forage in open stands of trees and shrubs that are not too dense, parks and sometimes urban areas. It feeds on moths and beetles taken from ground or air.

Genus *Miniopterus* (Bonaparte, 1837) – The Bent-winged Bats

This genus, which has ten species in the world, is represented by one species in the temperate zone Europe. They are fast fliers with high wing aspect ratios that forage in uncluttered environments. They are mainly cave dwellers.

***Miniopterus schreibersii* (Kuhl, 1817) – The Bent-winged Bat**

M. schreibersii inhabits southern and eastern Europe. It is a cave bat, which forms big clusters (between 1000-4000 individuals), especially in the summer roosts. In the winter, it hangs freely or forms clusters, preferring temperatures between 7-12°C. It hibernates from October to late March. Mating takes place in fall, and contrary to the other temperate species, fertilisation is immediate, but the development of the egg stops in the blastocyst stage. The young are born between late June to early July.

M. schreibersii is a very fast flier; its flight speed is 50-55 km/hr. Due to its wings that have high aspect ratios, it is a migratory species that can migrate around 100 km. It hunts in open and rocky landscapes, feeding on moths, gnats, and beetles.

ROOST UTILISATION

In general, all European bats have similar roost utilisation patterns. Four different types of roosts can be distinguished according to their biological needs; winter roosts, transient roosts, maternity roosts, and mating roosts. A general term "summer roost" has become established for the latter three types of roosts.

Species utilise winter roosts in order to hibernate, often forming large colonies of thousands of bats in a single roost. In some species, males hibernate singly, separate from the crowded female colonies. The winter roosts are typically uniform. They must meet the following requirements: (1) the temperature must not, at least in some parts of the cave, fall below 0°C, (2) the relative humidity must be high (up to 100%), and (3) there must not be any draft. In their winter roosts, certain species hang freely exclusively (horseshoe bats) or predominantly (mouse-eared bats) from the ceiling. Other species hang from the walls or seek out cracks in the walls, sometimes even in the rubble on the bottom of the caves (Schrober and Grimmberger, 1997).

When bats awake from hibernation, they seek out day or temporary (transient) roosts in which they generally stay for only a few weeks. In these temporary roosts there are mainly individual bats, and sometimes small groups. These transient roosts are utilised by bats on their migration from the winter roosts to summer roosts. For transient roosts, cave bats seek out not-too-cold natural caves, tunnels, or crevices. However, they also make use of a whole series of typical day roosts (Schrober and Grimmberger, 1997).

Maternity (nursery) roosts are shared by a large number of female bats for a period of several months. The females give birth to and rear their young there. The males of many species live alone in their day roosts during this time. Maternity roosts usually are larger than day roosts. The maternity roosts of cave-dwelling bats are always located in the warmest part of the cave. They can contain more than a thousand individuals that, depending on the species, hang close together on the ceiling, either uniting in fairly large groups or filling niches in the cave. After the maternity roosts disband, the males and females come together to mate. As a rule, the mating roosts do not differ from the day roosts (Schrober and Grimmberger, 1997).

In northern and central Europe, where the migration covers large distances between winter and summer sites, the four types of roosts are usually spatially separated. On the other hand, in the milder climate of southern Europe, the same bat species can live throughout the year in a single roost (Schrober and Grimmberger, 1997).

Speciation within the European bats, led to the specialisation over different roost conditions. Each species possess different tolerance intervals for humidity, temperature and other factors. As a result, slightly different patterns can be seen in their roost utilisation.

In determining the conservation status of each roost, assessment of how they are utilised and by which species, takes the precedence. In this section of the report, the field data is interpreted to the most reliable extend, in order to draw basic utilisation patterns. The field data is based on the counts within the caves in subsequent seasons, which is given in a table at the beginning of each section, and notes taken during the surveys. Six of the caves were surveyed three times, three caves were surveyed two times, and two caves were surveyed once. Field studies were performed during early spring (1999), mid-summer (1999) and late winter (2000).

Before making any interpretations, the following assumptions were made: (1) bat species did not show dramatic population fluctuations over a one-year period, from 1999 to 2000, and (2) each bat species continue its yearly roosting cycle without showing any dramatic changes. Therefore, the survey data was interpreted in the seasonal order as late winter, early spring and summer, regardless of their year. For example, in Kocakuyu cave, two surveys were held on 13 March 1999 and 18 February 2000. The *R. ferrumequinum* counts were 27 and 105, respectively. Concerning the first assumption, *R. ferrumequinum* population was not interpreted as having a fourfold population increase in one year. Concerning the second assumption, *R. ferrumequinum* colony was thought to be hibernating in the cave during the winter, and already leaving the cave by March. Moreover during the summer survey, held on 7 July 1999, there were no *R. ferrumequinum* in the cave. This data is used as complementary to the interpretation that, *R. ferrumequinum* utilises the cave as a winter roost.

However, in some of the caves, in which less than three surveys were performed, such reasoning is less solid. Our analysis would be much more reliable, if there would be more surveys held in these caves. Nevertheless, we believe that a general utilisation scheme for each roost can be acceptably deducted from this research.

Yaylacık Cave

	25 Mar (99)	5 Jul (99)	24 Feb (00)
R. ferrumequinum	13	0	9
R. hipposideros	0	0	1
M. schreibersii	1400	1400	1
M. myotis/blythii	6	200	3
M. capaccinii	150	1	0

The cave was surveyed three times. The surveys showed that the Yaylacık cave was utilised mainly during the summer, although a few bats stayed there over the winter to hibernate. During the spring and summer surveys, the bats were aggregated mainly in the dome chambers deeper in the cave, where the temperature stays relatively constant due to low air convection. During late winter, only a few individuals of *R. ferrumequinum* and *M. myotis/blythii* were seen hibernating inside the active gallery. The higher dome chambers, while crowded in the summer, were abandoned during late winter. This is probably due to the high temperatures above the hibernation tolerance levels.

A few males (9-13) of *R. ferrumequinum* were hibernating inside the cave. They seemed to prefer the lower and cooler perches of the chambers. On the other hand, two bats were also found in the active gallery. None were recorded during the summer survey.

In the late winter, there was one *R. hipposideros* individual found hibernating inside a small crevice at the entrance chamber. None were observed during the spring or summer surveys.

In the late winter, there were not any *M. schreibersii* in the cave. However, from March until the end of summer, the cave hosted a nursery colony of ~1400 individuals. There were two big nursery colonies residing in one of the dome chambers, and in a relatively smaller dome close to the end of the cave. In the former, the larger colony was composed of only *M. schreibersii*, whereas in the latter, *M. schreibersii* nursery was mixed with *M. myotis/blythii* nursery.

While there were only a few male *M. myotis/blythii* hibernating during the winter, the cave hosted a nursery colony of ~200 *M. myotis/blythii* individuals in the summer. This colony arrived at the cave later than the *M. schreibersii* colony, and formed a mixed nursery with them, inside the warm air trap at the end of the cave. During the visit it was observed that most females had already babies. Seven individuals were found floating dead in the water. They didn't seem to have suffered from any physical injury or starvation. Although bats are able to swim, difficulties in flight through the long and narrow gallery of Yaylacık might have exhausted some of them, resulting in their drowning.

It is difficult to comment how *M. capaccinii* utilises the cave. In early spring, the cave hosted a large group of 150 individuals that was already active. In late winter and summer no individuals were present. This species might be utilising the cave as a transient roost, to which it arrives after arousal from hibernation. Or the colony might be hibernating inside the concealed chambers that we couldn't access and survey.

During the survey held on 25.3.99, ~2000 bats were recorded inside the cave. However, during the exit counts, 3000 bats were counted flying out of the main entrance. The difference suggests that there are most probably some concealed roosting places in the cave.

The cave's spring and summer residents, *M. myotis/blythii* and *M. schreibersii* might be coming from a nearby hibernation site, the Kocakuyu cave, which at the same period is deserted by large colonies of *M. myotis/blythii* and *M. schreibersii*.

Kocakuyu Cave

	13 Mar (99)	7 Jul (99)	18 Feb (00)
R. ferrumequinum	27	0	105
R. hipposideros	27	0	0
M. schreibersii	1450	50	300
M. myotis/blythii	2100	400	3280

The cave was surveyed three times. Although, the Kocakuyu cave seems to be an inadequate summer roost, due to its inclined profile that acts as a cold air trap, its low temperature and high humidity makes it a suitable hibernation site. Consequently, crowded colonies of different species were found hibernating inside the two main chambers.

During the early spring survey, there were 27 *R. ferrumequinum* individuals in the second chamber. In the following season's survey, they were absent suggesting that they had migrated to a nearby summer roost. The closest known *R. ferrumequinum* nursery, the Sofular cave, is at the other side of the Bosphorus (101 km away), out of the bats migration range. There should be an unknown summer roost in the close proximity. During the late winter survey, a colony of 105 individuals had returned and were hibernating in a loose cluster. Therefore, *R. ferrumequinum* seems to be utilising the cave exceptionally as a winter roost, which it deserts during the spring.

During the mid-March survey, a small group of *R. hipposideros* was present in the second chamber, forming a loose cluster with the *R. ferrumequinum* group. They were torpid and inactive. However, none were present during the next February. *R. hipposideros* might be using the cave as a transient roost during spring. Except for this small group, no maternity or hibernation roosts were found in the European side of the research area.

Crowded clusters of *M. myotis/blythii* dominate both chambers of the cave throughout the year. However, their number gradually decreased from ~2100 bats in early spring, to 400 in mid-summer. The summer residents were mostly young males, one of which was identified as *M. blythii* by the presence of the white spot on its forehead. During the next year's winter survey, ~3300 individuals were recorded. These observations suggest that, *M. myotis/blythii* utilises the cave mainly as a winter roost.

There was a distinct decrease in the number of large *Myotis* species from winter to summer, ~2800 individuals. This number corresponds to the summer increase of *M. myotis/blythii* numbers in the two nearby caves, Yaylacık and Gökçeali (~2400). Both caves are used as nurseries, and they are 11.5 and 13.5 km away, respectively. Ringing surveys should be performed in order to clarify the seasonal movement patterns between these caves.

During the winter, there was a *M. schreibersii* colony of ~300 bats hibernating in the second chamber. Their number reached 1450 individuals by mid-March and dropped back to ~50 individuals by mid-summer. It seems that, a *M. schreibersii* colony utilises the cave mainly as a transient roost. This colony might be moving to the Yaylacık or Gökçeali caves in order to build up nursery colonies.

İkigöz Cave

	20 Jul (99)
R. euryale	14
M. mystacinus	1

The cave was surveyed once. During the survey, only the accessible part of the cave was investigated. The large galleries of the cave system were concealed behind the sinks, and couldn't be studied. In the speleological report of French expedition, 1992, the presence of bats in these galleries were recorded. However, there is no data about their identity or abundance. Actually, the size of these galleries are large enough to host big colonies, which would affect the bats' population distribution data of the region.

In the active main gallery, 14 *R. euryale* were recorded.

In addition, an accidental individual of *M. mystacinus* was captured with a hand net.

Gökçeali Cave

	7 May (99)	18 Feb (00)
R. euryale	40	0
M. schreibersii	1530	0
M. myotis/blythii	2200	0
M. capaccinii	60	0

The cave was surveyed twice. Although Gökçeali is a rather small cave, it was inhabited by a large number of bats during the summer survey. The cave has a low entrance, and its main dome acts as a warm air trap, which makes it adequate for a summer site. However, the cave stays warm also during the winter, which makes it unsuitable for a hibernation site. Consequently, no bats were present during the winter survey.

The cave hosts the largest summer colonies of *M. schreibersii* and *M. myotis/blythii* in the research area. Around 1500 *M. schreibersii* and 2200 *M. myotis/blythii* formed mixed and dense clusters on the confined ceiling space.

A small group of *R. euryale* was also present in the cave. A cluster of 40 individuals was hanging separate from the rest of the bats.

Approximately ~60 individuals of *M. capaccinii* were present and scattered within the *M. myotis/blythii* and *M. schreibersii* colonies.

During the May survey, none of the bats gave birth yet. Therefore, it is unclear if the cave is a transient or a nursery roost. Not the least, the cave is a favourite summer roost of these species.

Yarımburgaz Cave

	4 Mar (99)	6 May (99)
R. ferrumequinum	1	0
R. hipposideros	1	0
M. schreibersii	1	2

The cave was surveyed twice. Yarımburgaz is one of the largest caves in the research area. The cave was reported to host crowded colonies of different bat species in the speleological records. However, there were only three bats seen during the visits, each representing a distinct species: *R. hipposideros*, *R. ferrumequinum*, and *M. schreibersii.*

The bat community seemed to have deserted the cave because of continuous disturbance of humans. The cave is situated within the suburbs of İstanbul, and the area around it experiences a rapid urbanisation.

Gümüşpınar Cave

	20 July (99)
M. myotis/blythii	2

The cave was surveyed once. In this small cave only two individuals of *M. myotis/blythii* were recorded in summer. The cave is used as a dumping site by the surrounding shanties.

Horataşı Cave

	4 May (99)	28 Jul (99)	13 Mar (00)
R. euryale	42	60	10
R. ferrumequinum	2	1	51
M. schreibersii	660	620	360
M. myotis/blythii	440	425	14
M. emarginatus	1	7	6

The cave was surveyed three times. The Horataşı cave was inhabited by five different bat species throughout the year. Although it is a rather small cave, the species diversity and abundance, as well the amount of guano indicate its high utility for bats.

Individuals of *R. euryale* were recorded in all surveys. Their number increased from 10 in early spring to 60 by mid-summer. *R. euryale* seems to be utilising the cave mainly as a summer roost; arriving at the cave by early spring and reaching a maximum number by mid-summer. Although no surveys were held during mid-winter, it is expected that the species does not hibernate in the cave.

A small colony of *R. ferrumequinum* was recorded during the early spring survey. All the individuals were torpid. During the summer survey, there was only one individual present. This evidence suggests that the bats used the cave as a hibernation site in the prior winter season, started awakening by spring and left by the summer.

M. schreibersii was the most abundant species throughout the year. Their number almost doubled in two months time, from March to May. Some of the bats might have stayed over the winter, but most arrived during the spring, and stayed until the summer. The cave seems to be both winter and summer roost for *M. schreibersii.*

The cave's second most abundant species was *M. myotis/blythii.* During the late spring and mid-summer surveys, ~450 individuals were counted. By then, *M. myotis/blythii* and *M. schreibersii* were mixed in nursery clusters. However, during the early spring survey, only a few individuals were hibernating. *M. myotis/blythii* seems to be utilising the cave mainly as a summer roost.

A few *M. emarginatus* were roosting inside the crevices within the cave walls. During the summer, some were also seen hanging on the walls, among the *M. myotis/blythii* and *M. schreibersii* clusters.

Çilingoz Cave

	17 Jul (99)	9 Mar (00)
R. euryale	2500	360
R. ferrumequinum	0	105
M. schreibersii	2000	200
M. capaccinii	350	22

The cave was surveyed twice. Çilingoz was the largest cave surveyed in this research. It was populated with large colonies of four different species. The cave was utilised as a summer nursery site and as a hibernation site in winter. The cave hosted the largest nursery colonies of *M. schreibersii*, *R. euryale* and *M. capaccinii* in the research area.

During the summer survey, the largest nursery colony of *R. euryale* (2500 bats) was present. At this time, quite a few individuals were already seen with their babies. There were also crowded crèches of baby clusters. In the following early spring counts, 360 individuals were recorded. They were already active. The species seemed to arrive at the cave by early spring, and form a big nursery colony in the summer. Although there were no mid-winter surveys held, the cave is most probably utilised only as a maternity roost. As there were no hibernation sites of *R. euryale* found in the research area, these bats might be coming from the Istıranca mountains in the northwest.

M. schreibersii utilised the cave quite the same way as *R. euryale* colony. There were 200 bats counted during early spring, whereas their number increased tenfold by mid-summer, to 2000 individuals. During the early spring survey, unlike *R. euryale*, which were active and scattered through the main gallery, *M. schreibersii* colony was hibernating in one cluster situated close to the cave entrance. During the summer survey, *M. schreibersii* chooses the inner parts of the cave.

There were few *M. capaccinii* individuals recorded in early spring. By mid-summer there were 350 individuals, which formed a nursery colony mixed with *M. schreibersii* and *R. euryale*.

During the early spring survey, ~100 *R. ferrumequinum* individuals were found hibernating. They were scattered in clusters of 10-15 individuals, in the first 100 m of the gallery. Somehow, instead of perching at ceiling height of 7 m, they preferred lower places, approximately 1,5 m above the ground. This might be due to their lower temperature and higher humidity requirements for hibernation. As there were no individuals recorded in the summer, *R. ferrumequinum* is supposed to be the only species that is utilising the cave just for hibernation.

Sofular Cave

	11 Mar (99)	1 Jul (99)	3 Mar (00)
R. euryale	2	500	3
R. ferrumequinum	1	520	5
R. hipposideros	4	0	9
M. schreibersii	0	300	3
M. capaccinii	3	?	24

The cave was surveyed three times. Sofular is an ascending cave, where the entrance stays lower than the rest of the cave. As a result the cave acts as a warm air trap, and makes it inadequate for hibernation. The same situation can be observed in Gökçeali cave, in which no bats were found during the winter. Nevertheless, these conditions create an appropriate site for a nursery roost.

During the summer surveys, crowded nursery colonies were present in the cave. *R. euryale*, *R. ferrumequinum* and *M. schreibersii* formed nurseries of ~500, 520 and 300 individuals, respectively. However, during early spring only a few individuals of each species remained inside.

A few *R. hipposideros* males were observed hibernating in the cave, hanging torpid from perches very close to the ground. None were recorded during the summer.

During the two early spring visits, a small group of *M. capaccinii* was seen inside the crevices within the cave walls. During the summer visit, the cave was extremely crowded with nursery colonies of other species. In order not to disturb these colonies, we could not survey the crevices. Despite the limited observations, *M. capaccinii* might be utilising the cave as a winter or full-time roost. Winter survey is necessary to further confirm this point.

İnkese Cave

	21 Mar (99)	10 Jul (99)	17 Feb (00)
R. euryale	135	500	0
R. ferrumequinum	255	0	300
R. hipposideros	3	0	5

The cave was surveyed three times. The İnkese cave hosts exclusively horseshoe bats through out the year.

During the late winter and early spring surveys, ~300 *R. ferrumequinum* individuals were recorded hibernating in the cave. It was the largest winter colony recorded in this research. During the late winter, the colony was gathered in the relatively dry dome situated in the fossil upper branch of the main chamber. During the early spring, this species seemed somehow more active. They were scattered in small groups of ~20 in the active gallery. However, *R. ferrumequinum* were absent in the summer. They might have moved to a nearby summer roost. The only *R. ferrumequinum* maternity roost in the region was the Sofular cave, which is 24.5 km away. The species seems to be utilising the cave mainly as a hibernation roost, and may be staying for sometime in early spring.

A colony of *R. euryale* was recorded during the early spring and summer surveys. Their number increased from 135 individuals in spring, to 500 in summer. In early spring, they were already active, and occupying the fossil upper branch of the main chamber. Later in summer, they moved to the fossil gallery close to the Suçıkan entrance, where they probably formed a nursery. However, there were no *R. euryale* observed during the winter. İnkese seemed to be a summer roost for *R. euryale*, to which bats arrive by early spring, stay throughout the summer, and desert by the winter months.

During the late winter, when there was no *R. euryale*, *R. ferrumequinum* seemed to prefer the fossil branch of the main chamber. However, when *R. euryale* arrived in the early spring, *R. ferrumequinum* abandoned this place to *R. euryale*, and retreated to the inner active gallery.

In the fossil branch of the main chamber, there were a few *R. hipposideros* males hibernating. However none were seen during the summer survey. The cave most probably is a hibernation roost for *R. hipposideros*.

Yukarıkışla Cave

	17 Jul (99)	17 Feb (00)
R. euryale	25	0
R. hipposideros	0	7

The cave was surveyed twice. During the surveys of this small cave, there were only horseshoe bats present.

During the summer, a group of *R. euryale* males was observed. They were most probably the males of the nursery colony residing in the İnkese cave, which is only 370 m away.

A few *R. hipposideros* males were hibernating inside the cave. None of the observed specimens were hanging at the ceiling height; on the contrary, they chose medium heights on the walls, between the ceiling and the cave floor. This might be due to their preferences for lower temperatures and higher humidity during hibernation.

Gökçeören Cave

	6 Mar (99)	31 Jul (99)	8 Mar (00)
R. euryale	115	21	280
R. ferrumequinum	3	50	44
R. hipposideros	1	0	1
M. schreibersii	310	4	26
M. capaccinii	5	17	17

The cave was surveyed three times. Gökçeören's inclined profile coupled with the underground water system in the lower gallery keeps this cave relatively cold throughout the year. Therefore, the cave does not seem to be an adequate nursery.

The cave was most crowded during the early spring. By this time, all of the species were already active and leaving the roost to forage at night. Therefore, it was not apparent if these species used the cave as a winter or transient roost. However, the surveys of two subsequent years showed quite different patterns in species abundance. This might be due to the difference in the ambient temperatures of these two years: 11.0°C and 14.2°C, respectively.

In early spring, *R. euryale* was abundant in the cave. Their number decreased to ~20 individuals by mid-summer. The majority of individuals probably moved to a nearby summer roost. This species seems to be utilising the cave as a transient roost, however there is a low probability that it might have stayed over the winter. Winter data are needed to confirm this point.

The cave hosted ~50 *R. ferrumequinum* individuals during the summer. The spring counts were relatively lower. There were only three individuals in March 1999. The next year's spring, the numbers had increased to 44, most probably due to that year's high seasonal temperatures resulting in their early arrival. *R. ferrumequinum* seems to be arriving at the cave early in the spring, and utilising the cave as a summer roost.

There was a single *R. hipposideros* male, in both of the early spring surveys, hanging torpid at the same perch close to the cave's entrance.

The highest counts of ~ 300 *M. schreibersii* individuals were recorded in March 1999. By July, they had left, except for four individuals. The next year's early spring counts were surprisingly low, ~ 26 individuals. *M. schreibersii* is thought to be utilising the cave as a winter hibernation roost. Their earlier departure in the second year might have been due to the higher seasonal temperatures.

During the three surveys, there were a few *M. capaccinii* individuals roosting inside the cracks of the cave walls. Majority was in the lower active section of the cave. They seemed to stay throughout the year.

Deliklibent Tunnel

	20 May (99)
R. ferrumequinum	11
R. euryale	1

The tunnel was surveyed once. This old human-made tunnel hosted a few *R. ferrumequinum* females and young males. This species is known to be forming nurseries from May on. However this cave seems to be utilised as a transient roost at this time of the year.

There was only one *R. euryale* female captured with hand net, while flying inside the tunnel. No other *R. euryale* was recorded. As *R. euryale* is a gregarious species, there might have been another roost in the close proximity, hosting a colony. Among the known caves, the İnkese cave, 11.6 km away, was the closest one that hosted *R. euryale*.

STATISTICAL ANALYSIS

Having at hand a large set of data, collected during two seasons, we tried to get some understanding of bats' distribution patterns and, if possible, to find factors affecting them. We refer to data collected in June, July and August as summer data, and to data collected in February and March, as winter data. The winter data refer to the hibernating species. In the figures and tables, wherever we used the abbreviations Rhieu, Rhife, Rhihi, Minsc, Myola, Myoca and Myoem, we referred to the species *R. euryale, R. ferrumequinum, R. hipposideros, M. schreibersii, M. myotis/blythii, M. capaccinii* and *M. emarginatus*, respectively.

Species-Abundance Relations

Species-abundance in the Çatalca-Kocaeli region is shown in Figure 1.

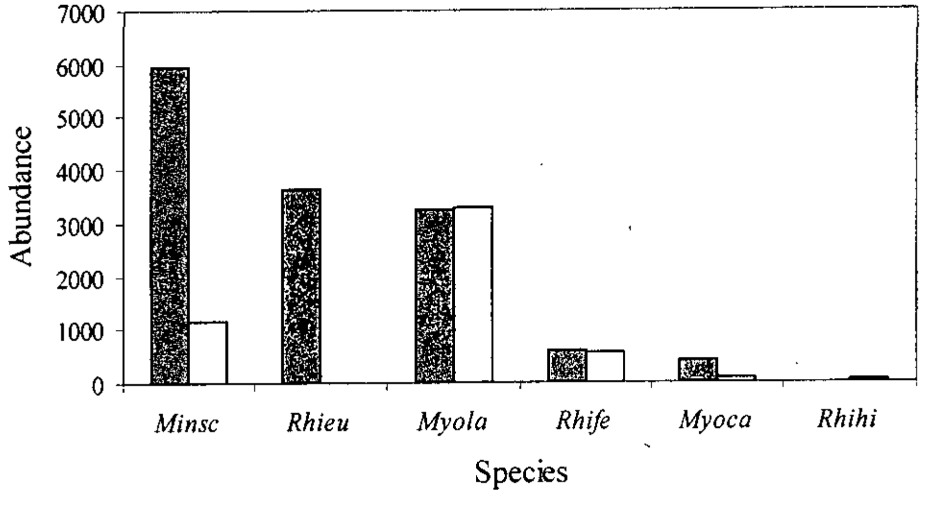


Figure 1. Species-abundance in the Çatalca-Kocaeli region. Results of the summer (dark bars) and winter counts.

There were approximately 3,000 large *Myotis* individuals and 600 *R. ferrumequinum* found in both seasons in the region. A small number of *R. hipposideros* was seen only in winter. In contrary, although about 3,600 individuals of *R. euryale* were seen in summer, no individual of this species was ever seen hibernating in winter. The number of encountered *M. capaccinii* changed from approximately 400 in summer to 60 in winter. The numbers of *M. schreibersii* varied greatly. About 6,000 individuals were found in summer and only 1,100 in winter. Although some of the individuals might be leaving the region for winter, it is highly possible that there are some unknown caves providing hibernation roosts for them. The cave system connecting the Kocakuyu and İkigöz caves might be one of them.

The bat species in the Çatalca-Kocaeli region showed varied degrees of clumping as measured by the Green's index (Table 2). In summer, *R. ferrumequinum* had the most clumped distribution among all the species and distribution of *M. schreibersii* was the closest to random. In winter, only large *Myotis* showed a very high clumping. Individuals of other species were distributed much more randomly. It is interesting that whereas the Green's index for *M. schreibersii* is low and hardly changes between the seasons, the index for large *Myotis* and *R. ferrumequinum* changes drastically. It seems that these species utilize only a very few caves as hibernation sites.

Table 2. The Green's index for the bat species.

Green's Index	Minsc	Rhieu	Myola	Rhife	Myoca	Rhihi
Summer	0.17	0.46	0.45	0.78	0.66	NA
Winter	0.15	NA	0.99	0.25	0.23	0.22

Abundance patterns were analysed by plotting the relative abundance of each species in order of its rank (Figure 2 and Figure 3). The distribution of abundance was relatively even and similar to the broken-stick distribution model. It suggests that there is rather little competition and overlapping between species in utilization of the critical resources. During summer, *M. schreibersii*, *R. euryale*, and large *Myotis* are the most frequently encountered species and make the bulk of bats' community. During winter, large *Myotis* is predominant, followed by *M. schreibersii*, and *R. ferrumequinum*.

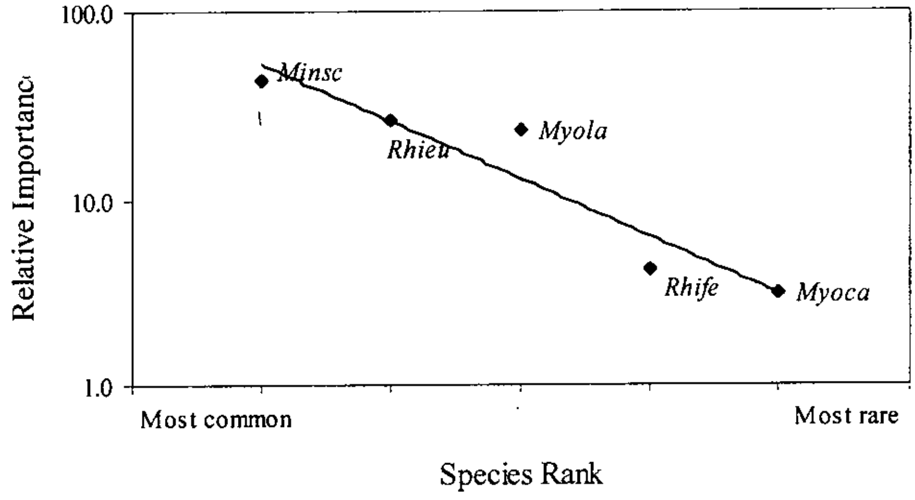


Figure 2. Relationship between relative importance of species and their rank based on the summer counts. The relative importance of species is given in terms of percentage on a logarithmic scale.

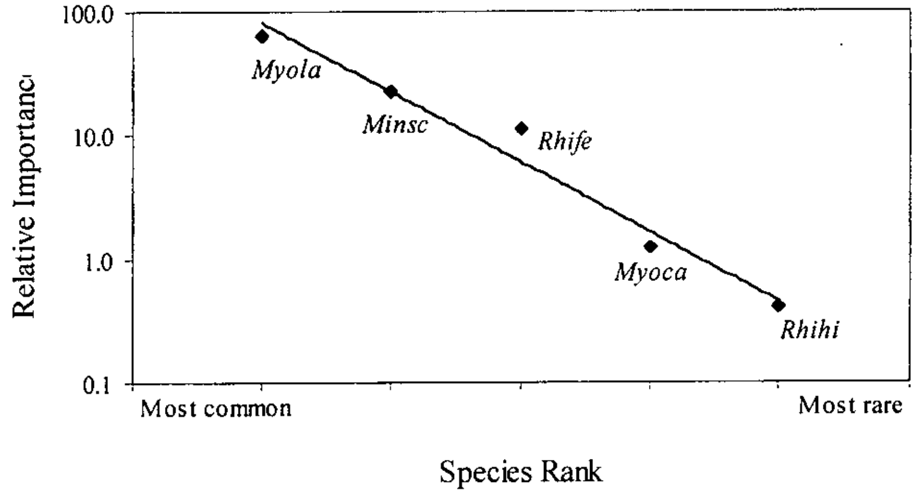


Figure 3. Relationship between relative importance of species and their rank based on the winter counts. The relative importance of species is given in terms of percentage on a logarithmic scale.

The distribution of abundance in the individual caves followed mostly the general abundance pattern observed in the region. In summer, the caves accommodated, on average three species, two of them being generally much more abundant than the rest (as indicated by the Hill's diversity numbers). The evenness indices (the modified Hill's ratio) were relatively high, in most of the caves the value was approximately 0.8, indicating rather even distribution of species (Table 3). In winter, species abundance was somehow less even as indicated by the value of the evenness index of approximately 0.7. Although many roosts hosted three species, in most of the caves there was a single species of dominant abundance.

Table 3. The Hill's diversity indices (N0, N1, and N2) and the evenness index (E5) for the investigated caves. The caves on the European side are in bold.

	N0		N1		N2		E5	
	summer	winter	summer	winter	summer	winter	summer	winter
Kocakuyu	2	3	1.42	1.51	1.25	1.25	0.59	0.50
Gökçeali	4		2.22		2.04		0.85	
Horataşı	4	3	2.26	1.66	2.08	1.37	0.85	0.55
Yaylacık	3	2	1.46	1.62	1.28	1.48	0.61	0.78
Çilingoz	3	3	2.45	2.33	2.27	2.08	0.87	0.81
İkigöz	1		1		1		NA	
İnkese	1	2	1	1.09	1	1.03	NA	0.38
Yukarıkışla	1	1	1	1	1	1	NA	NA
Sofular	3	3	2.92	2.46	2.86	2.18	0.97	0.81
Gökçeören	4	2	3.06	1.23	2.65	1.11	0.80	0.48
Deliklibent	2		1.33		1.2		0.60	

Species Affinity

Although relationship between relative importance of species and their rank indicated the broken-stick distribution model and consequently little interaction between species, we tried to clarify this point by checking our data for interspecific association. To analyse association between species, we used binary data describing the presence or absence of species in particular caves (Table 4 and Table 5).

Table 4. Presence or absence of bat species during summer in the surveyed caves. The caves in the European side are in bold.

	Minsc	Rhieu	Myola	Myoca	Rhife
Kocakuyu	1	0	1	0	0
Gökçeali	1	1	1	1	0
Horataşı	1	1	1	0	1
Yaylacık	1	0	1	1	0
Çilingoz	1	1	0	1	0
İkigöz	0	1	0	0	0
İnkese	0	1	0	0	0
Yukarıkışla	0	1	0	0	0
Sofular	1	1	0	0	1
Gökçeören	1	1	0	1	1
Deliklibent	0	1	0	0	1

Table 5. Presence or absence of bat species during winter in the surveyed caves. The caves in the European side are in bold.

	Minsc	Myola	Rhife	Myoca	Rhihi
Horataşı	1	1	1	0	0
Çilingoz	1	0	1	1	0
Yaylacık	0	1	1	0	0
Kocakuyu	1	1	1	0	0
Sofular	0	0	1	1	1
İnkese	0	0	1	0	1
Yukarıkışla	0	0	0	0	1
Gökçeören	1	0	0	1	0

Even though the variance ratios, derived from a null association model, for the summer and winter data were 1.3 and 1.4 respectively, hinting the possibility of a positive association, a statistics, *W*, associated with the test was not significant in any of the cases. Accordingly, our initial conclusion that the niches of species we investigated overlapped little or no at all was supported further. On the species pairs level a chi-square test statistics pointed to a possible negative association between *R. euryale* and large *Myotis* in summer. However, all the values were biased due to the small sample size and when the Yates's correction was used, they all proved insignificant.

Community Classification

In the next step we took in order to make our data easier to interpret, we used association and cluster analyses as classification techniques. For the association analysis between the caves we used the species presence-absence data. The analysis utilises the notion of a divisor species, present or absent in a particular location, and performs a chi-square statistics. Because of a relatively small number of the caves analysed, we had to apply the Yates's correction factor. The technique did not find the divisor species and so, did not split the caves into more homogenous groups for any of the data sets.

In cluster analysis we computed an ecological resemblance function between all pairs of caves in order to quantify their similarity or dissimilarity, and then to group them according to their resemblance. Among numerous available resemblance functions, we have chosen the chord distance for its reputation of being a very versatile measure over diverse types of ecological data. The measure stresses the relative proportions of species in a particular location rather than their absolute quantities. For a clustering we used a space conserving flexible strategy (Figure 4 and Figure 5). The Kocakuyu and İkigöz were analysed together as they form the same cave system.

The results of clustering based on the summer data revealed a distinct regional pattern. Horataşı, Gökçeali, Yaylacık, and Kocakuyu – the caves situated on the European side were grouped together. They were the only caves that accommodated large *Myotis* species and they hosted relatively large numbers of *M. schreibersii*. The caves on the Asian side, Deliklibent, Gökçeören, Sofular, İnkese, and Yukarıkışla, were grouped because of the consistent presence of *R. euryale* and the presence of *R. ferrumequinum* in three of them (Deliklibent, Gökçeören, and Sofular). The Çilingoz cave with a big colony of *R.*

euryale and the absence of large *Myotis* species (very atypical setting for the caves on the European side) was classified closer to the caves on the Asian side.

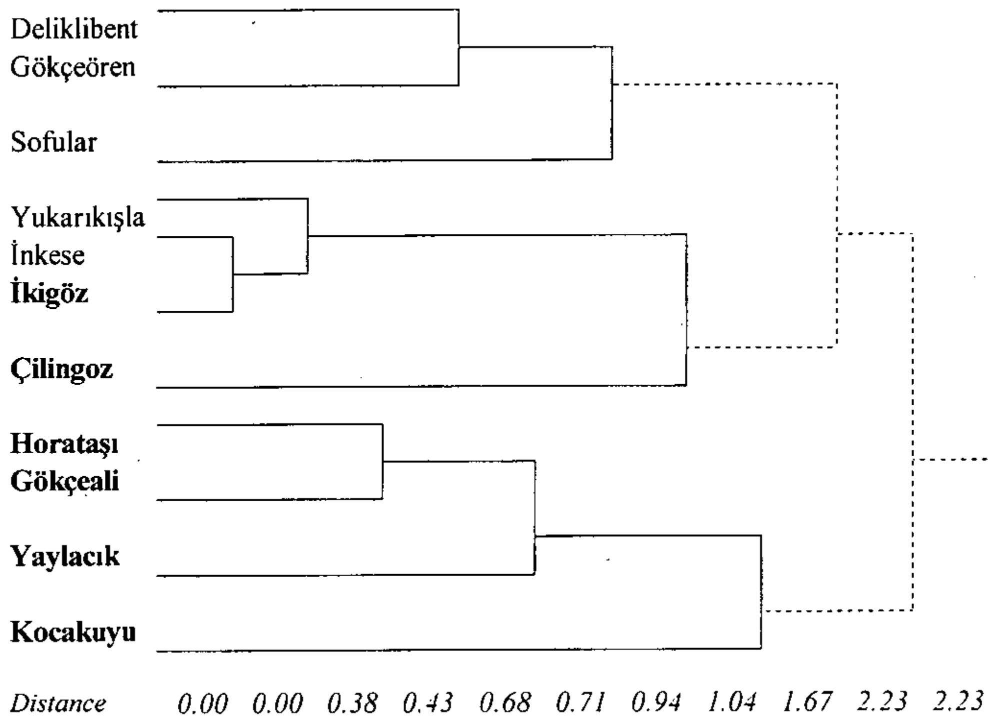


Figure 4. Dendrogram of the clustering of the summer data using the chord distance and the flexible strategy ($\beta = -0.25$). The caves on the European side are shown in bold.

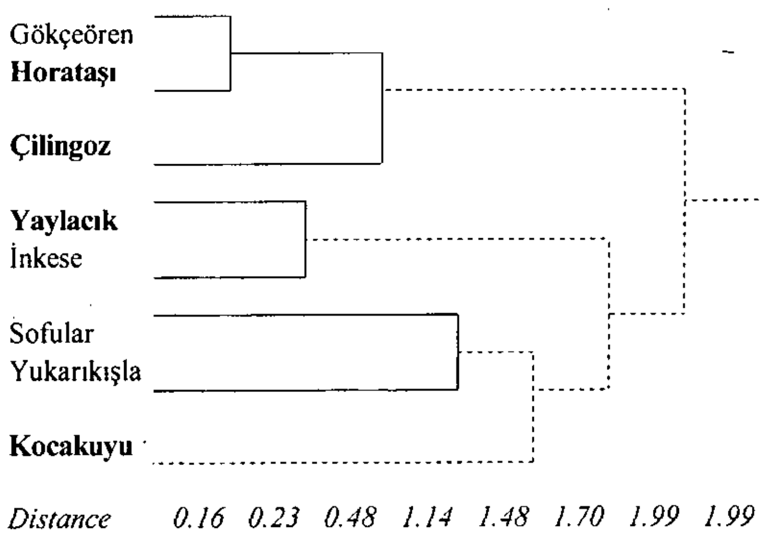


Figure 5. Dendrogram of the clustering of the winter data using the chord distance and the flexible strategy ($\beta = -0.25$). The caves on the European side are shown in bold.

The results of clustering based on the winter data did not show clear geographical distinction between caves or any other easy to interpret pattern.

Community Ordination

To obtain more information about ecological similarities between the caves and to search for underlying factors that might be responsible for the existing patterns, we tried to simplify our data by using ordination techniques. Correspondence analysis of the summer data revealed two distinct patterns (Figure 6).

The caves were grouped separately by their geographical location, the European and Asian side. To explain the observed patterns we expended analysis to species ordination. The European caves' pattern seems to arise as a result of complicated relations in relative abundance between three species: large *Myotis*, *M. schreibersii*, and *R. euryale*. For the Asian caves the relation between species was not so clear.

Correspondence analysis for the winter data also revealed two distinct patterns (Figure 7). Although not as obvious as in the case of the summer data, the caves on the European side were separated from the caves on the Asian side. We can not provide any clear explanation for these.

Despite difficulty in interpreting clearly the resulting patterns, we would like to point to the rather consistent separation of caves by geographical regions. It seems more sound, from the bats' distribution point of view, to refer to the investigated area as the Çatalca region and the Kocaeli region separately rather than the Çatalca-Kocaeli region. This is somehow surprising as the caves are not very distant from each other. The distance between two nearest caves located on the both sides of the Bosphorus strait is approximately 200 km, a distance that should not be a serious obstacle for the bat species. It is possible that strong winds, almost continuously blowing over Bosphorus, create difficult to penetrate natural barrier.

Other possible environmental factors that might affect distribution of species and cause the presence of side-specific patterns are habitat types in the vicinity of the caves. Although habitats do not differ very much from region to region, closer investigation might reveal important dissimilarities.

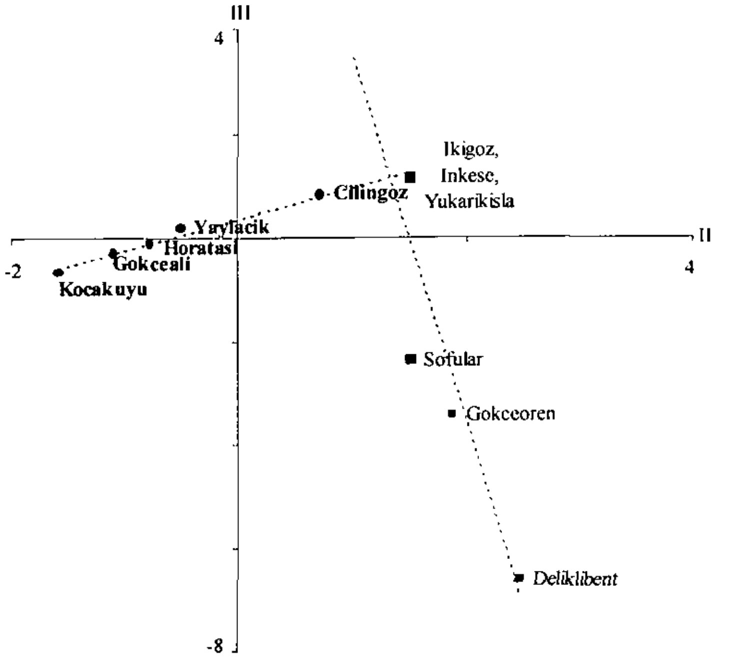


Figure 6. Correspondence analysis ordination of the summer data. The caves on the European side are shown in bold.

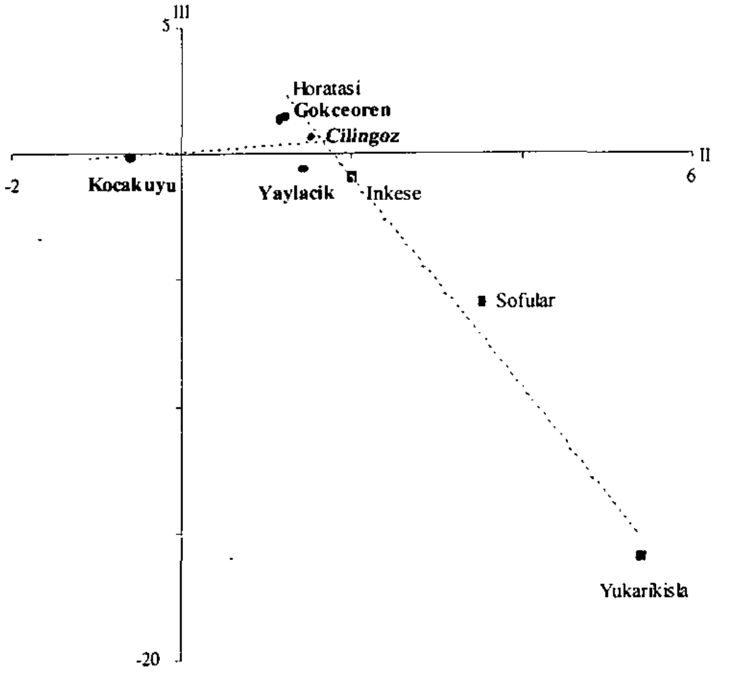


Figure 7. Correspondence analysis ordination of the winter data. The caves on the European side are shown in bold.

CONSERVATION STATUS OF ROOSTS

When attributing a conservation status to our sites, we based most of our evaluation on the analysis techniques presented in the "Eurobats Agreement – Trans-boundary Programs – Underground Habitats" report.

The conservation importance of roosts has been assessed on three basic criteria:

- Species presence,
- Abundance of species,
- Particular utilisation of each site.

A simple preliminary scoring system from the Eurobats report was used to rank sites. The proposed scoring is based on the Eurobats priority list and conservation status from the draft European Red Data Book of Vertebrates (ERDB) (Council of Europe, 1997).

Species, which are Eurobats priority or considered VU in the ERDB score four points. Species, which are LRnt score two points. The remaining species score one point (Table 6). This preliminary evaluation of the sites has to be supported by the supplementary site utilisation schemes.

Table 6. The status of European bats, their dependence on underground habitats, and the scores attributed to them.

Scientific name	Eurobats priority	ERDB status	Dependence on underground habitats	Proposed score
Rhinolophus blasii	-	VU	H	4
Rhinolophus euryale	-	VU	H	4
Rhinolophus ferrumequinum	Y	VU	H	4
Rhinolophus hipposideros	Y	VU	H	4
Rhinolophus mehelyi	Y	VU	H	4
Myotis bechsteinii	Y	VU	M	4
Myotis blythii	-	-	H	2
Myotis brandtii	-	-	M	1
Myotis capaccinii	Y	VU	H	4
Myotis dasycneme	Y	VU	M	4
Myotis daubentonii	-	-	M	1
Myotis emarginatus	Y	VU	H	4
Myotis myotis	-	LRnt	H	2
Myotis mystacinus	-	-	M	1
Myotis nattereri	-	-	M	1
Myotis schaubi	-	-	M	1
Pipistrellus kuhlii	-	-	L	1
Pipistrellus nathusii	Y	-	L	1
Pipistrellus pipistrellus	-	-	L	1
Pipistrellus savii	-	-	L	1
Nyctalus lasiopterus	-	LRnt	L	1
Nyctalus leisleri	-	-	L	1
Nyctalus noctula	-	-	L	1
Eptesicus bottae	-	LRnt	L	1
Eptesicus nilssonii	-	-	L	1
Eptesicus serotinus	-	-	L	1
Vespertilio murinus	-	-	L	1
Barbastella barbastellus	Y	VU	M	4
Barbastella leucomelas	-	VU	M	1
Plecotus auritus	-	-	L	1
Barbastella austriacus	-	-	L	1
Miniopterus schreibersii	Y	VU	H	4
Tadarida teniotis	-	-	L	1
Otonycteris hemprichii	-	-	L	1

When applying the scores to the surveyed roosts, for each species, the highest count during the three visits was taken (Table 7).

Table 7. The highest counts recorded during the surveys.

	Rhieu	Rhife	Rhihi	Minsc	Myola	Myoca	Myoem
Yaylacık	0	13	1	1400	200	150	0
Kocakuyu	0	105	27	1450	3280	0	0
İkigöz	14	0	0	0	0	0	0
Gökçeali	40	0	0	1530	2200	60	0
Yarımburgaz	0	1	1	2	0	0	0
Gümüşpınar	0	0	0	0	3	0	0
Horataşı	60	51	0	660	440	0	7
Çilingoz	2500	105	0	2000	0	350	0
Sofular	500	520	9	300	0	24	0
İnkese	500	300	5	0	0	0	0
Yukarıkışla	25	0	7	0	0	0	0
Gökçeören	280	50	1	310	0	17	0
Deliklibent	1	11	0	0	0	0	0

Table 8. Total scores assigned to the investigated roosts.

Underground Sites	*Total Score*
Çilingoz Cave	19820
Kocakuyu Cave	12888
Gökçeali Cave	10920
Yaylacık Cave	6656
Sofular Cave	5412
Horataşı Cave	3992
İnkese Cave	3220
Gökçeören Cave	2632
Yukarıkışla Cave	128
İkigöz Cave	56
Deliklibent Tunnel	48
Yarımburgaz Cave	16
Gümüşpınar Cave	12

The relative importance of the roosts was assessed in accordance with the scores given in Table 7 and data in Table 8. The results are given in Table 9. Taking into consideration the distribution of the scores, we propose four priority levels:

Table 9. Grading levels proposed for the roosts in the surveyed region.

Total Score	Priority
Over 10.000	Grade 1
1.000 – 10.000	Grade 2
100 – 1.000	Grade 3
Below 100	Grade 4

These scores can be used for preliminary evaluation in nominating underground sites. However certain sites may have specific conditions which must be considered in a higher grade. In such cases, the sites should be given the appropriate priority based on the genuine evaluations.

Description of the sites' grade presented in the following paragraphs is based on the similar sites' grading scheme used by Bat Conservation Trust in United Kingdom.

Grade 1 Sites:

These are the most important underground roosts, having the highest conservation priority. Strict conservation action should be obligatory for these sites. A formal access control is highly recommended. Although these sites are usually utilised all the year, most of them have particularly critical seasons. An extreme caution has to be taken, at least during these critical seasons (e.g. summer for the Gökçeali cave). The most straightforward way of protecting these sites would be by setting grilles at the entrance allowing free access for bats but limiting human admission.

Grade 2 Sites:

These are also very important underground habitats for bat species. The sites can be divided into more groups, according to the European, national or local conservation priority of the inhabiting species, and according to the species' cave utilisation schedule.

To propose such a division, more field surveys are needed in order to have accurate data of the species' abundance.

Only the sites with the higher priority should be grilled. Moreover, continuous monitoring of these roosts by authorised bat experts is needed in order to understand if the inhabiting bats are being disturbed. Visits in the critical seasons should be avoided.

Grade 3 Sites:

These sites, having less priority, are usually small caves, which are used by small populations of bats. Special attention should be given to those that are critical in terms of inhabiting species.

Grade 4 Sites:

These sites, having the least priority, are used by only a few bats. In some seasons no bats are present. No access control is needed. However some of these sites (e.g. the Yarımburgaz cave) were reported to host colonies in the past. In such cases, current threats and restoration opportunities should be evaluated.

Conservation Status for Surveyed Sites

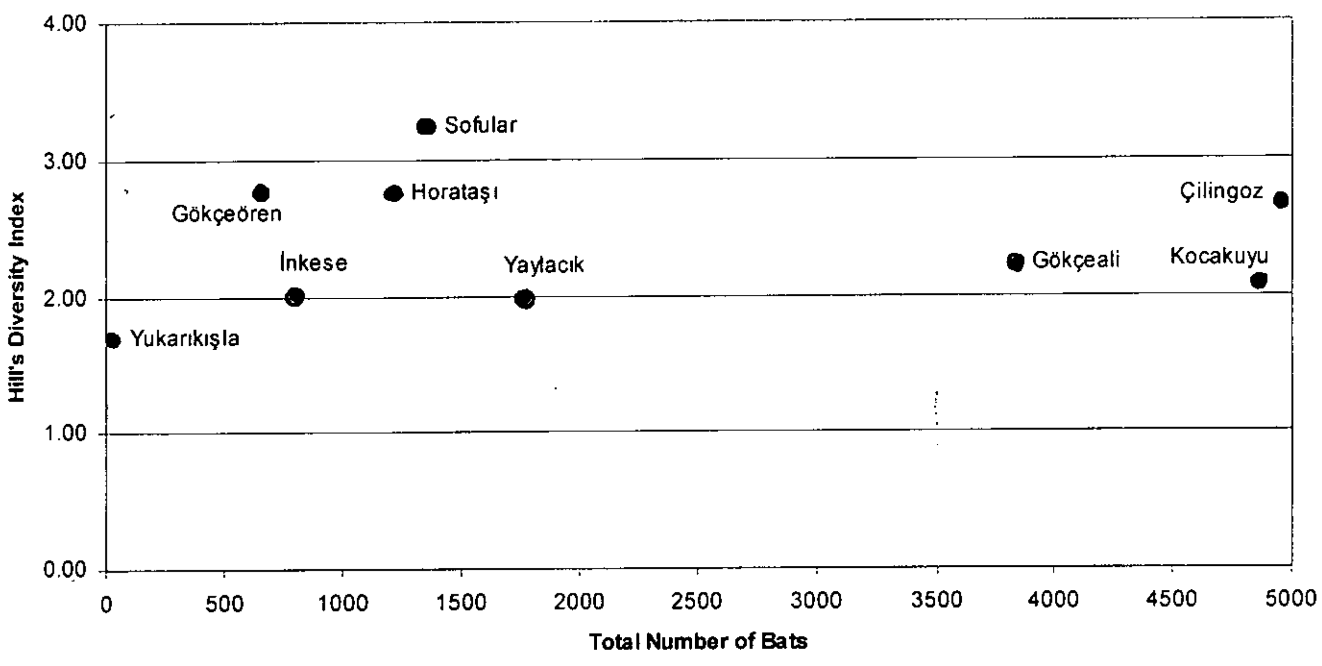


Figure 8. Hill's diversity index (N1) compared to total number of bats for 1st, 2nd and 3rd grade sites (Red, blue and green plots respectively).

Among the surveyed caves, Çilingoz, Gökçeali and Kocakuyu are nominated as Grade 1 sites; Yaylacık, Sofular, Horataşı, İnkese and Gökçeören as Grade 2 sites; Yukarıkışla as Grade 3 site; and İkigöz, Yarımburgaz, Gümüşpınar, and Deliklibent as Grade 4 sites. The comparison of species diversity (based on Hill's index) in these sites to the total number of bats counted, is given in Figure 8.

This grading, based solely on score evaluation, conforms well to the conservation priorities based on the species abundance and site utilisation schemes given in the relevant section.

Presently there are no regulations protecting bat species or their roosts in Turkey. The species composition and abundance, however, indicate their unquestionable importance and call for a formal setting of the bats' status in Turkey without further delay.

CONSERVATION ACTION

Bat Research Group

Throughout the project, substantial efforts were focused on establishing a new bat research volunteer group. Following an introductory seminar in the Boğaziçi University Speleological Society (BUMAK), invitation to and information about each fieldtrip were posted in the Society Bulletin and on the University news boards. On average, five to six volunteers, cavers and other university students, took part in each survey. During the project, a total number of 55 individuals participated in the fieldtrips. Additionally, on 10th November 1999, 19 volunteers participated in a specially organised fieldtrip exclusively dedicated to on-site education.

Although relatively large number of volunteers participated in bat surveys, for many of them, interest in bat studies was only temporary. Consequently, in order to establish a self-operating and effective bat group, still further efforts are needed. Despite all limitations, in February 2000, the first winter roost counts of the Istanbul region was held with the help of these volunteers. It has to be stressed, that formation of a bat research group within BUMAK is well appreciated among the Turkish cavers.

Training

The initial plan of the project included a trip to Spain, to meet Bat Research Group of the Estación Biológica de Doñana. The meeting would help to learn more about the recent field techniques, particularly on the usage of heterodyne detectors. Unfortunately, because of severe time constraints, this program had to be cancelled. Instead, some team members participated in a fieldwork carried on in Dadia Forest Reserve, in Greece. In the frame of this fieldwork, led by Kikki Kati and Yves Laurent, seven different habitats were surveyed for dominant bat species, between 22nd and 29th August 1999. The event provided us with a great opportunity to master the skills of identification of bats by means of heterodyne detectors.

Slideshows and Presentations

To increase public awareness and interest in bats conservation issues, we prepared a slideshow composed of dia selected from the collection of our field photos. The slideshow 'Bats of the Çatalca–Kocaeli Region', prepared in October 1999, consisted of 80 slides and lasted for approximately 30 minutes. The slideshow was designed to illustrate a thematic approach to the species diversity in the region, their roosts, and scenes from our fieldwork. Bat clicks recorded by ultrasound bat detectors were used to create background sound effects.

The presentation 'Yarasalar' (Bats), prepared in the late October 1999, combined the modified slideshow with additional information about bats' morphology, their metabolism and behaviour, ecology and conservation issues, a brief history of bat studies in Turkey, and information about Eurasian Bridge'99 and BP Conservation Program. In the presentation, which took approximately 90 minutes, a wide range of visual and audio multimedia effects was used. The presentation aimed to address a broad audience.

The first public presentation was held on 16th October 1999 in a cafe-house of Turkish Society for Protection of Nature (DHKD). The audience was interdisciplinary and included people of almost all age groups. There were many questions and vivid discussions at the end of the show. The second presentation was held in a private high school 100 Yıl Işıl on 27th November 1999. The audience consisted of the high school students. Both demonstrations were well appreciated. The third presentation was held in the Forestry Faculty, İstanbul University. This time, the audience was composed of graduate students of Forestry Department, and the main intention was to develop understanding of interactions between faunal biodiversity and habitat types. The fourth event took place in the Institute of Environmental Sciences, where the presentation was addressed to Boğaziçi University students and faculty members. The last event was held in a general meeting of cavers in Istanbul. The intention of this event was to introduce the topic of bat conservation into the cavers' agenda, and propose bats as means of cave conservation.

Presentations will continue in year 2000. The nearing events include a presentation for a group of students from a primary school, another public slideshow (arranged by DHKD), and a presentation followed by a larger slideshow for students of Boğaziçi University. In August 2000, another presentation is planned in Ankara, at the annual meeting of Turkish Union of Cavers. Moreover, European Bat Night event, in 27-28 August, will be held also in Turkey, with the help of DHKD.

Cavers' Awareness

One of the very important issues regarding bat conservation is awareness of cavers. Although almost each caving society bears a club logo with bat on it, cavers seem to be of more threat to bats than local people. There were many cases of unintentional or ignorance based disturbance of cave-dwelling bats. By encouraging participation of BUMAK members in our project, we hoped to raise their knowledge about bat's behaviour, and so to minimise unintended impact on bats. We wished to add the topic bat conservation into the agenda of the Turkish Union of Caving Societies, which will give bats a formal status.

A field guidebook to identification of cave-dwelling bats of Turkey, officially recognised by BUMAK, is planned to be published by the project team in a few months time. The guidebook will address cavers, and will discuss important bat and roost conservation issues. The book will be distributed to members of caving societies during the annual meeting of the Turkish Union of Caving Societies.

SCIENTIFIC OUTCOMES

Research and Development in Turkey 1999

In the spring 1999, a poster, '***Bat Research in Northwestern Turkey***', was presented during the annual exhibition organised by the Scientific and Technical Research Council of Turkey. In the poster, we provided information about our project (Eurasian Bridge 99), the present bats' status in Turkey, description of our activities, and information on how to contact us.

European Bat Research Symposium 1999

Preliminary findings relating cave-dwelling bats distribution in relation to the habitats found in the vicinity of the caves they populate, were reported in a poster, 'The Distribution of Cave-Dwelling Bat Species in North-western Turkey', presented during the 8th European Bat Research Symposium, August 23-27 1999, Krakow, Poland. The poster investigated the fact that the genus *Rhinolophus* was found to be present more dominantly in the caves of the Çatalca region, whereas the genus *Myotis* and *Miniopterus* were more dominant in the caves of the Kocaeli region.

European Bat Research: Scientific Paper

Some of the results of the bat survey were summarised in a paper, 'Cave-Dwelling Bats (Mammalia: Chiroptera) of Çatalca – Kocaeli Region, Northwestern Turkey', to be published in European Bat Research book. The paper provides new information on the distribution of the bats in northwestern Turkey and reports first data about bat species from ten previously unexplored caves. Some species were recorded for the first time in the Çatalca and Kocaeli regions, some were recorded for the first time nearby Çatalca (European side), and some for the first time nearby Kocaeli (Asian side). In the paper, we also compare our findings with data from the caves studied previously, pointing to considerable changes in bats species inhabiting these caves.

MEDIA COVERAGE

Since the beginning of the project, the media has been truly interested in our work. Bats are apparently an exotic topic for the public, and an international award received for their study raised general interest and alerted many newspapers, magazines, and TV channels. In three of our fieldtrips, we were accompanied by journalists from two daily newspapers and a camera-crew from a TV channel. We also gave some interviews. During the presentation in a cafe-house of DHKD, journalists were present among the audience.

The list of media coverage about our project (Appendix) includes:

TV

- NTV Documentary, 16 May 1999

Newspapers

- Zaman, 13 June 1999
- Hürriyet, 17 June 1999
- Forum, 18 June 1999
- Hürriyet, 7 July 1999
- Dünya, 19 June 1999
- Hürriyet, 21 June 1999
- Asabi, 23 June 1999
- Milli Gazete, 24 June 1999
- Milliyet, 18 June 1999
- Ekonomist, 4 July 1999
- Posta, 5 July 1999

Magazines

- Audi Magazin, November 1999
- Enerji, July 1999
- Uluslararası Taşımacılık Dergisi, July 1999
- Petrol, July 1999

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APPENDIX

Photo 1. The entrance of the İnkese cave.

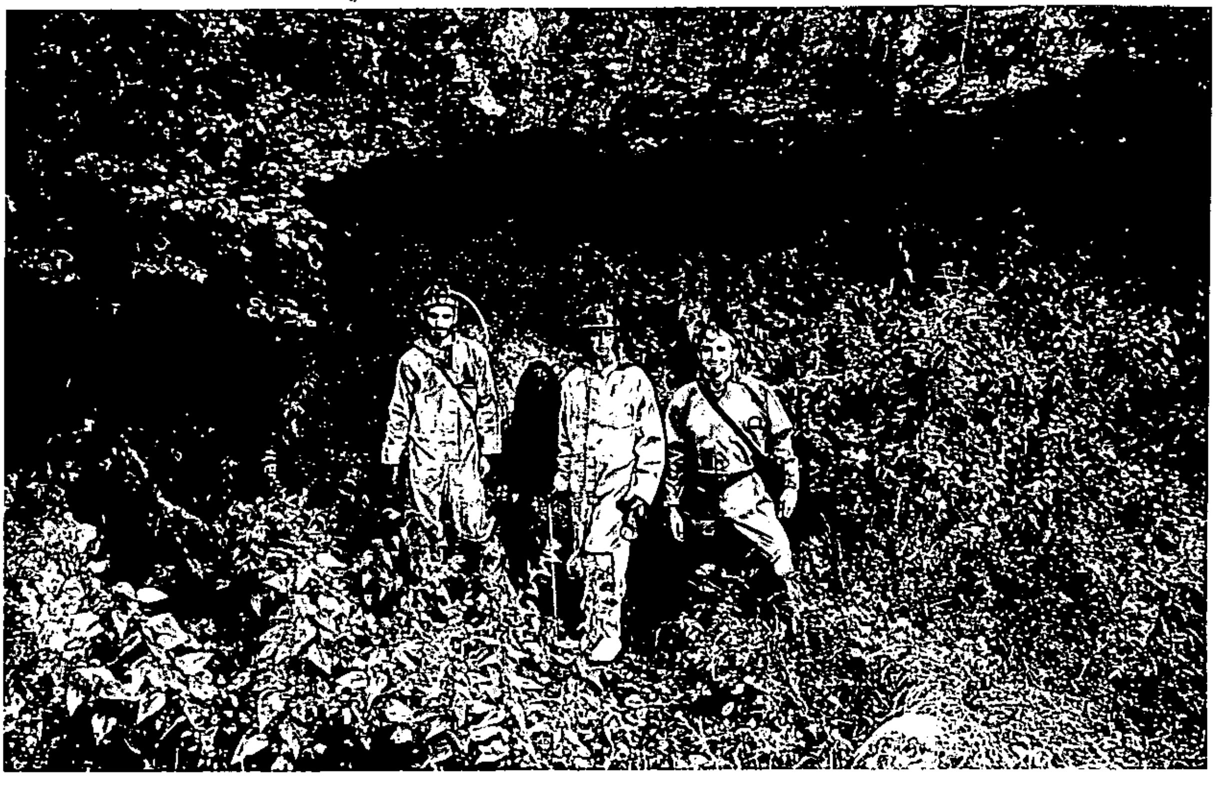

Photo 2. The entrance of the Horataşı cave.

Photo 3. The entrance of the Çilingoz cave.

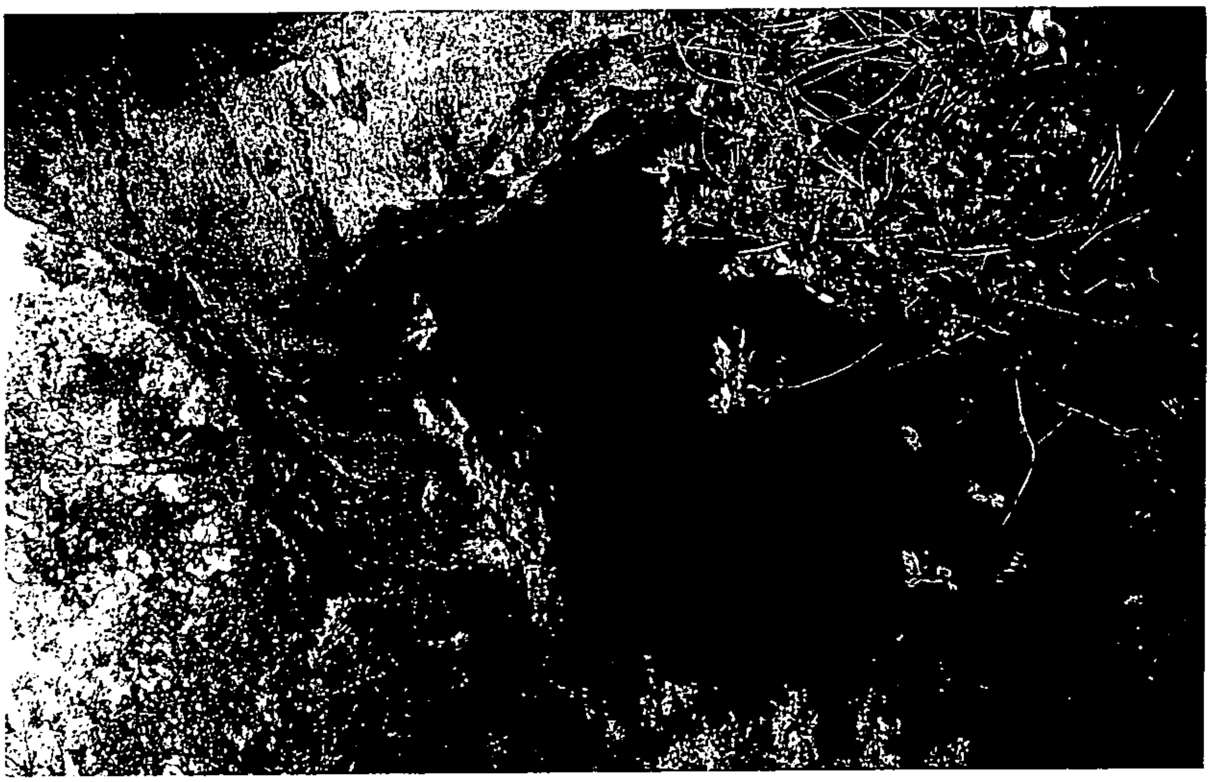

Photo 4. The entrance of the Gökçeali cave.

Photo 5. The entrance of the Kocakuyu cave.

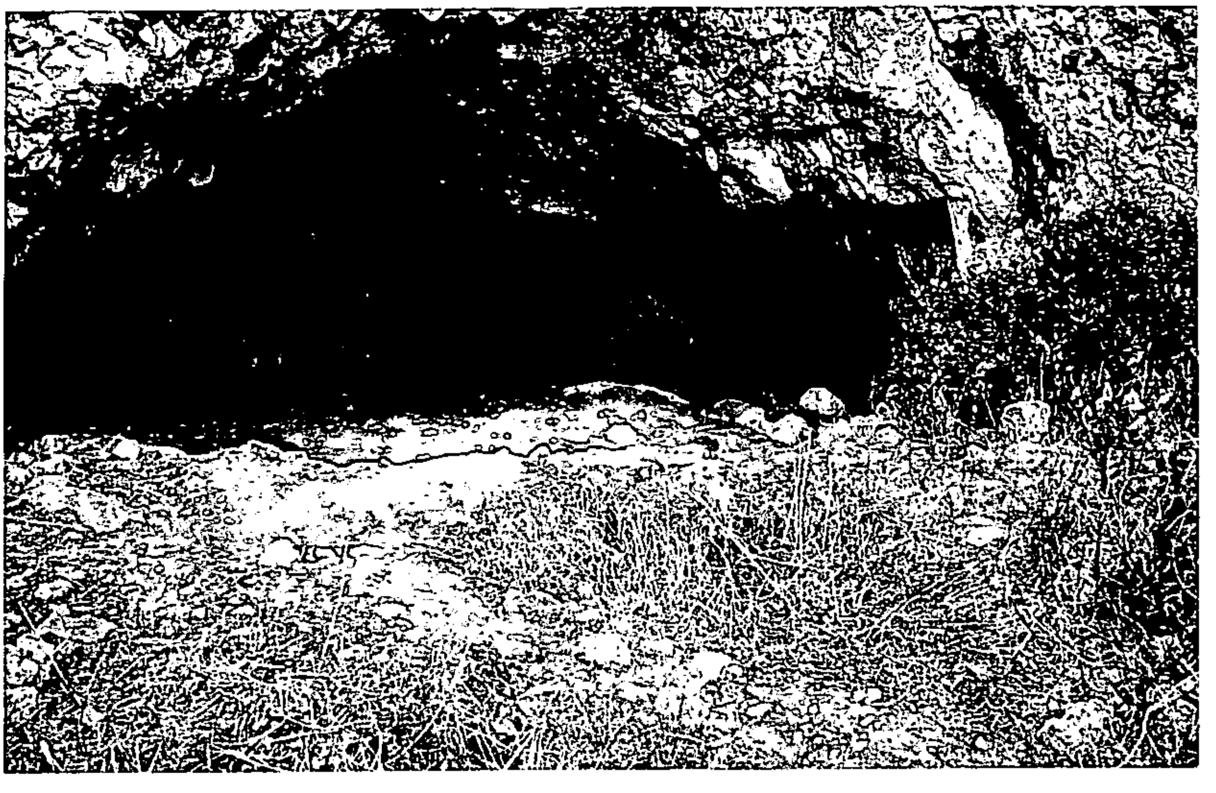

Photo 6. The entrance of the Sofular cave.

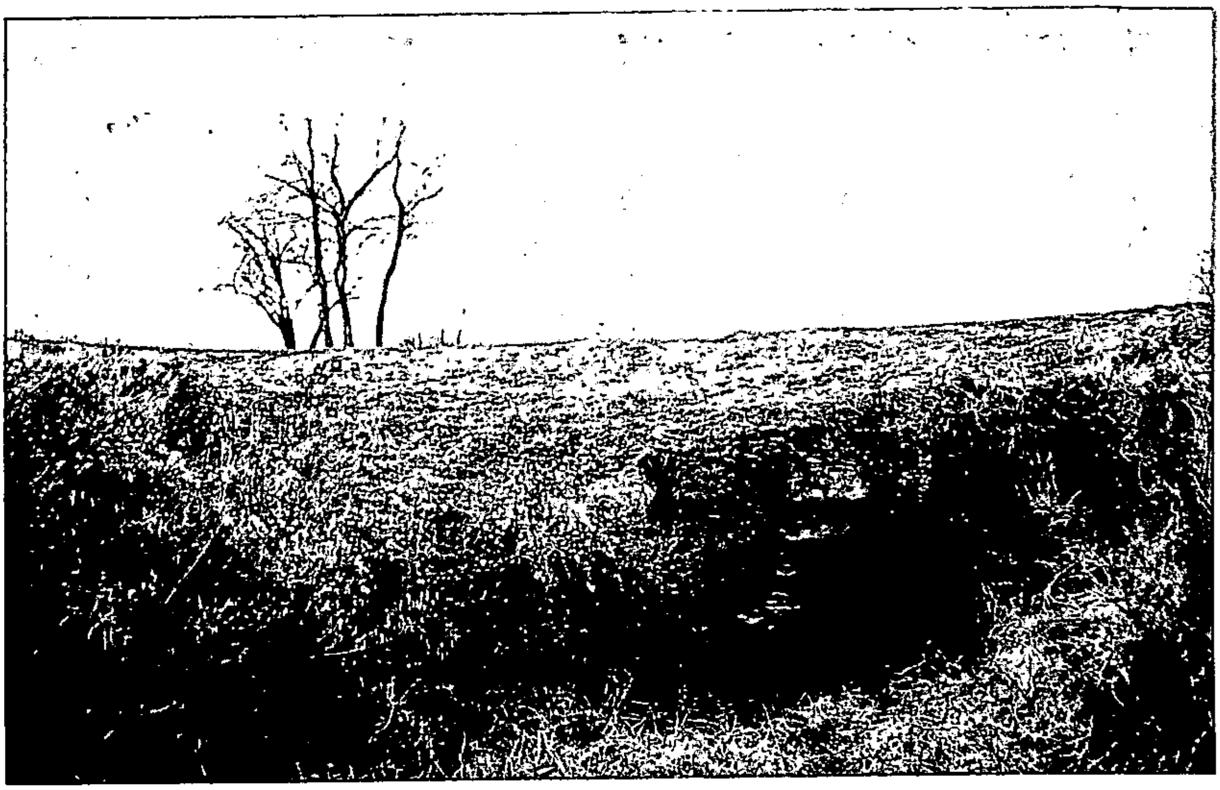

Photo 7. The entrance of the Yaylacık cave.

Photo 8. The entrance of the Yukarıkışla cave.

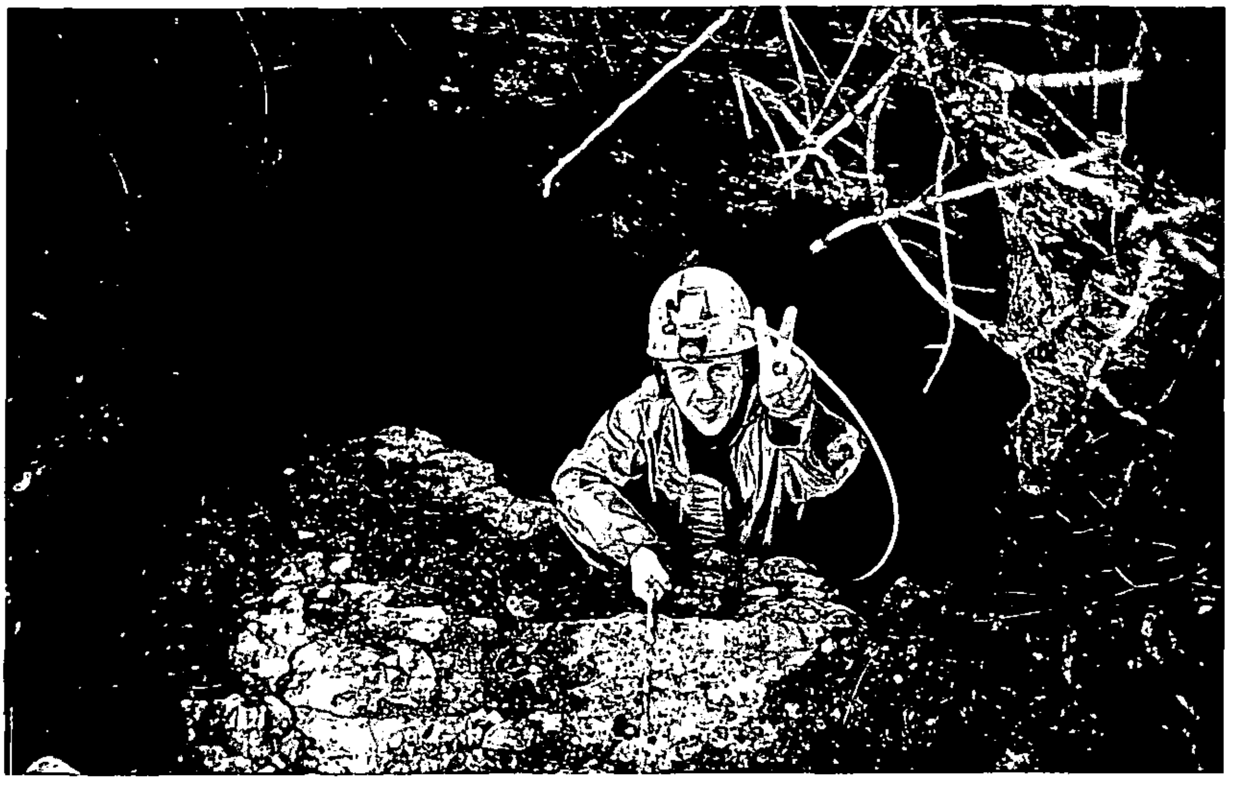

Photo 9. The entrance of the Gökçeören cave.

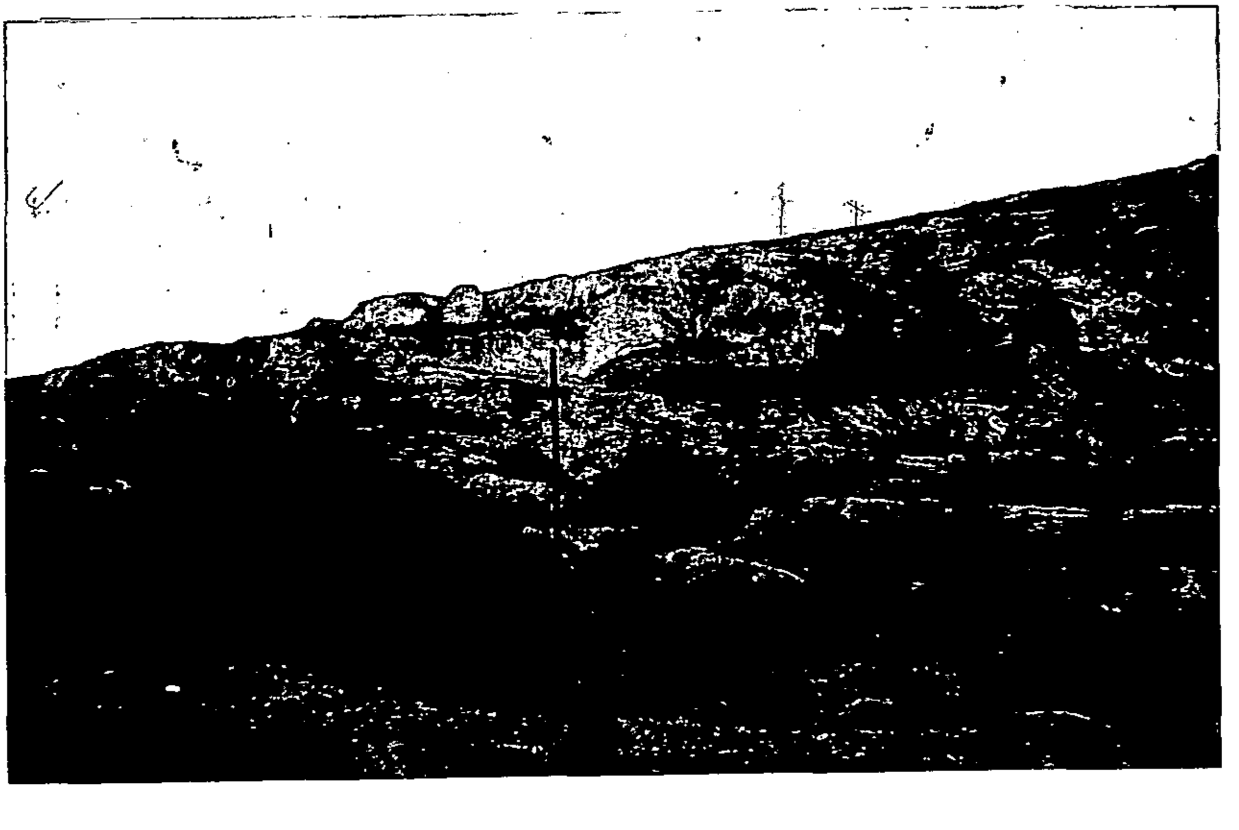

Photo 10. The entrance of the Yarımburgaz cave.

Photo 11. The entrance of the İkigöz cave.

Photo 12. A habitat edge between woodland and meadow (European side).

Photo 13. A habitat edge between woodland and water (European Side).

Photo 14. A coastal habitat (Anatolian side).

Photo 15. A poplar plantation within a deciduous forest (European side).

Photo 16. An individual of *R. ferrumequinum* (Dupnisa cave, October'99).

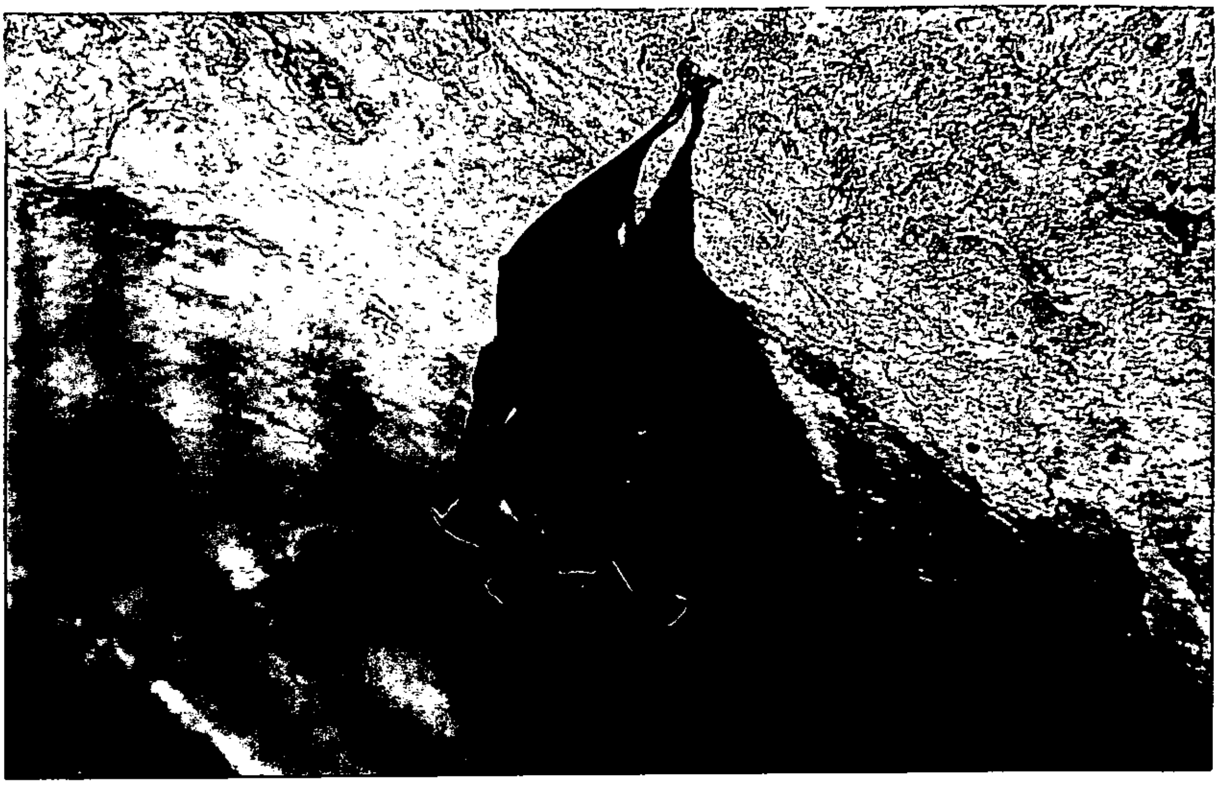

Photo 17. An individual of *R. ferrumequinum* (Dupnisa cave, October'99).

Photo 18. An individual of *R. ferrumequinum* (Çilingoz cave, March'00).

Photo 19. An individual of *R. ferrumequinum* (İnkese cave, March'99).

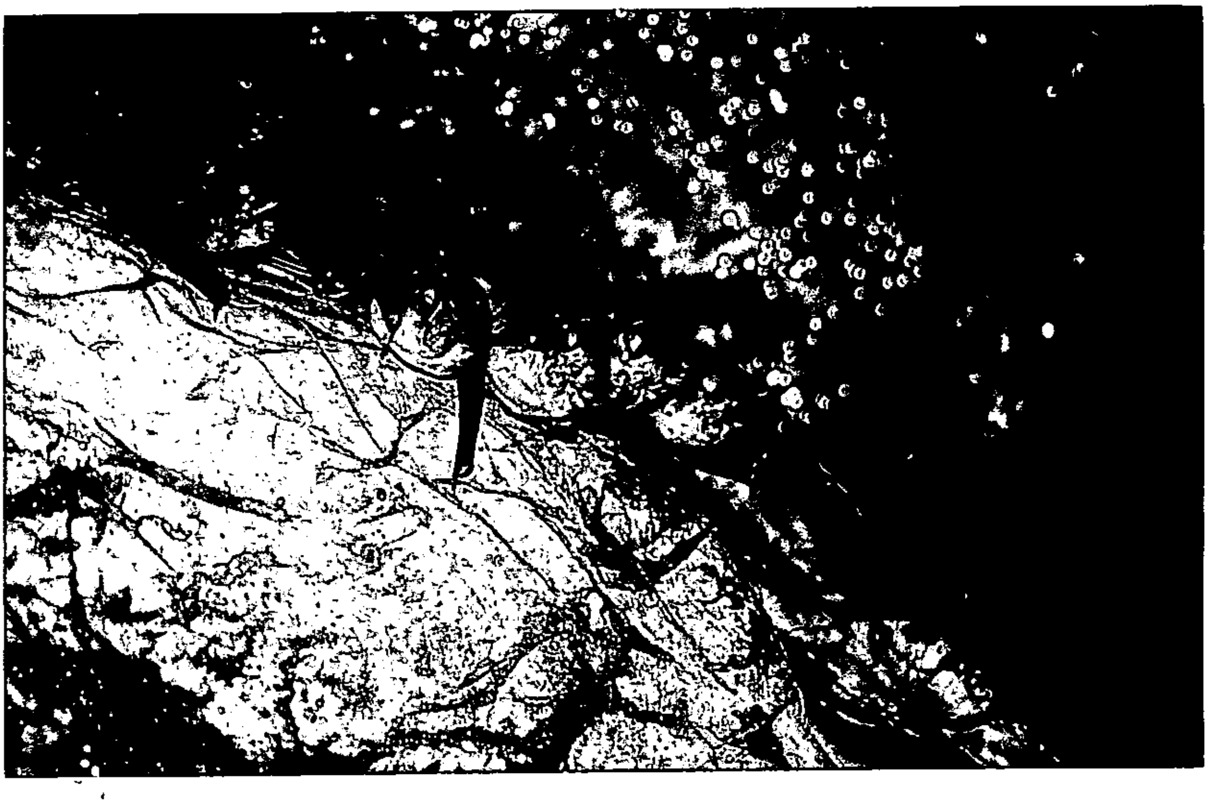

Photo 20. Individuals of *R. ferrumequinum* (Gökçeören cave, March'99).

Photo 21. Individuals of *R. ferrumequinum* (Çilingoz cave, March'00).

Photo 22. Individuals of *R. ferrumequinum* (Çilingoz cave, March'00).

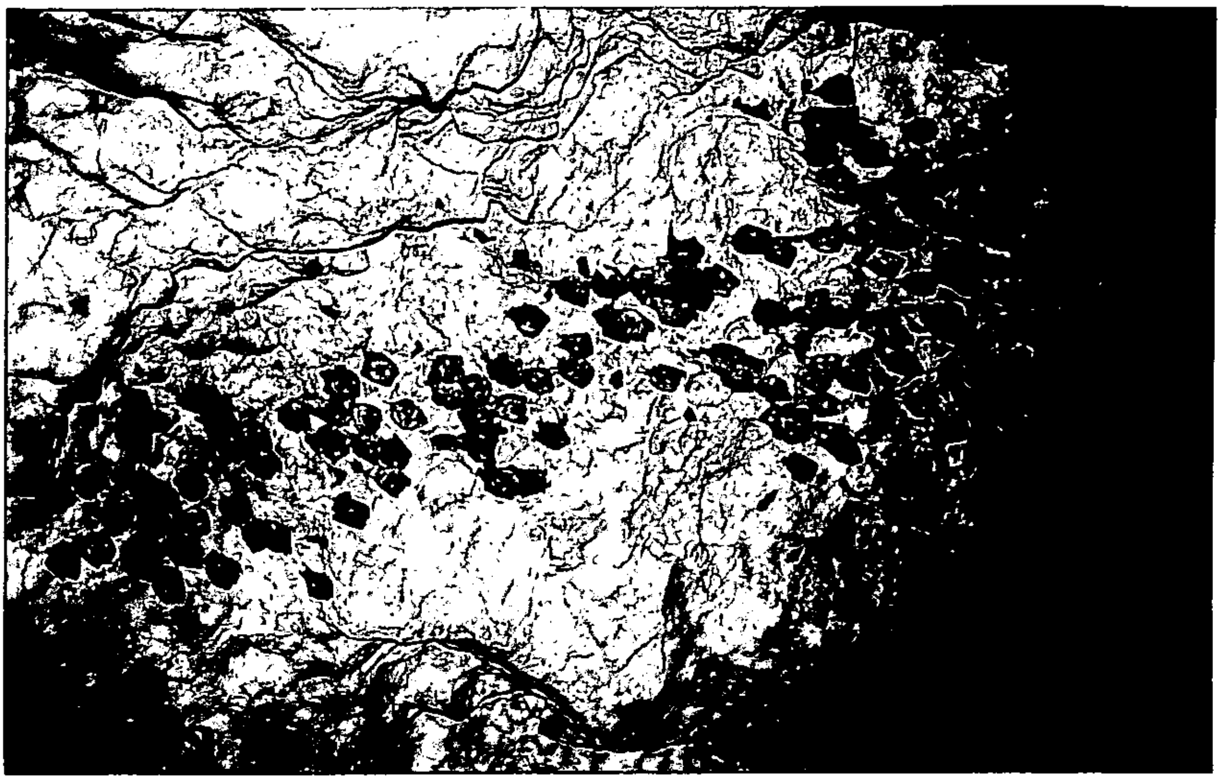

Photo 23. A cluster of *R. ferrumequinum* (Kocakuyu cave, February'00).

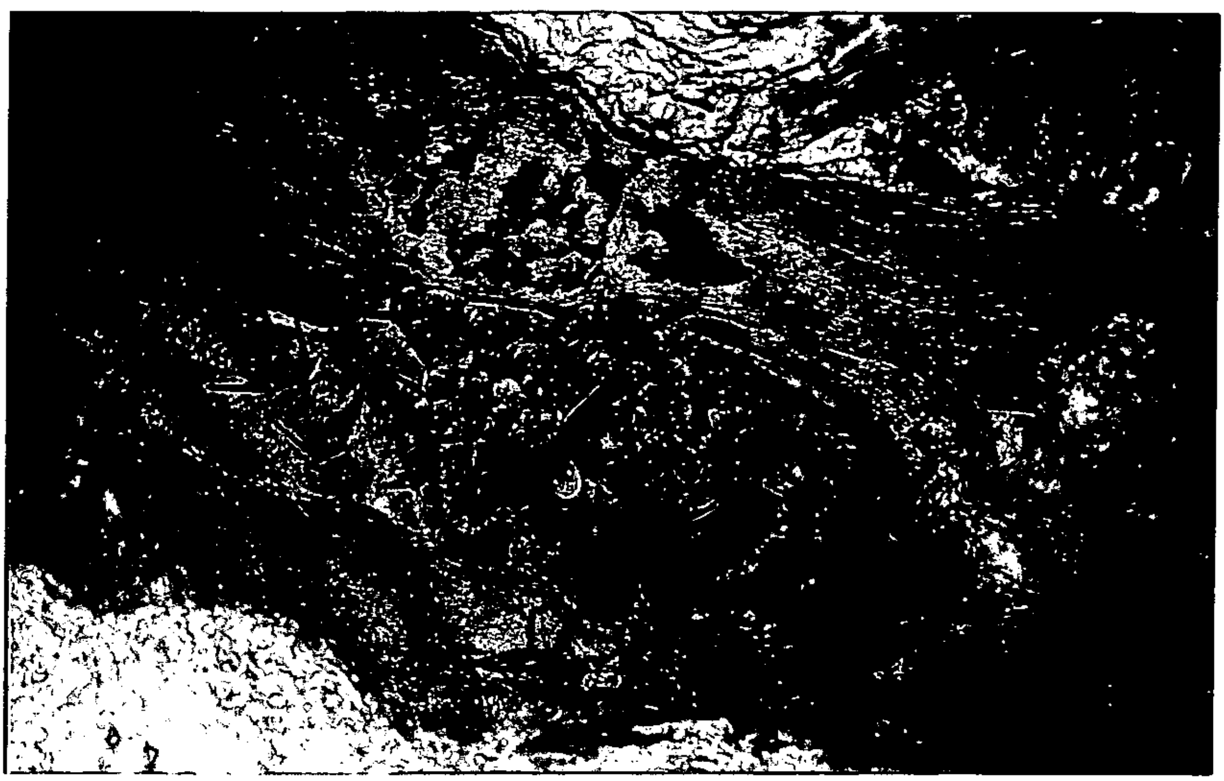

Photo 24. A cluster of *R. euryale* (İnkese cave, July'99).

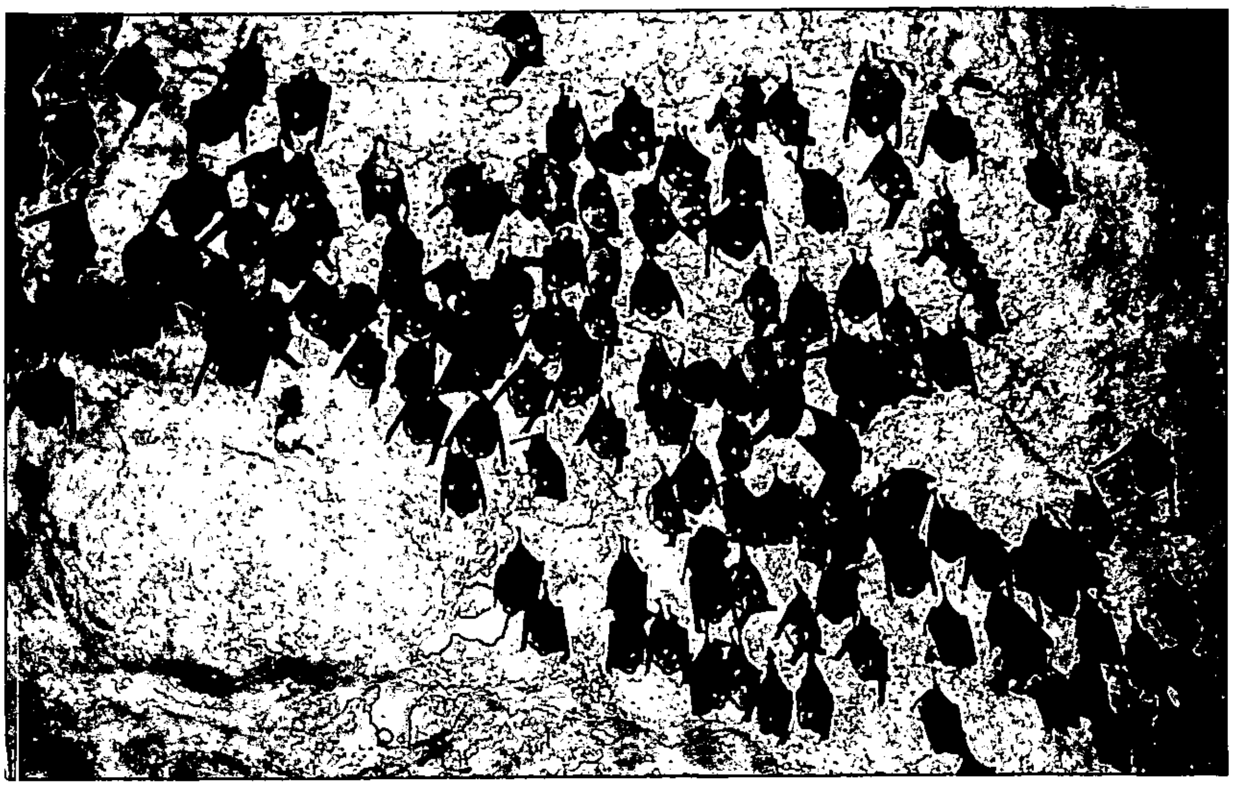

Photo25. A cluster of *R. euryale* (Çilingoz cave, March'00).

Photo 26. A colony of *R. euryale* (Çilingoz cave, July'99).

Photo 27. A crèche of *R. euryale* (Çilingoz cave, July'99).

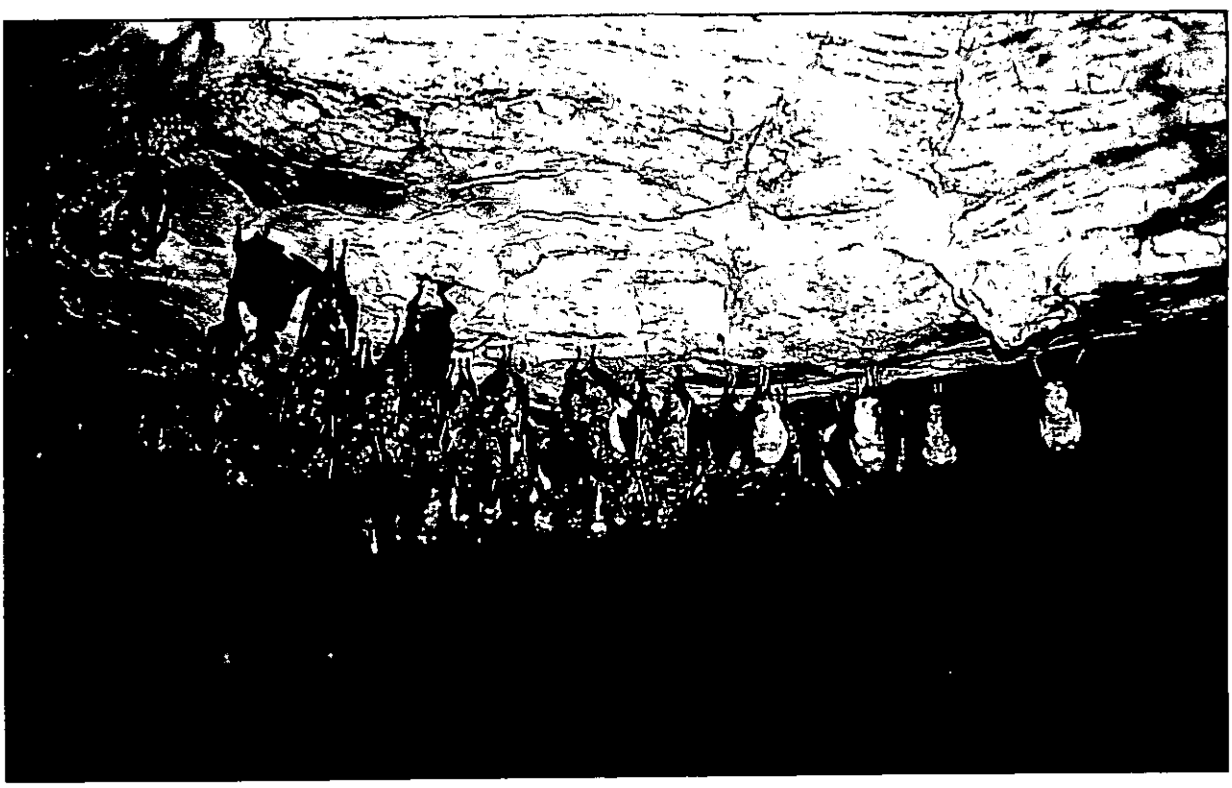

Photo 28. A cluster of *R. euryale* (Gökçeören cave, March'00).

Photo 29. A cluster of *R. euryale* (Gökçeören cave, March'00).

Photo 30. An individual of *R. hipposideros* (Kocakuyu cave, March'99).

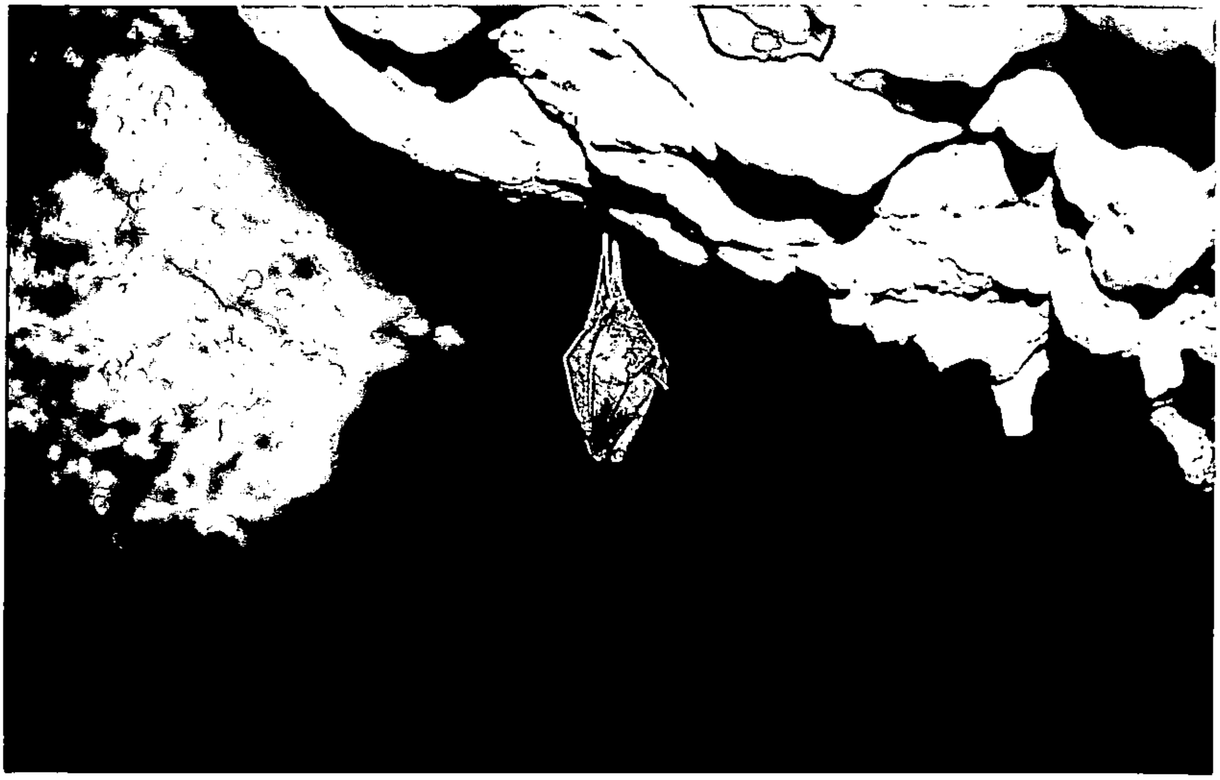

Photo 31. A hibernating individual of *R. hipposideros* (Sofular cave, March'00).

Photo 32. An individual of *M. schreibersii* (Dupnisa cave, October'99).

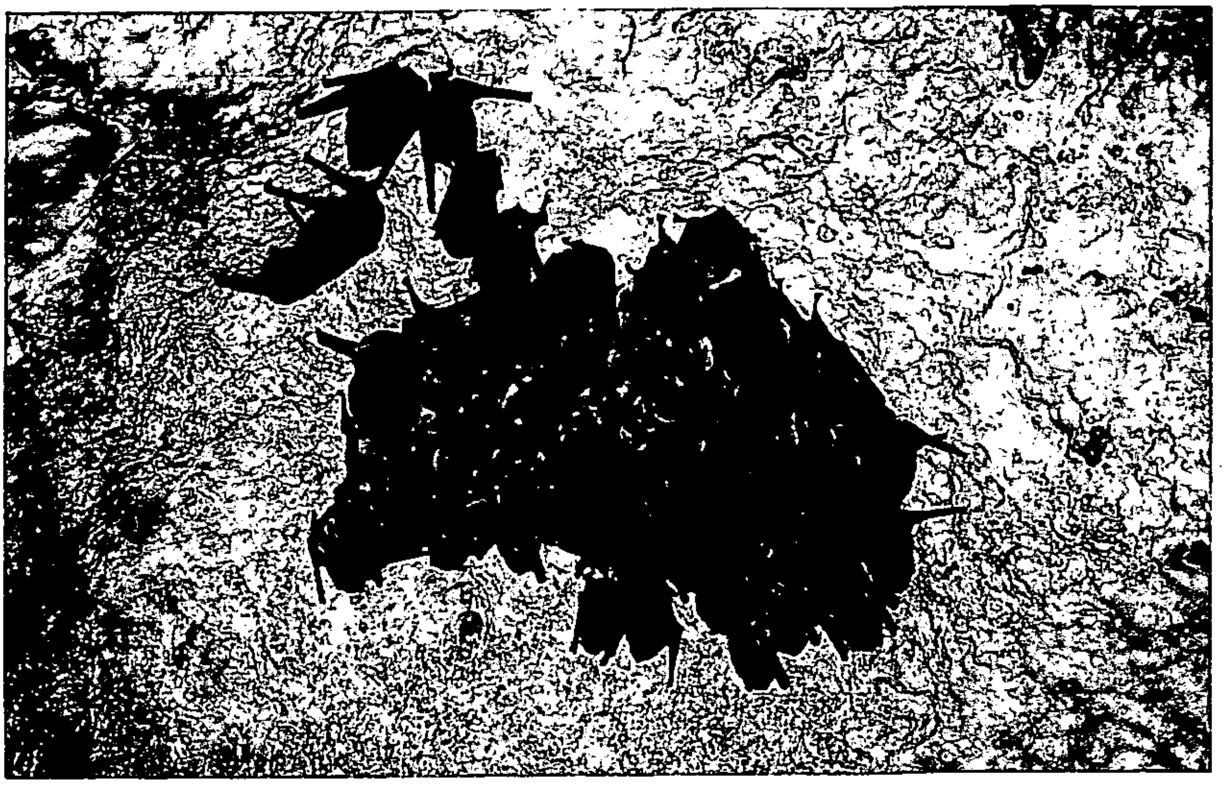

Photo 33. A cluster of *M. schreibersii* (Çilingoz cave, March'00).

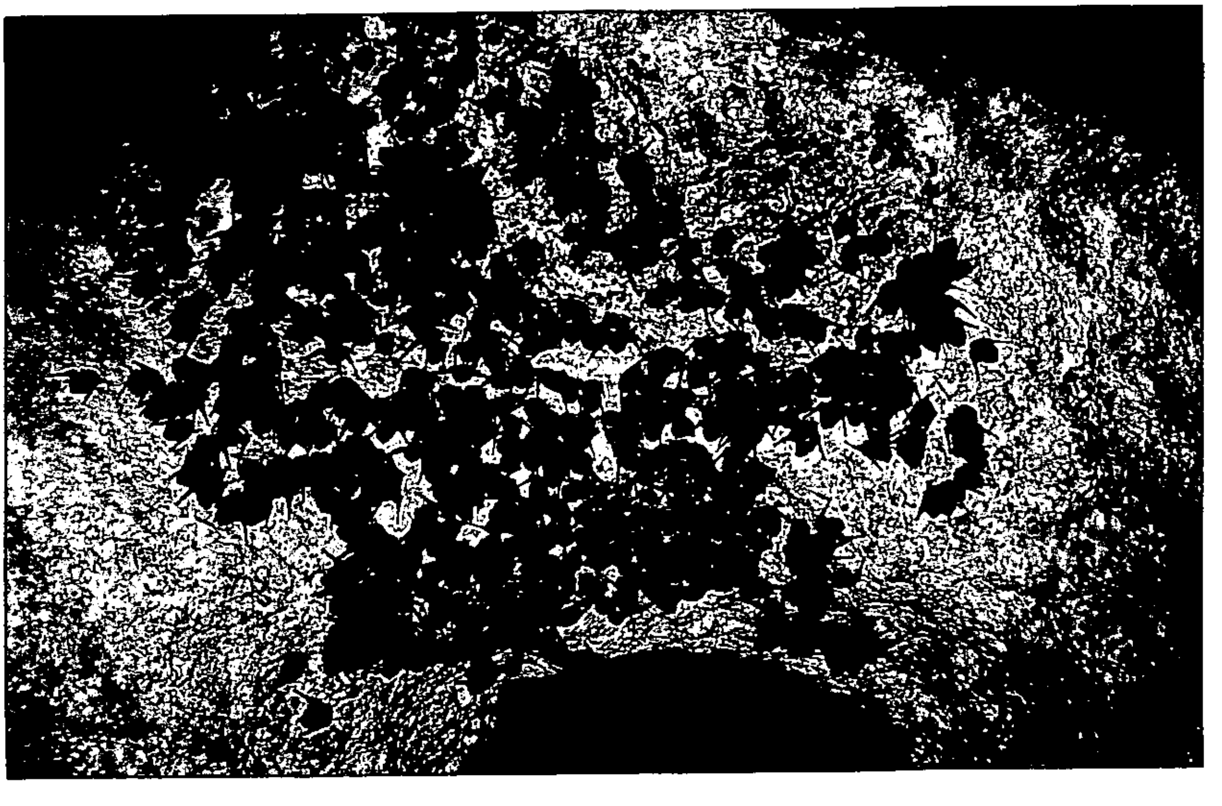

Photo 34. A colony of *M. schreibersii* (Yaylacık cave, March'99).

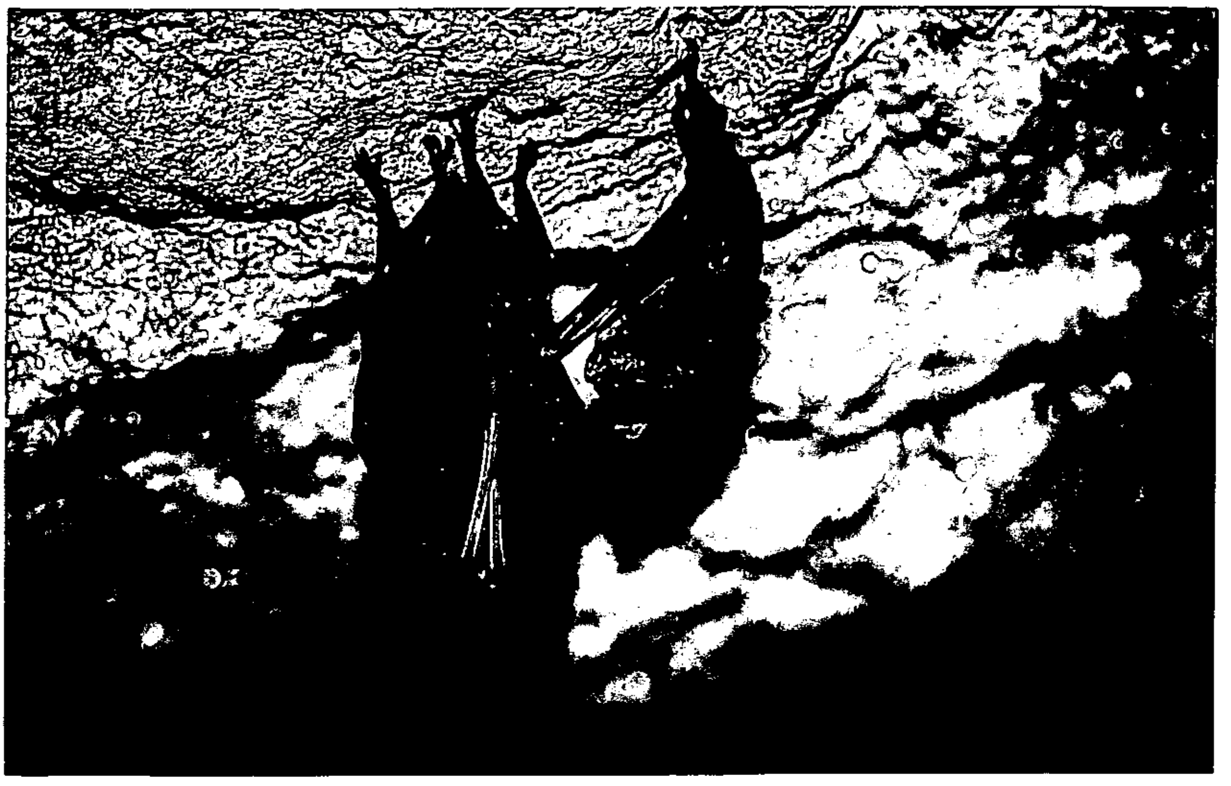

Photo 35. Individuals of *M. schreibersii* and *R. ferrumequinum* (Yaylacık cave, March'99).

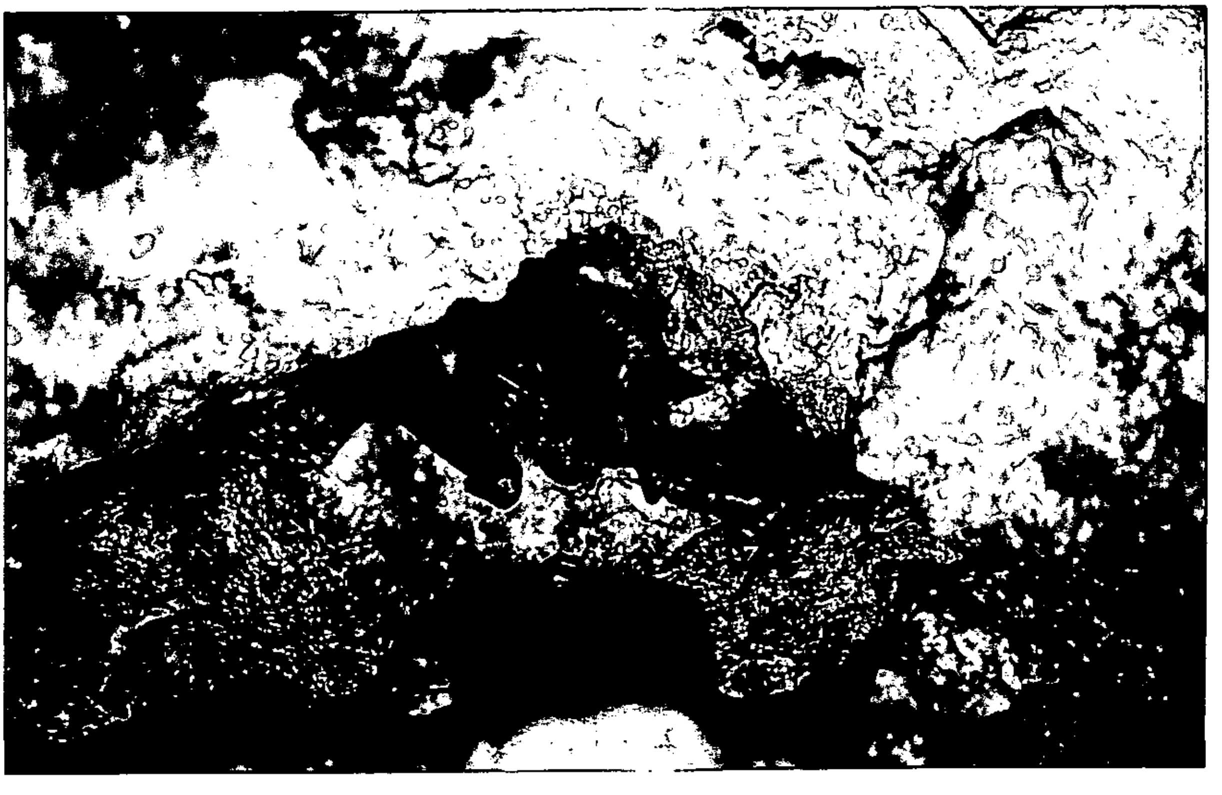

Photo 36. An individual of *M. myotis/blythii* (Gümüşpınar cave, July'99).

Photo 37. A hibernating individual of *M. myotis/blythii* (Yaylacık cave, February'00).

Photo 38. An individual of *M. blythii* with the distinctive white spot on the head (Kocakuyu cave, March'99).

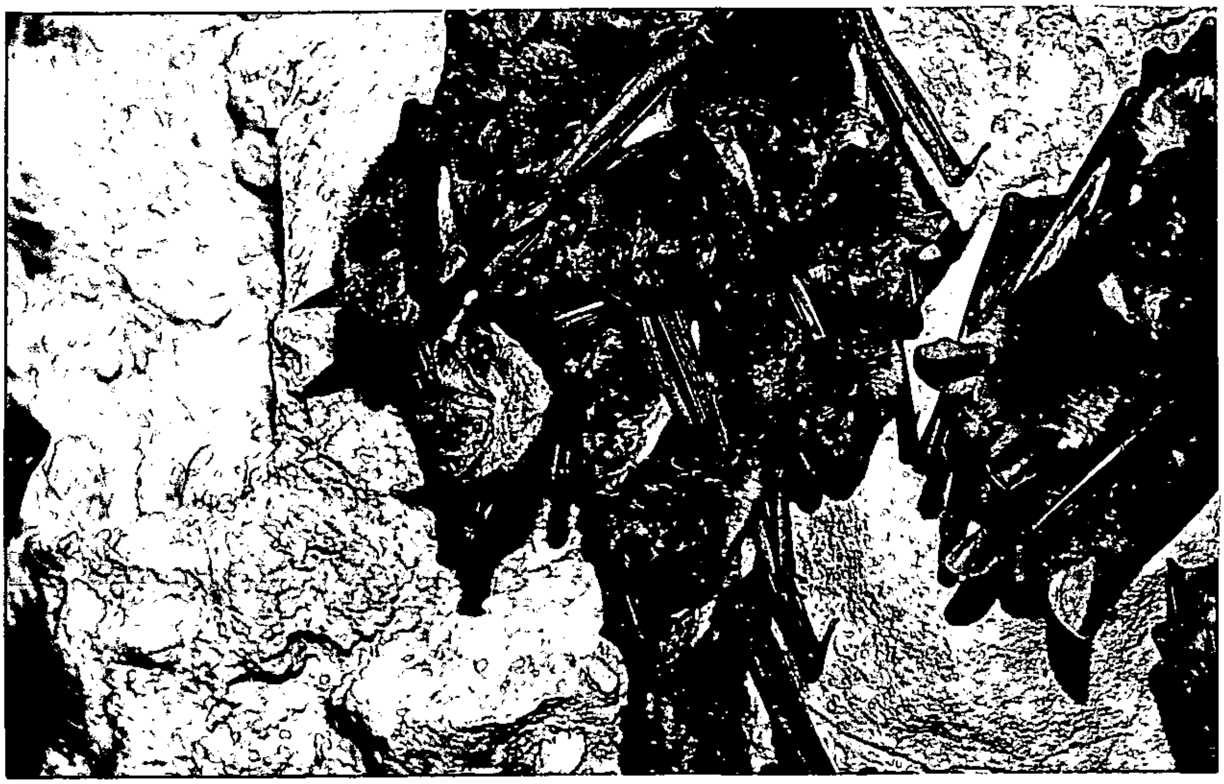

Photo 39. A cluster of *M. myotis/blythii* (Kocakuyu cave, March'99).

Photo 40. An individual of *M. myotis/blythii* hibernating inside a travertine formation (Kocakuyu cave, March'99).

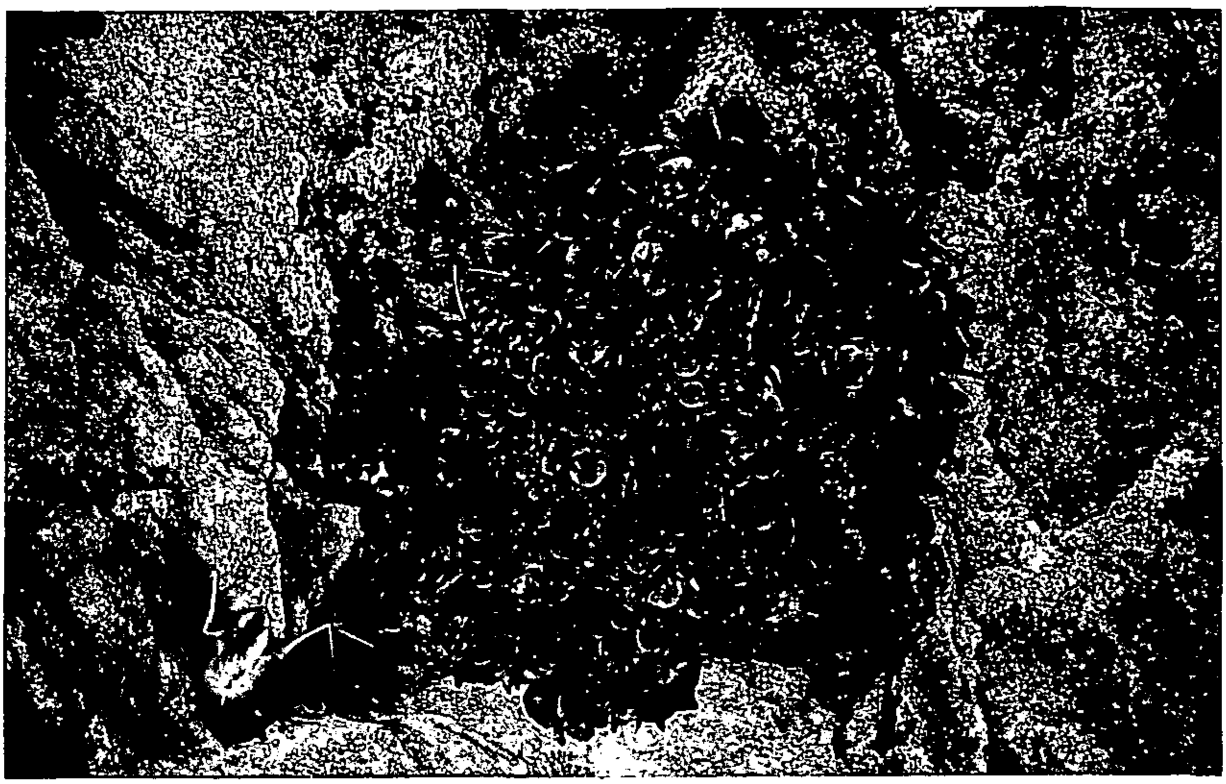

Photo 41. A mixed colony of *M. myotis/blythii* and *M. schreibersii* (Gökçeali cave, May'99).

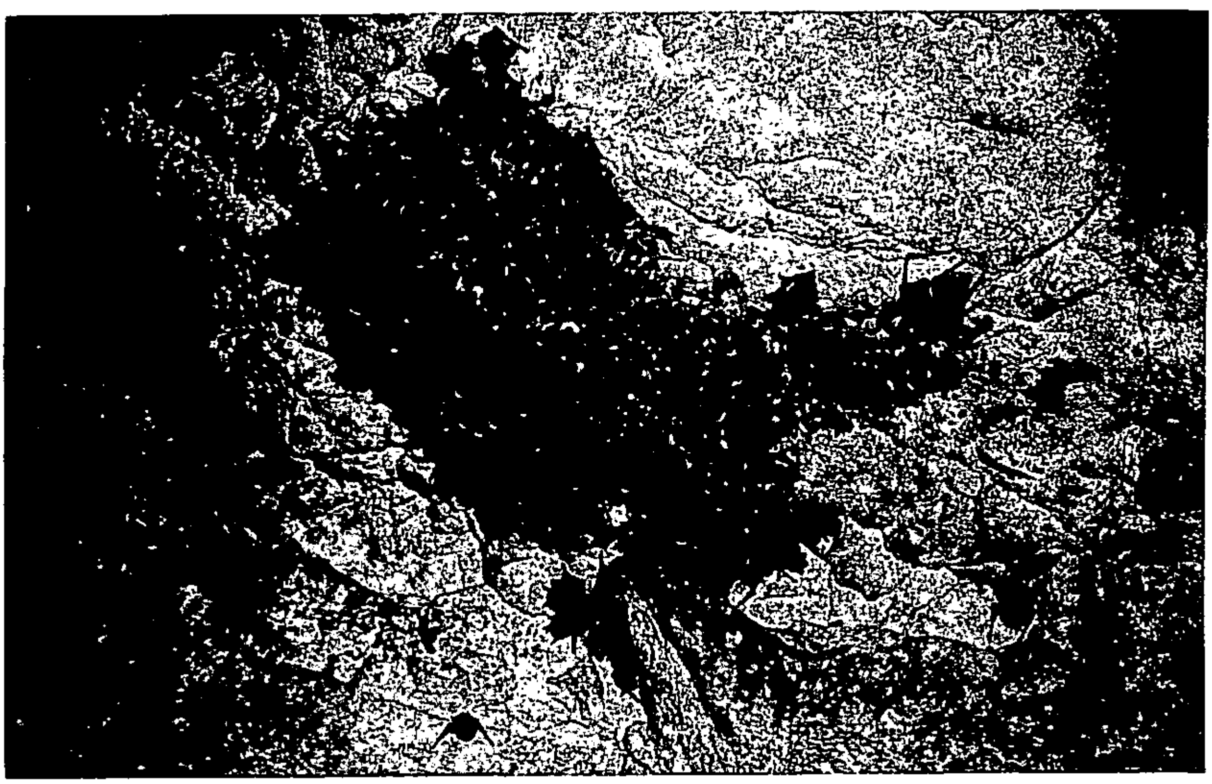

Photo 42. A mixed colony of *M. myotis/blythii* and *M. schreibersii* (Gökçeali cave, May'99).

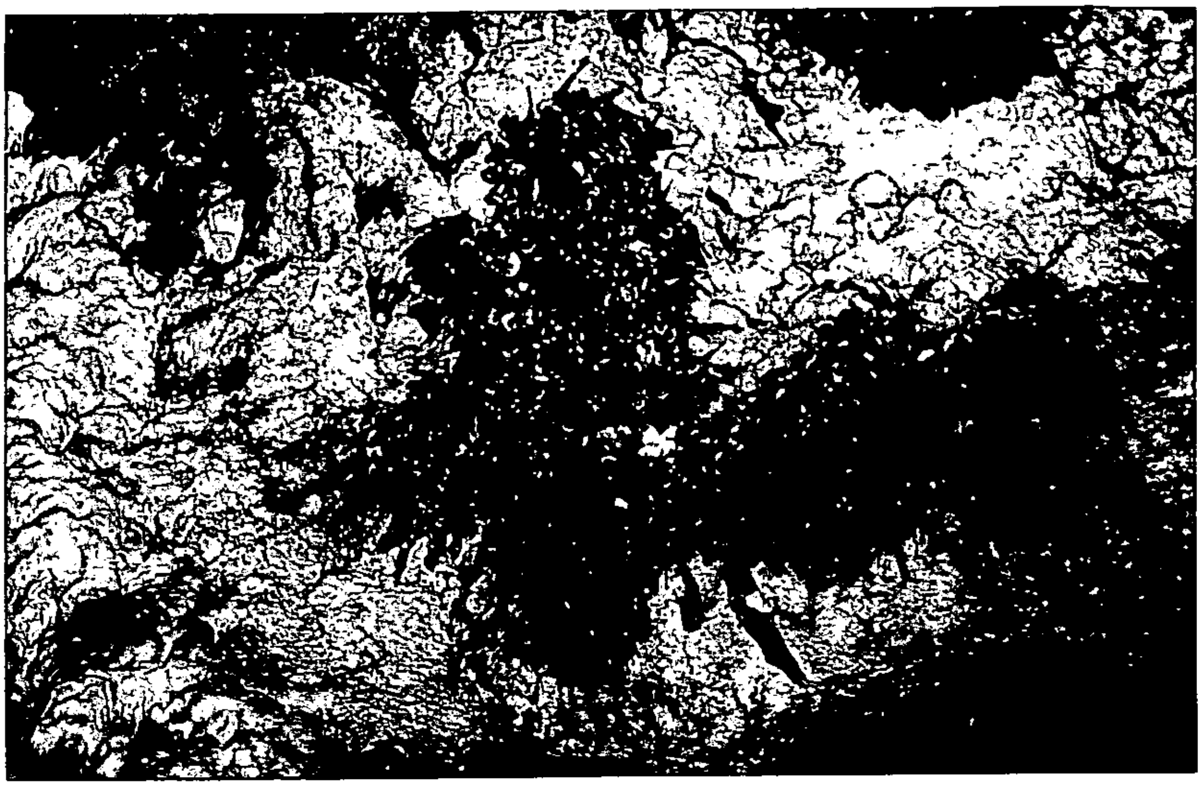

Photo 43. A mixed colony of *M. myotis/blythii* and *M. schreibersii* (Horataşı cave, July'99).

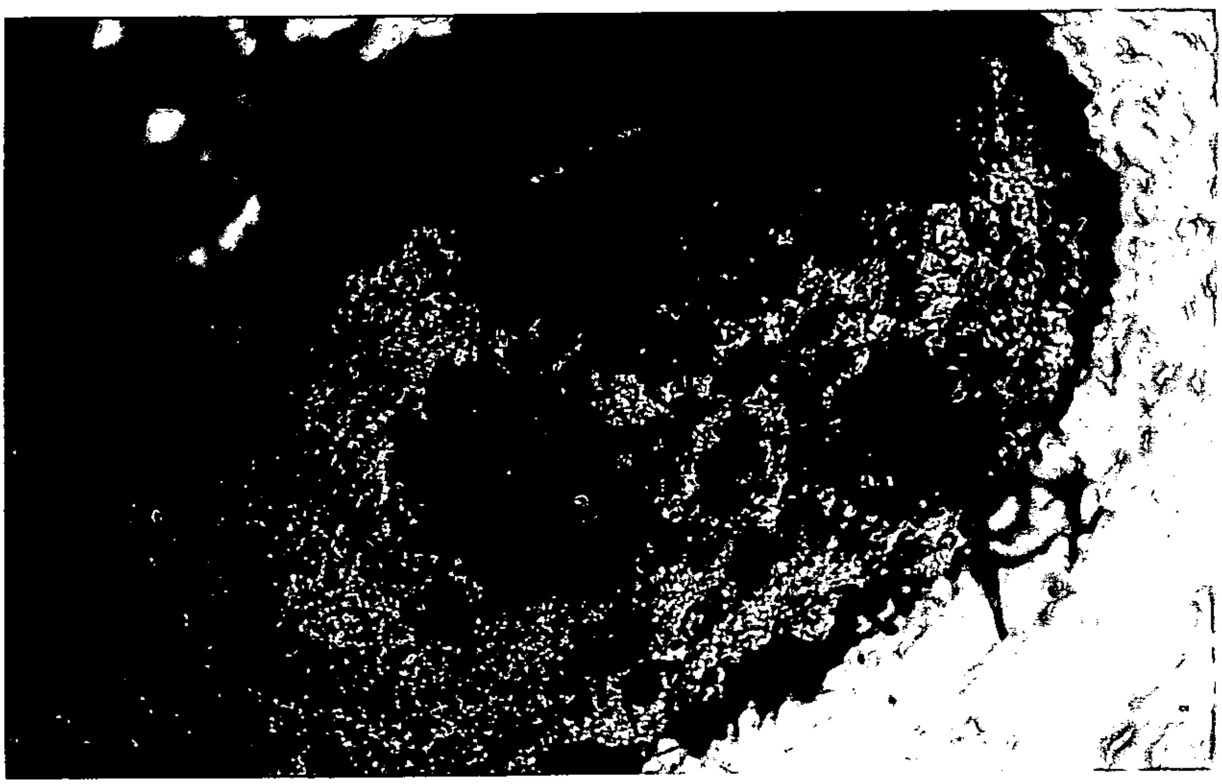

Photo 44. A mixed nursery of *M. myotis/blythii* and *M. schreibersii* (Yaylacık cave, July'99).

Photo 45. An individual of *M. capaccinii* (Gökçeören cave, March'00).

Photo 46. An individual of *M. capaccinii* (Gökçeören cave, March'00).

Photo 47. An individual of *M. capaccinii* (Gökçeören cave, July'99).

Photo 48. Individuals of *M. capaccinii* (Gökçeören cave, March'00).

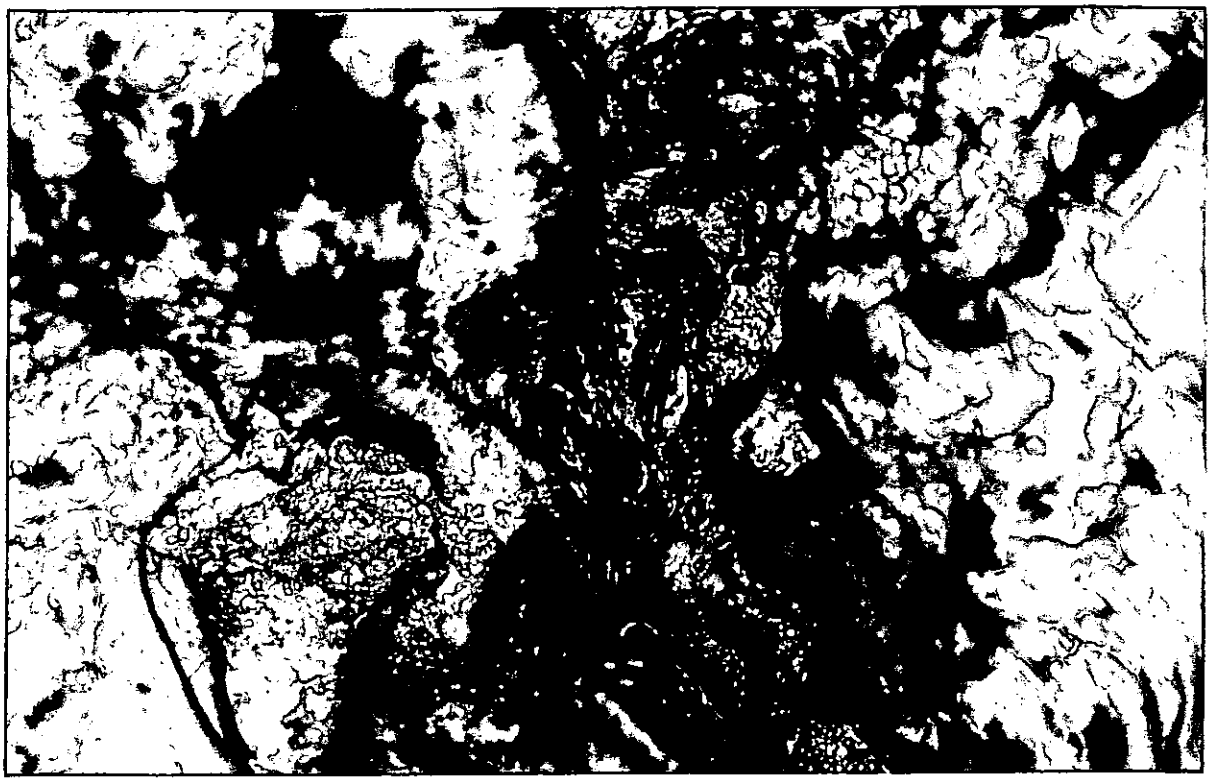

Photo 49. A cluster of *M. capaccinii* inside a crevice (Gökçeören cave, July'99).

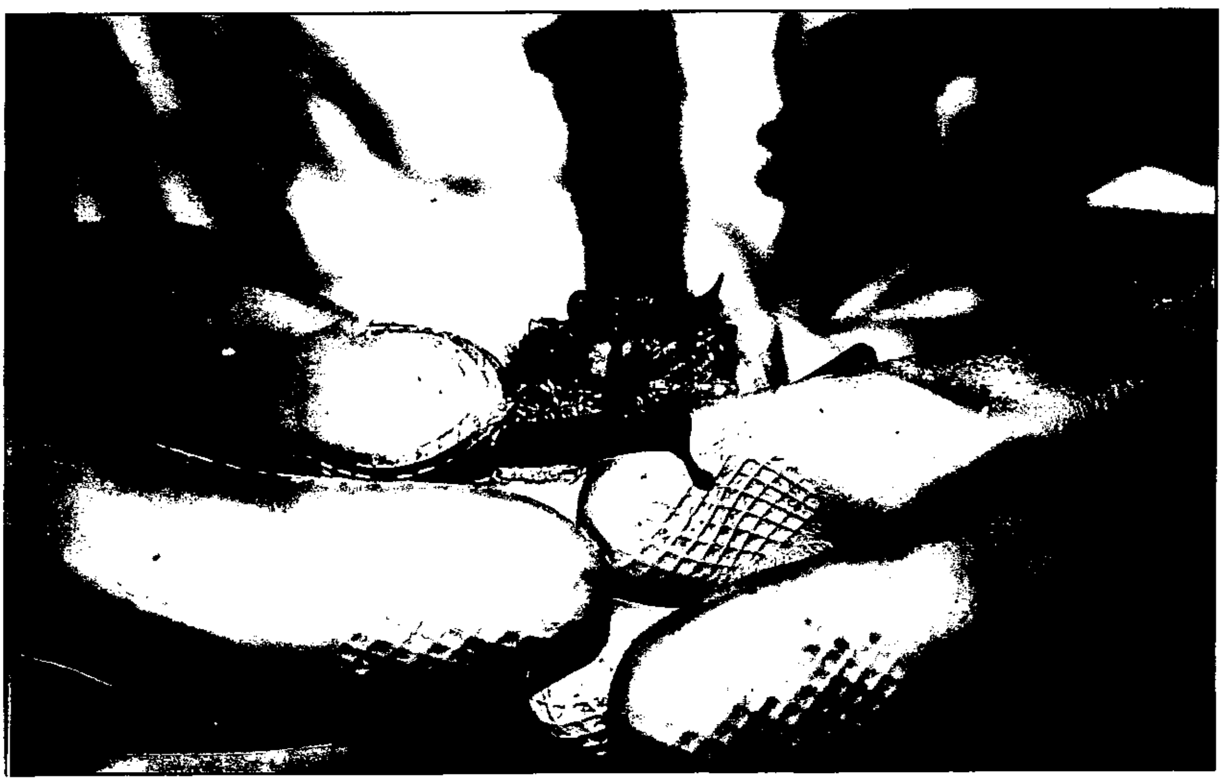

Photo 50. An individual of *M. emarginatus* (Horataşı cave, May'99).

Photo 51. An individual of *M. emarginatus* (Horataşı cave, July'99).

Photo 52. Identification of a specimen (*R. ferrumequinum*).

Photo 53. Identification of a specimen (*R. ferrumequinum*).

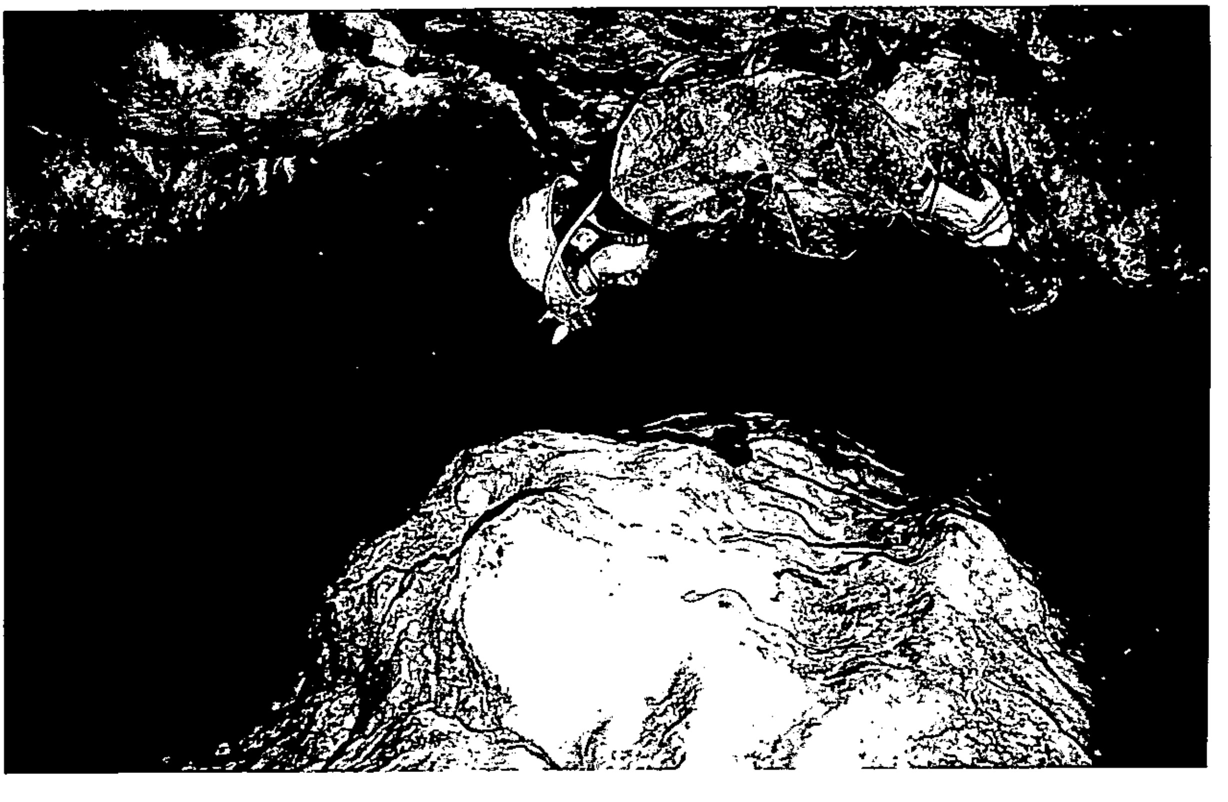

Photo 54. Identification of a specimen (*R. ferrumequinum*).

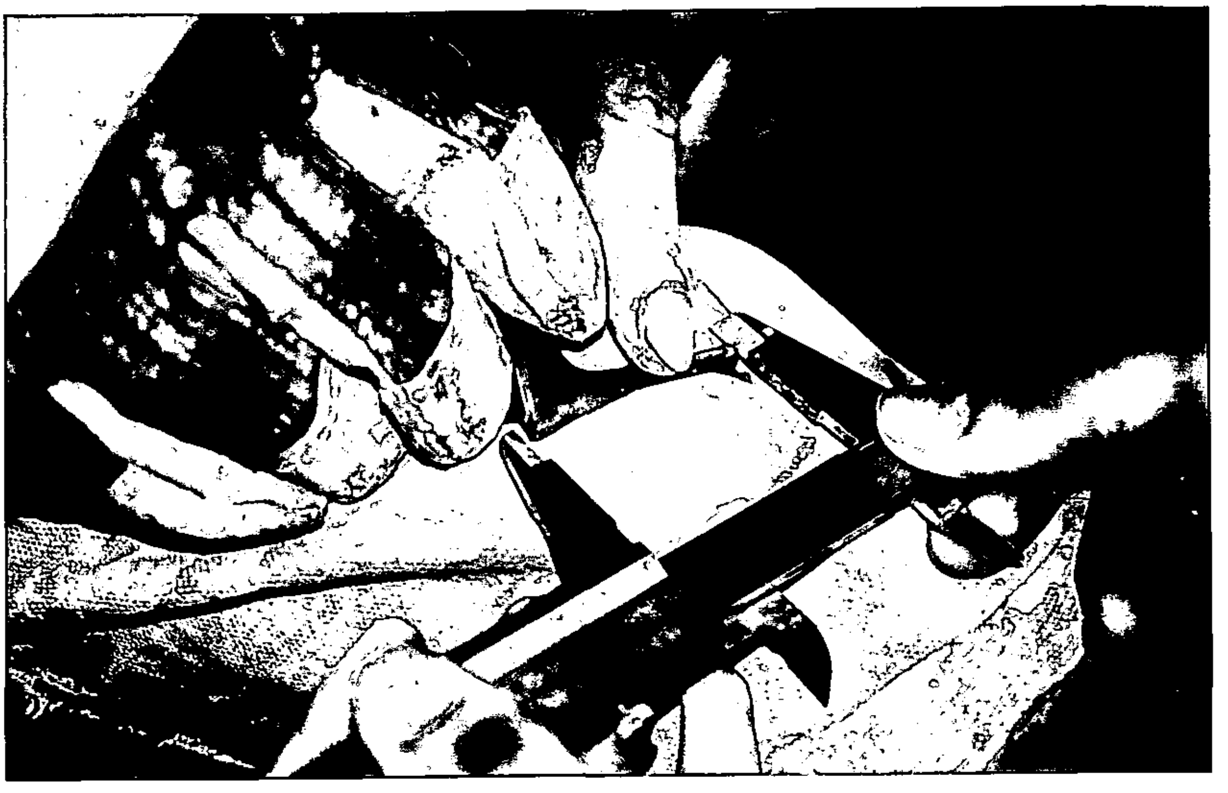

Photo 55. Measurement of a specimen (*M. capaccinii*).

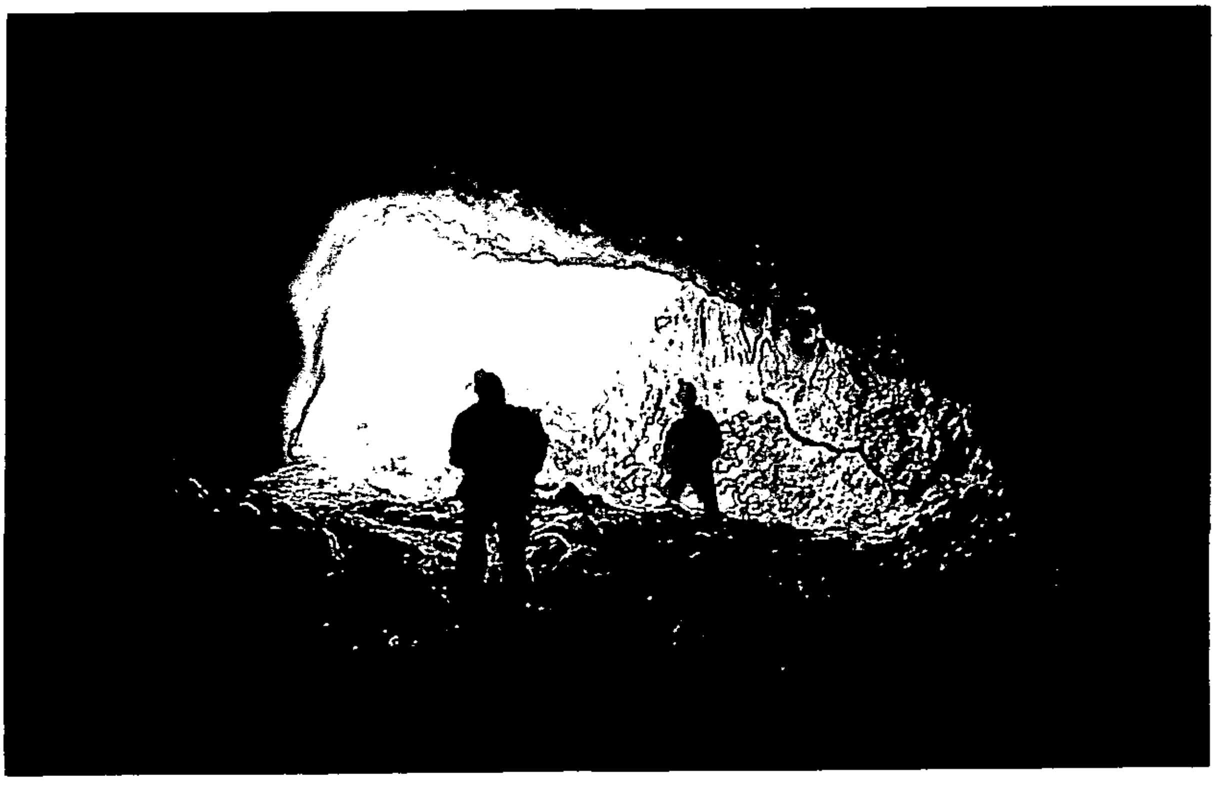

Photo 56. Descending inside the Kocakuyu cave.

Photo 57. Supervising bat volunteers in Kocakuyu cave.

Photo 58. With participants from the Speleological Society.

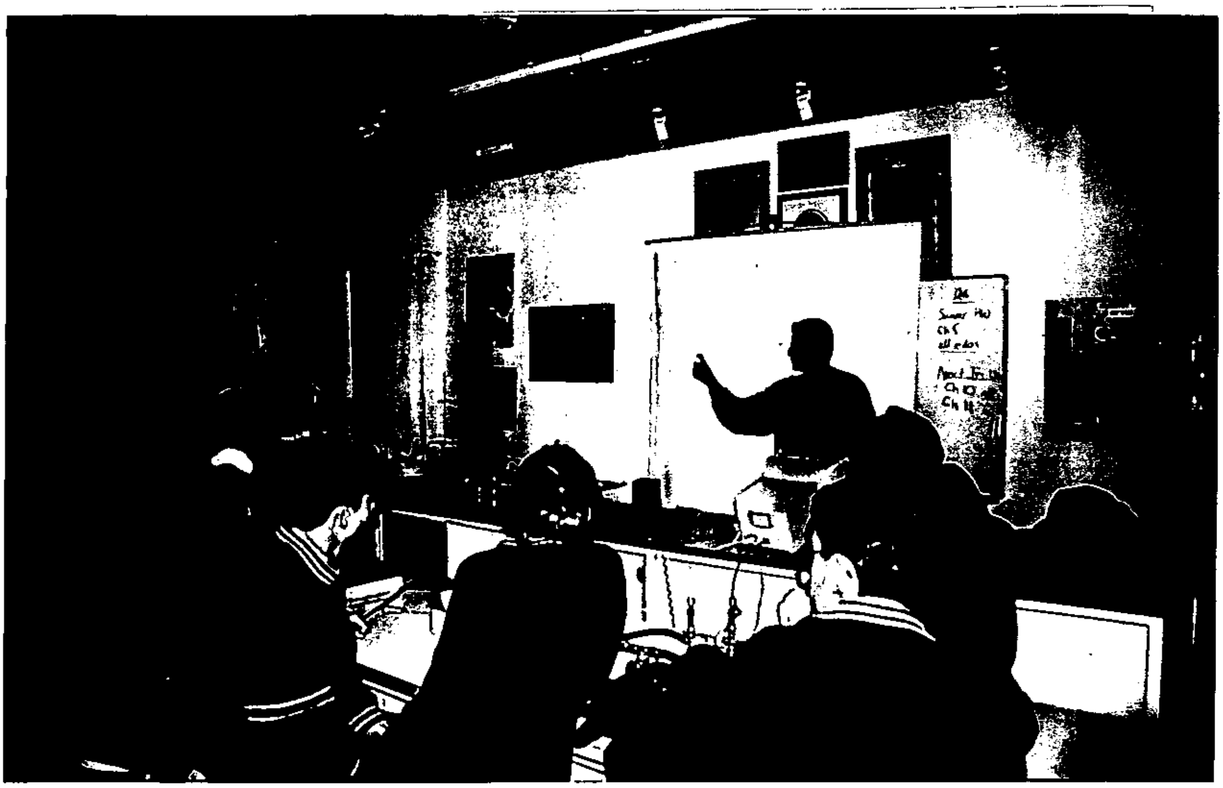

Photo 59. During a seminar for a high school audience.

Photo 60. A young bat-volunteer.

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