MONITORING FOR ENVIRONMENTAL CHANGE
THE EARTHWATCH EUROPE S'ALBUFERA PROJECT

A summary report of the fifth season's work 1993

by NICK RIDDIFORD and TERRY WELLS

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1. INTRODUCTION

This report outlines the fifth year of fieldwork for Earthwatch Europe's Project S'Albufera , carried out at S'Albufera Natural Park, Mallorca by a team of ecologists and volunteer fieldworkers. Fieldwork involved an established format of Earthwatch and Balearic volunteers assisting and working alongside specialist scientists for six weeks in spring and two weeks in autumn. In addition, a number of studies and monitoring tasks were carried out by scientists and resident Mallorcan volunteers outwith the designated Earthwatch Europe sponsored fieldwork periods.

Details of the establishment of the Project and choice of site were given in the first season's report (Newbould & Riddiford 1990) and its first four years' progress in Newbould & Riddiford (1990), Riddiford & Newbould (1991), Riddiford (1991), Riddiford & Perring (1992) and Riddiford (1993). The objectives of the Project were

(a) To assemble full & detailed ecological data, including climate, hydrology, soils, pollution, past & present land uses & cultural influences and reconstruction of past conditions to reach an understanding of composition, functioning and dynamics of major ecosystem types.

(b) To provide standardised comparative data for evidence of local, regional & global change, to be reconciled with aerial photography & space sensory data and to be re-recorded at intervals of time; to provide a model for other global monitoring stations.

(c) To afford material for application in further research & reserve management at S'Albufera and in general conservation practice.

(d) To provide resources for comprehensive interpretive programmes & dissemination in all appropriate forms.

(e) To serve as a focus for education of residents & visitors of all age-groups & levels and to help in creating environmental awareness & commitment.

Spring fieldwork in 1993 followed the now established pattern of three two-week teams, each separated by a gap of two days reserved for review of information gathered and further planning. There was a further two-week period of fieldwork in the autumn. There were 4 supervising scientists and 8 volunteers in the first spring team, 5 scientists and 8 volunteers in the second, and 9 scientists and 4 volunteers in the third. The autumn team comprised 7 scientists and 7 volunteers. Team dates were 28th March-11th April, 14th-28th April, 1st-15th May and 23rd October-6th November. The international nature of the Project continued. The teams contained volunteers from a number of countries, 7 from the United States, 6 from the United Kingdom, 2 from Germany, 7 from the Balearic Islands and 5 from peninsular Spain. Scientists were mainly British, but ecological interpretation designer Hannah Bonner (an American Mallorcan) was co-opted to Team I and the logistics for Team II were undertaken by Canadian Alexandra Torn.

To ensure the continued successful implementation of Project aims

and to increase contact and co-operation, valuable advice was sought and received from a number of visiting scientists including several members of the Universitat de les Illes Balears (UIB), Dr Edward Maltby from the University of Exeter's Wetland Ecosystems Research Group and vice-chairman of the IUCN's Commission on Ecology (Wetlands), Max Nicholson of Earthwatch Europe, all participating scientists, and the Park's director, Sr. Joan Mayol. The overall responsibility for planning and supervision, however, remained with the Project's Principal Investigators, who were Dr Terry Wells and Nick Riddiford. Details of all participants are given in Appendix 1.

2. PROJECT S'ALBUFERA FIELDWORK IN 1993

As before, baseline work continued to fill gaps in our knowledge but, with the Project entering its fifth consecutive year of fieldwork, research again focused mainly on the development and application of long-term monitoring, including the study of the processes at work in the ecosystem.

Botanical studies comprised a continuation of research already in place to investigate the influence of grazing by horses and other mammals on the vegetation of the fossil dunes, to obtain long-term data on orchid population dynamics and to record plant distribution within each of the Park's compartments. Baseline studies comprised further efforts towards making the already extensive reference herbarium of flowering plants as comprehensive as possible, and a first study of bryophytes through the collection of moss samples from a range of habitats.

Aquatic studies comprised continued research into the diversity and population size of dragonflies (Odonata) based on larvae. This research has been extended to include a range of other aquatic invertebrates considered to be of significance for monitoring change - particularly in relation to water quality. In addition, aquatic fauna and flora were sampled at the mouth of the Gran Canal to establish a marine life baseline.

A wide ranging monitoring programme was established for selected vertebrates and land invertebrates during 1989-92. Tasks related to this programme continued. These comprised regular transects to monitor butterfly numbers and distribution in relation to habitat and to monitor hoverflies (Diptera: Syrphidae); and transect and ringing studies to monitor bird population dynamics. Studies of the impact of Park habitats on the bird fauna included the use by bird species of grazed and ungrazed open areas of wetland during the spring migration period, and research into the body condition of migrants and breeding residents in spring and autumn. Bird faunal studies in relation to habitat were extended to include investigation of feeding behaviour, in the first instance by recording habitat choice and time budgets of Coot *Fulica atra*. Attempts were made, too, to investigate the impact of releasing a group of White-headed Ducks *Oxyura leucocephala* into the Park in March 1993 as part of a population recovery programme - though this was severely hampered by the elusive nature of the ducks.

Several aspects of the processes at work in the ecosystem were investigated. These included further work on the impact of moth larvae on the marshland plant *Phragmites australis*, concentrating on identifying the species involved, their phenology and life

cycles, their role in diversifying the reedbed structure in terms of stem damage and weakening, and evolutionary aspects of the resident Reed Bunting Emberiza schoeniclus witherbyi whose thick bill gives it access to the larvae. Another important ecosystem study researched the importance of S'Albufera for the Moustached Warbler Acrocephalus melanopogon , a species of specialised habitat and restricted World range. This was carried out in conjunction with Roy Taylor of University College London and demonstrated the international importance of S'Albufera to the species, as well as confirming its specialist needs and specific ecological requirements - in particular its need for old, undisturbed reedbeds with both vertical stands of Phragmites and a lower, horizontal layer of broken, dead material. Mammal studies also concentrated on reedbed sites and demonstrated that undisturbed reedbeds, including over water, were important for three species of mouse, with at least some separation of the species both spatially (including vertically within the reedbed) and temporally.

We also continued to expand our baseline knowledge, with studies of Marsh Frog Rana perezi distribution and temporal activity, further moth trapping and expansion of the invertebrate collection. Computerisation of baseline data continued, enabling us to draw up a first list of flora and fauna demonstrating the biodiversity of S'Albufera.

Research into human use of the Park continued by means of a survey of Park tracks and visitors; and a summary paper outlining the impact and importance of Ecotourism at S'Albufera and in Mallorca generally was submitted to the European Community Model of Sustainable Tourism (ECOMOST Project). In furtherance of education and interpretation objectives, the Project assisted Hannah Bonner, designer of interpretive display materials, with her modelling display of two major S'Albufera ecosystems, depicting freshwater and salt marsh habitats; and provided copy, photographs and translation facilities for the new S'Albufera Interpretation Centre. Further progress was made by Jo Newbould and Dinah McLennan towards producing interpretive material, including posters and a booklet, on the plants of S'Albufera.

Finally, "ground truthing" work was again undertaken in relation to remote sensing monitoring and, in the summer, another two research projects were undertaken for the Project by students from the University of Aberdeen's Department of Remote Sensing and Mapping Science using a combination of LANDSAT satellite images and "ground truthing".

3. FIELDS OF RESEARCH

The following is a summary, by category, of research studies by Earthwatch Europe's Project S'Albufera in 1993 (and see Appendix 2 for more details).

Marshes

Study continued, in spring and autumn, of the amounts and impact of infestation by internal stem-feeding larvae on the major marshland plant Phragmites australis . Research has demonstrated

that larvae of more than one insect species were involved and, to investigate this further, studies were extended, with the help of Mallorcan volunteers, into winter 1993-94. The results so far are presented in Annexes 1 and 2 of this report.

For further details of research into infestation of *Phragmites australis* by internal stem-feeding larvae at S'Albufera, see Riddiford (1993). For other studies of S'Albufera marshes ecology see Wood (1989, 1991), Riddiford & Newbould (1991) and Riddiford & Perring (1992).

Dunes

Fossil dunes . Study continued to monitor the impact of grazing by horses on the dune vegetation at Turo de Ses Eres, with particular reference to the distribution and development of the *Euphorbia terracina* population, a potential shade species apparently unpalatable to grazing animals. This involved plotting the position and stage of growth of individual plants within fixed quadrats in repetition of work begun in 1992, as a means of observing changes in their distribution and number. Details of methodology and initial results are given in Annex 3 of this report.

For further details of dune studies, see Wood (1991), Riddiford & Newbould (1991), Riddiford & Perring (1992) and Riddiford (1993).

Coastal/Marine Habitats

This new category was launched with a baseline study of the marine life at S'Oberta, where the Gran Canal meets the sea. A preliminary investigation of this coastal habitat, a man-made rocky breakwater, produced a total of 22 identified taxa representing 7 faunal and floral groups.

Flora

a) Species populations . For the third consecutive spring, British orchid population authority, Terry Wells, continued his study of long-term recruitment and survival rates of orchids, begun in 1991. He again located and mapped the exact position of all orchid plants within three large quadrats, two in the fossil dunes and one in marshland. He also monitored the distribution and population size of the marshland orchid *Orchis (laxiflora) palustris* . The results of his study were presented as a Poster display at the 1993 World Orchid Congress in Glasgow, Scotland. The poster was subsequently presented to Park director, Joan Mayol, for use in the Balearic Islands, including at the *Parc Natural de S'Albufera* .

b) Total list . New species of flowering plants continue to be found and specimens added to the Park herbarium. A total of 590 species are currently known from S'Albufera. Details of these were published in the first list of S'Albufera animals and plants (Riddiford & Nicholson 1993).

e) Mosses . A collection of mosses was made from a wide range of

S'Albufera habitats in autumn 1993, to fill a gap in our knowledge of the Park's biodiversity. Two sets were established, one remaining in Mallorca and the other taken to Britain for identification. Results of the identifications, undertaken by R. C. Stern, are presented in Annex 4 of this report.

For further details of botanical studies see Wood (1991), Newbould & Riddiford (1990), Riddiford & Newbould (1991), Riddiford & Perring (1992) and Riddiford (1993).

Invertebrates

a) Butterfly transects . Two transects designed to monitor butterfly habitat preferences and population variations, the first established in 1989 and the second in 1991, were repeated during regular walks throughout the spring and autumn fieldwork periods. For further details of butterfly transects, including methodologies, see Riddiford & Perring (1992).

b) Invertebrate database . Further records were gathered and collections made, mainly of Lepidoptera, to add to the on-site reference collection. Identifications and preparations of moth (Lepidoptera) specimens were undertaken by British moth authority, Barry Goater. Other insect identifications were provided by bug (Heteroptera) specialist, Dr Peter Kirby, and lacewing (Neuroptera) specialist, Colin Plant. We also received help and advice from members of the Balearic Invertebrate Group, based at the University of the Balearic Islands in Palma, particularly for beetles (Coleoptera) and spiders (Arachnida). A computer database record was made of all invertebrate, and other fauna and flora records. A detailed summary of moth studies is presented in Annex 5 and an up-dated moth list in Annex 6 of this report.

c) Hoverfly studies . The hoverfly (Diptera: Syrphidae) transect, established in 1991, was repeated by regular walks during the spring and autumn fieldwork periods. For further details of hoverfly studies, including transect methodology, see Riddiford & Perring (1992) and Riddiford (1993).

d) Dragonfly studies . Ed Cross continued to monitor dragonflies (Odonata) at their aquatic, larval stage, and extended his studies to include a range of other freshwater invertebrates. Fieldwork was undertaken in May and October. The results of his 1992 work are described in Annex 7 of this report. Details of his previous work are given in Riddiford (1993).

e) Beetle studies . The results of a 1992 pitfall trapping study of two beetle families (Coleoptera: Carabidae and Tenebrionidae) undertaken by members of the Balearic Invertebrate Study Group were published in 1993 (Palmer & Vives 1993). Forty-three species were recorded, five of them first records for the Balearic Islands. Details of this study have been summarised in Annex 8 of this report.

f) Spider studies . The results of a 1992 pitfall trapping study of spiders (Arachnida: Araneae) undertaken by a member of the Balearic Invertebrate Study Group were published in 1993 (Pons 1993). Fifteen of the fifty-three species trapped were first records for the Balearic Islands. Details of this study have been

summarised in Annex 8 of this report.

For further details of invertebrate studies see Newbould & Riddiford (1990), Riddiford & Newbould (1991), Riddiford & Perring (1992) and Riddiford (1993).

Vertebrates

a) Birds . Data were again obtained of temporal and longer-term fluctuations of breeding and migrant birds by means of two techniques. The first comprised two bird transects begun in 1989-90. Both were repeated at regular intervals in 1993 during the spring and autumn fieldwork periods. For details of the bird transect methodology see Riddiford & Perring (1992). The second comprised a constant effort ringing study (CES). This study, following methodology described in the 1991 report (Riddiford and Perring 1992), was conducted at Ses Puntes but, the second site, added in 1992 on the south-east edge of Es Colombar, was abandoned because of the introduction of grazing animals there - providing a physical problem of net placement and a change in circumstance which invalidated any further `constant effort' effect.

Work begun in 1991 on the body condition of birds using S'Albufera was continued. A suite of useful data was again obtained for a number of species, particularly in the autumn from roosts of wintering and/or transient White Wagtails Motacilla alba and resident and migrant Reed Buntings Emberiza schoeniclus . A new site developed at the north-east corner of Es Colombar in the autumn proved successful for the collection of data for weight, adipose fat and muscle condition for a good sample of birds. S'Albufera was host in October-November 1993 to part of an exceptional irruption of Siskins Carduelis spinus , normally rare visitors to Mallorca, and opportunity was taken to obtain a run of data for that species as it fed on Chenopodium album seeds at Sa Roca.

Further study was conducted into the ecology and morphology of S'Albufera Reed Buntings and their role as predators of the moth larvae of Phragmites stems. Observations were made of Reed Bunting feeding behaviour, and morphological data obtained by trapping. Autumn trapping activities enabled the morphological study to investigate structural differences between resident and visiting migrant individuals.

For the first time in 1993, studies were made of habitat choice and time budgets of birds. The two species involved were Coot Fulica atra and White-headed Duck Oxyura leucocephala . Coot was chosen for initial research in this field because it is a significant year-round constituent of the avifauna of open, wet habitats at S'Albufera; White-headed Duck to study the reactions and interactions of captive individuals released into the Park as part of a species recovery programme.

The results of the Siskin study, Reed Bunting bill morphology and other bird trapping studies are presented in Annex 9, the Coot study in Annex 10 and the White-headed Duck study in Annex 11 of this report.

b) Mammals . Following a preliminary trapping study in October 1992, more detailed systematic trapping was undertaken in May and October-November 1993 to establish utilisation of habitats, populations and inter-specific relationships for three species of mouse at S'Albufera. Data were also collected for a range of other species, and the mammal transect established in 1991 was continued. Results of the mouse study are given in Annex 12 of this report.

c) Frogs . Two studies were undertaken in spring, one to assess Marsh Frog *Rana perezi* distribution and the other to assess its activity patterns. Results of these studies are presented in Annex 13 of this report.

For further details of vertebrate studies see Wood (1991), Newbould & Riddiford (1990), Riddiford & Newbould (1991), Riddiford & Perring (1992) and Riddiford (1993).

Meteorology

Meteorological data were collected daily by Park staff.

Remote Sensing

"Ground-truthing", under the supervision of Bernie Young, was again carried out in May 1993; and for the second successive year in-depth studies were undertaken by two students of the University of Aberdeen's Centre for Remote Sensing and Mapping Science. The results of the Centre for Remote Sensing studies were presented in Gonzalez (1993) and McGovern (1993).

Data Management

Data management work in 1993 focused strongly on formulating a database structure suitable for the recording of all biotic records and of sufficient flexibility to be compatible with similar systems, upgrades and other improvements. By the end of the year, a database was in place and holding all S'Albufera records for fauna and flora known to the Project. The database records formed the basis of a first biodiversity list for S'Albufera, produced in 1993 (Riddiford & Nicholson 1993). The structure of this work is described in Annex 14 of this report.

The Human Factor

a) Park visitors . At the request of the Park authorities, Earthwatch Europe volunteers undertook a visitor survey in April. Though April is not the peak tourist season in Mallorca, it is the busy month for visitors to the Park, demonstrating the role S'Albufera is playing in extending the tourist season and attracting visitors with specialist (environmental) interests to the island. Figures for 17th April 1993 indicated that a minimum of 433 visitors used the Park that day. This is very much a minimum because the Earthwatch team was too small to do a complete survey, and only visitors using the main entrance track

were counted. The total comprised visitors leaving by the main track. Only 341 entered by that route, indicating that a considerable proportion entered along other tracks. Visitors both entering and exiting the Park by other entrances would not have been counted. The survey also collected details of mode of transport. The proportion entering by motorised vehicle was 44%, by bicycle 29% and on foot 27%. Visitors are not permitted to leave the pathways, so wildlife disturbance is minimal. They do, however, have an impact on the Park infrastructure, including the tracks. We calculated through measurement that the area used by the majority of visitors (tracks, hides, etc.) was 15,431 m 2 or just over 1.5 hectares. This amounts to just under 1% of the Park. Knowledge of visitor numbers and how they use the Park are important factors in management planning and implementation.

b) Ecotourism . A more general overview of visitors was made in the autumn in a summary paper outlining the impact and importance of Ecotourism at S'Albufera, which was submitted to the European Community Model of Sustainable Tourism (ECOMOST Project). For futher details see Annex 15 of this report.

Interpretation and Education

Work done by Project S'Albufera is increasingly being used as resource material for educational and interpretation purposes. This included, in 1993, input into a teacher's resource pack aimed at primary teachers throughout the UK. The pack, entitled Water and the Environment, was designed by the Centre for Environmental Education, Cheltenham, and developed by Earthwatch Europe through funding by Whitbread plc. In addition, scientific study and interpretation was a major theme of Coneguem el Parc Natural de S'Albufera ("Know S'Albufera Natural Park"). This work-book for Mallorcan schoolchildren, produced in 1993 by the Balearic conservation service's Environmental Education Team (which includes a past Project S'Albufera volunteer), builds on the impressive S'Albufera model for environmental education which is well-established for Mallorcan schoolchildren and was, in spring 1993, extended to include a guide-rope itinerary for the blind supported by a brail and sensory interpretation programme. Project S'Albufera teams also supplied material for and contributed manually to the preparation of the new S'Albufera Interpretation and Display Centre, scheduled to be officially opened in 1994. Finally, work by Dinah McLennan and Jo Newbould to provide interpretation material on the plants of S'Albufera continued in the form of water-colour representations of major habitats (freshwater marsh representation by Dinah already complete), to be produced as posters; and a flower guide for visitors currently in preparation.

For further details of interpretative work, see Annex 16 and Annex 17 of this report.

4. ADDITIONAL STUDIES

The Project pursued its policy of augmenting the wide ranging data gathering during the Earthwatch Europe spring and autumn fieldwork programme with additional more specific research at other seasons. In 1993 the Project benefited from the

participation of a number of specialist individuals and groups. Post-graduate studies were again carried out by two members of the University of Aberdeen's Centre for Remote Sensing and Mapping Science, one member of University College London's Ecology and Conservation Unit and, for his third and final season, Jon King of the Edward Grey Institute of Field Ornithology, University of Oxford. There was an increased interest in participation by members of the UIB, in particular by Dr Hip$lito Medrano who brought members of his Department of Vegetal Physiology to begin studies of the physiology (including productivity and carbon cycling) of the reedbed plants. In March the University of Durham's Department of Biological Sciences ran a course of applied studies for their MSc Ecology students, a successful venture which will be repeated in 1994.

Routine monitoring and data collection outside the field work periods was carried out by members of the Park staff (particularly meteorological and hydrological recording). The Project's scientific team was also greatly assisted by follow-up data collections undertaken in winter 1993-94 by local volunteers Bernat Bergas, Cristina Moy… (parasitism of *Phragmites* stems by insect larvae) and Nicole Smith (frog activity patterns).

Research by the Centre for Remote Sensing and Mapping Science students in 1993 comprised a study of the distribution and changes in woodland cover on the mountains forming the water catchment area for S'Albufera and a study to detect urban change, including on land adjacent to the Park. The first three years' work by the Project demonstrated the need to consider the role of the entire catchment area to fully understand the workings of the Park and its ecosystems. Both studies are pertinent to our understanding of changes and events impacting on the Park, the first in relation to the water resource and the second in relation to tourist and other urbanisation developments. The studies used LANDSAT images shared by the Centre and Earthwatch Europe, with ground-truthing fieldwork undertaken in summer 1993. Both studies culminated in Master's dissertations (Gonzalez 1993; McGovern 1993), copies of which have been deposited at the Parc Natural de S'Albufera and at Earthwatch Europe's office in Oxford, England.

An important study undertaken in summer 1993 comprised research into the habitat and feeding ecology of the Moustached Warbler *Acrocephalus melanopogon* . The study, undertaken by Roy Taylor of the University Colleg London's Ecology and Conservation Unit, revealed many aspects of Moustached Warbler ecology and the species' role in the ecosystem. He applied his findings to produce guidelines for management planning sympathetic to this species of specialised habitat and restricted World range. The results of his study were presented in a Master's dissertation (Taylor 1993), copies of which have been deposited at the Parc Natural de S'Albufera and at Earthwatch Europe's office in Oxford, England. Taylor's study relates to many aspects of Project S'Albufera work on the marshland ecosystem so, to make his work more accessible, extracts of his findings, conclusions and guidelines are presented in Annex 18 of this report.

In May 1993, Jon King of the Edward Grey Institute of Field Ornithology, University of Oxford, completed his third and final season of research into aspects of Fan-tailed Warbler *Cisticola juncidis* breeding behaviour and ecology, at S'Albufera. The

results of this research will be presented as a Doctoral thesis, currently in preparation.

The involvement of Mallorcan and Spanish nationals in S'Albufera studies is of vital importance to the Project on several levels. These include improved perception of the value and aims of the Project locally, nationally and internationally, ease of access to the site at all seasons and the introduction to the Project of local experience and expertise. Volunteer, University and Park staff help in 1993 has been outlined above. A number of recent examples have led to publication of results. In 1992 work on spiders was carried out by Guillem Pons and on beetles by Miquel Palmer, both of the Balearic Institute of Advanced Studies and Balearic Invertebrate Study Group. The results of their respective studies were published in 1993 in the Bulletin of the Balearic Natural History Society (Pons 1993; Palmer & Vives 1993) and are summarised in Annex 8 of this report. Similarly, work by F. Esteve-Ravent¢s of the Department of Vegetal Biology, University of Alcal de Hernares, Madrid and M. Enderle of Leipheim-Riedheim, Germany on fungi at S'Albufera led to the discovery of a previously unknown species of *Psathyrella*, ecologically linked to to one of S'Albufera's dominant marshland plants, *Cladium mariscus*. An account of this exciting discovery and a description of the new taxa is given in Esteve-Ravent¢s & Enderle (1992).

5. PROGRESS AND FUTURE PLANNING

Project S'Albufera has been conducted during the past five years by teams organised by Earthwatch Europe, whose headquarters is situated at Oxford, England. Direction has been in the hands of a Trustee, E. M. Nicholson, former Director-General of the UK Nature Conservancy. Operations in the field have been led by a series of Principal Investigators including Professor Palmer Newbould, Dr Franklyn Perring, former head of the official Biological Records Centre at Monks Wood and Dr Terry Wells of Monks Wood, continuously supported by Nick Riddiford, recently head of the Fair Isle Bird Observatory, and by a number of universities, of which the Ecology and Conservation Unit of University College London, the Centre for Remote Sensing and Mapping Science, Aberdeen and the University of the Balearic Islands have been most active. Despite obvious British links and an apparent bias towards British scientists, the Project is truly international in its organisation, participants, structure and outlook. Nevertheless, there has been a perception of it as a `British project operating on foreign soil' and this may have been to the detriment of the Project, including in the pursuit and acquisition of funding. From the start Project planning has recognised and sought to encourage the participation and a move towards responsibility by conservation and scientific bodies based in the Balearic Islands and Spain; and the involvement by research departments from across Europe and beyond. This has been a gradual process, but major steps are now being taken to develop and encourage the Project's international and Balearic/Spanish aspect.

While Earthwatch Europe has hitherto borne the main organising responsibility this is about to be transferred to a new international partnership, the Balearic International

Environmental Research Centre. This will bring together the direction of the Parc Natural , the University of the Balearic Islands and other European universities, with the continued support and participation of Earthwatch Europe. The Director-designate is Nick Riddiford, through whom continuity will be ensured.

Funding difficulties have been a reality from the Project's inception, and without the unstinting support and efforts of Earthwatch Europe the Project would have long since folded. Limited resources have not prevented the Project from achieving an enormous amount (as this and previous reports clearly demonstrate) but the Project needs more support, in terms of substantial funding targeted at specific areas of detailed research and international scientific involvement, if it is to build successfully on innovative and solid beginnings. The creation of an international Centre, based in Mallorca, not only frees Earthwatch Europe from the responsibilites and burdens of meeting the Project's additional demands, but forms a platform from which the Project may strive to achieve its long-term objectives. Earthwatch Europe will continued to support the Project, however, through its normal channel of providing volunteers to assist at designated fieldwork periods.

Details of the 1994 Project S'Albufera programme are given in Appendix 3.

6. ACKNOWLEDGEMENTS

As may be expected from an international, multi-disciplinary Project, the Principal Investigators (and editors of this report) owe a debt of gratitude to many people and organisations. Over the five years of its existence, Project S'Albufera has brought together a team of loyal, dedicated and skilful scientists who give of their time and expertise freely and willingly. We, and they, could not operate successfully without the help of a truly international set of volunteers, drawn in 1993 from Britain, the United States, Canada, Germany, Mallorca, Menorca and mainland Spain. We, the scientists and volunteers, would not be able to operate effectively within the Park without the enthusiastic support and help of all the Park staff. The guidance and advice given on numerous matters, logistic and scientific by the Park's technical assistant and liaison officer to the Project, Biel Perell¢, was again of enormous value, as was his skill in obtaining the services of excellent Balearic and Spanish volunteers. Other volunteers came through Earthwatch, including the very welcome newly established Earthwatch Spain office. As in previous years, they integrated well and were of the highest quality.

We would not have been able to operate at all without the consent of the Estructures Agraries i Medi Natural section of the Balearic Conselleria d'Agricultura i Pesca . This department has offered far more than mere consent, their high level of co-operation doing much to smooth the way and operations of our research. For this we express our sincere thanks to its Director General, Sr. Fernando Garrido Pastor, Sr. Mateo Castello Mes, and the Conservation Director, Sr. Joan Mayol Serra. Joan Mayol, in particular, continues to strive tirelessly on our behalf, during fieldwork periods and throughout the year.

In addition to supplying volunteers, the organisations of Earthwatch, Earthwatch Europe and Earthwatch Espa¤a, their members and staff in Boston, Oxford and Madrid, were again supportive and helpful in numerous ways. Many friends within and outwith the Balearic Islands continued to support our cause and give encouragement. They included Pat and Dennis Bishop, the Bonner family, the Friends of S'Albufera , the Natural History Society of the Balearic Islands, several departments of the University of the Balearic Islands, the Balearic Invertebrate Study Group, Professor Ed Maltby of the University of Exeter's Wetland Ecosystems Research Group, and many individuals. We especially thank Mallorcan residents Bernat Bergas, Cristina Moy… and Nicole Smith for collecting additional data outside the fieldwork periods. We also gratefully acknowledge the input of individuals and groups undertaking research on our behalf: from University College London's Ecology and Conservation Unit, University of Aberdeen's Centre for Remote Sensing and Mapping Science, and the University of Durham's Department of Biological Sciences. Once again, we offer special thanks to Project advisor, Max Nicholson, for his committed guidance, planning and support. Finally, the scientific work could not have run smoothly without the behind-the-scenes efforts of logistics co-ordinators Sara Hawkswell (Team I), Alexandra Torn (Team II) and Chris Donnelly (Teams III and IV) and the highly appreciated bonus of superb meals provided by Park cook, Margalida Moranta.

The number of advisors, helpers and supporters grows longer each year, increasing the chance of omissions. To all who have helped, named or otherwise, we extend our warmest thanks. They include all participants in, and visitors to, the Project, detailed in Appendix 1 below.

APPENDIX 1 - List of Participants

Principal Investigators
Dr Terry Wells and Nick Riddiford

Scientific/Logistics Assistants
Sara Hawkswell (Computerisation of data, Team I Logistics), Alexandra Torn (Team II Logistics), Chris Donnelly (Ecological studies, Team III & Team IV Logistics)

Parc Natural de S'Albufera Advisor to Project
Joan Mayol (Director of Balearic Natural Areas, Mallorca)

Parc Natural de S'Albufera Liaison Officer to Project
Biel Perell¢ (Conselleria d'Agricultura i Pesca, Estructures Agraries i Medi Natural)

Cook
Margalida Moranta

Team 1 (28 March-11 April)

Scientists
Nick Riddiford (PI), Sara Hawkswell (computerisation of data), Alan Radermacher (reedbed plant-insect interactions), Hannah Bonner (designer of interpretive display materials)

Volunteers
Nadene Donner, Timothy A Haselton (USA), Robert Barrington, James Farrer (UK), Jaume Mas Canyelles (Mallorca), Fernando Saura Gonzalez de Lara (Menorca), Pamela Cooper, Marlyn K Namato (Peninsular Spain)

Team 2 (14-28 April)

Scientists
Nick Riddiford (PI), Terry Wells (PI), Sheila Wells (orchid studies, mycology), Jon King (ornithological studies), Alexandra Torn (logistics)

Volunteers
Betty Pridy, Gail Dempsey, Connie Waymer, Corinne Dale (USA), Daniela Dalk (Germany), Julio Valera Torres, Neus Verdera Bonnin, Miguel Angel Vicens i Siguier (Mallorca)

Team 3 (1-15 May)

Scientists
Nick Riddiford (PI), Edward Cross (odonata), Bernie Young (ground-truth studies for remote sensing), Sara Hawkswell (computerisation of data), Rob Strachan (mammal studies), Dinah McLennan (botanical studies and illustrations), Jon King (ornithological studies), Michael Wood (ornithological studies),

Christine Donnelly (logistics)

Volunteers
Hilary Potter, Jim Potter (UK), Sergio Romero de Tejada Martinez (Catalunya, Spain), Maria Zas Anegui (Spain)

Team 4 (23 October-6 November)

Scientists
Nick Riddiford (PI), Edward Cross (freshwater invertebrate studies), Alan Radermacher (reedbed plant-insect interactions), Rob Strachan (mammal studies), Roy Taylor (ornithological studies), Roger Riddington (ornithological studies), Chris Donnelly (logistics)

Volunteers
Kenneth April (USA), Rosemary Baxendale, Barbara Duguid (UK), Bernat Bergas Fiol, Cristina Moy… Company (Mallorca), Javier Sanchez Vaquero (Peninsular Spain), Monika Schrepfer-Shaefer (Germany)

Additional scientist and volunteer contributions

19th-26th March
University of Durham, M.Sc. Ecology field course

Scientists
Professor Peter Evans, Dr Brian Huntley, Dr Philip Hulme, Dr Nigel Dunstone, Robert Strachan, Gill Hinchcliffe

Students
Liz Allchin, Annette Brodeth, Nick Brodin, Eula Eliades, Marjorie Waddecar, Margaret Heath, Jenny Duckworth, Eileen Brennan, Heather Luff, Jo Payne, Sarah Hanley, Dave Bell (UK), Isabelle Alenns (Belgium), Antonia Siquier Crespi (Mallorca), Miquel Cifre (Mallorca)

April
Andy Dossett (Biological Imaging, Univ of Derby): environmental studies through photography

April-May
Jon King (Edward Grey Institute of Field Ornithology, University of Oxford): ornithological studies

June-July
Manuel Gonzalez, Paul McGovern (Centre for Remote Sensing and Mapping Science, University of Aberdeen): remote sensing studies

June-August
Roy Taylor (Ecology and Conservation Unit, University College London): Moustached Warbler ecology studies

October
Jo Newbould, Dinah McLennan: botanical interpretation studies

Winter 1993-94
Bergat Bergas, Cristina Moy…: (parasitism of Phragmites stems by insect larvae)
Nicole Smith: (frog activity patterns)

Identification advisors in U.K.
Barry Goater (Lepidoptera: moths)
Pete Kirby (Heteroptera: bugs)
Dave Moon (Lepidoptera: silk-moth)
Colin Plant (Neuroptera: lacewings)
R.C. Stern (Bryophyta: mosses)

Visitors to the Project
Max Nicholson (Earthwatch Europe)
Professor Edward Maltby (Wetland Ecosystems Research Group, University of Exeter; vice-chairman of the IUCN's Commission on Ecology (Wetlands))
Jose Antonio Gainzarain, Judit Jausoro (Basque Country, Spain), Alfonso Gonzalez (Dept of Geography, Univ. of Calgary, Canada)
Anton¡ Martinez Taberner, (Dept. Biologia, Univ. Illes Balears)
Hip¢lito Medrano Gil (Dept. Fisiologia Vegetal, Univ. Illes Balears)
Pat & Dennis Bishop (Friends of S'Albufera)
Juan Carlos Muntaner Cerda (Treasurer, Friends of the Albufera)
Graham Hearl (Mallorca RSPB/GOB representative)
Representatives of Friends of S'Albufera and the Grupo Ornitologico Balears

Staff, Parc Natural de S'Albufera
Joan Mayol i Serra - Director
Gabriel J. Perell¢ i Coll - Technical Assistant
Lloren‡ Capell - Chief Warden
Alexandre Forteza i Pons - Reception Centre
Pilar Lacalle Pons-Estel - Reception Centre
Pere Vi‡ens i Siquier - Ornithologist
Jaume Gamundi Capo - Guard
Vi‡ens Lillo Colomar - Guard
Manuel Coello Vazquez - Maintenance
Anton¡ Ray¢ Amengual - Maintenance
M'Angels Ferragut Mu¤oz - Monitor
Anton¡ Verd Canellas - Monitor
Jeronia A. Bonnin Roca - Monitor
Margalida Moranta Pericas - Cook

APPENDIX 2 - 1993 Fields of Research

The following is a catalogue of information collected in 1993. This information, along with 1989-92 material, has been deposited at Earthwatch Europe's Oxford (UK) headquarters. A second set of the material is held at S'Albufera Natural Park. Details of published material are given in Appendix 4.

Category : Marshes
Title of Work Done :
Phragmites infection by caterpillars.
Catalogue Reference Number : 93/10

Category : Dunes
Title of Work Done :
T he impact of grazing: distribution of Euphorbia terracina at Turo de Ses Eres.
Catalogue Reference Number : 93/15

Category : Coastal/Marine Habitats
Title of Work Done :
Marine life baseline.
Catalogue Reference Number : 93/13

Category : Flora
Title of Work Done :
Orchid population studies.
Catalogue Reference Number : 93/16

Category : Flora
Title of Work Done :
Bryophyte survey.
Catalogue Reference Number : 93/17

Category : Vertebrates
Title of Work Done :
Bird habitat choice and time budgets: Coot.
Catalogue Reference Number : 93/1

Category : Vertebrates
Title of Work Done :
Bird habitat choice and time budgets: White-headed Duck.
Catalogue Reference Number : 93/2

Category : Vertebrates
Title of Work Done :
Bird population surveys: Moustached Warbler census.
Catalogue Reference Number : 93/4

Category : Vertebrates
Title of Work Done :
Bird population surveys: grazing marsh study.
Catalogue Reference Number : 93/5

Category : Vertebrates
Title of Work Done :
Bird population surveys: transects 1 and 2.
Vegetation description of bird transect 1.
Catalogue Reference Number : 93/12

Category : Vertebrates
Title of Work Done :
Ringing studies: bird population survey.
Ringing studies: Reed Bunting ecology and morphology.
Ringing studies: condition of migrant birds.
Catalogue Reference Number : 93/14

Category : Vertebrates
Title of Work Done :
Mammal studies: small mammal trapping.
Mammal studies: Mammal observations.
Mammal studies: Mammal transect.
Catalogue Reference Number : 93/6

Category : Vertebrates
Title of Work Done :
Marsh Frog studies: population, distribution and activity.
Catalogue Reference Number : 93/7 Marsh Frogs

Category : Invertebrates
Title of Work Done :
Butterfly transects.
Catalogue Reference Number : 93/3

Category : Invertebrates
Title of Work Done :
Invertebrate collection: moths, hoverflies and beetles.
S'Albufera moth list.
Catalogue Reference Number : 93/11

Category : Invertebrates
Title of Work Done :
Hoverfly studies.
Catalogue Reference Number : 93/9

Category : Invertebrates
Title of Work Done :
Freshwater Invertebrate studies.
Catalogue Reference Number : 93/18

Category : Meteorology
Title of Work Done :
Park meteorological data.
Catalogue Reference Number : 93/19

Category : Park Management
Title of Work Done :
Visitor studies: park tracks; visitor survey
Catalogue Reference Number : 93/8

Category : Data Management
Title of Work Done :
Biodiversity data base.
Ca talogue Reference Number : Computer Disk " Project S'Albufera

Biodiversity List "

APPENDIX 3 - 1994 programme details

Project Title
Monitoring for environmental change at S'Albufera, Mallorca.

Research Site
Parc Natural de S'Albufera , Mallorca, Spain.

Principal Investigators
Dr Terry Wells and Nick Riddiford

Team Dates in Field
TEAM I March 27-April 10, 1994
TEAM II April 13-April 27, 1994
TEAM III April 30-May 14, 1994
TEAM IV October 22-November 5, 1994

Team Composition: integrated teams of Scientists, Earthwatch Volunteers and Mallorcan Students.

Project S'Albufera scientists, 1994
K eith Bowey (Acting PI, Team I) - ornithological & invertebrate studies
Ed Cross - freshwater invertebrate studies
Alan Radermacher - ecology of Phragmites
Rob Strachan - small mammal studies
Dinah McLennan - botanical studies
Jo Newbould - botanical studies
Sarah Hawkswell - data programming
Bernie Young - remote sensing
Sheila Wells - fungi
Barry Goater - lepidoptera
Chris Donnelly - ecological studies, logistics

Fields of Research

Ecology of Phragmites
1. T he ecological relationships of Phragmites , moth larvae and birds (Alan Radermacher)

Botanical
1. Orchid studies (Terry Wells)
2. Herbarium (Jo Newbould; Dinah McLennan)
3. P lant Illustrations/Preparation of botanical interpretation material (Dinah McLennan)
4. D istribution of Euphorbia terracina in areas of grazing (Jo Newbould; University of Durham)

Vertebrates
1. B ird population studies (Keith Bowey; Nick Riddiford) - transects, constant effort site ringing, body condition of migrants, Reed Bunting biometrics
2. Bird foraging studies (Keith Bowey)
3. Mammal population studies (Rob Strachan: University of Durham)

Remote Sensing
1. G round-truthing census work (Centre for Remote Sensing and Mapping Science, Department of Geography, University of Aberdeen, Scotland)

Invertebrates

1. Entomology
   a) insect reference collection (Bowey; Goater; Riddiford)
   b) studies of Diptera, Syrphidae (Bowey)
   c) butterfly and dragonfly transects (Bowey)
   d) freshwater invertebrate population studies (Ed Cross)

Computerisation of Data

1. P rogram development for standardised data processing and storage (Sarah Hawkswell; Riddiford)
2. Biodiversity studies (Riddiford; Hawkswell; Bowey)

APPENDIX 4 - List of publications

The directorate of the Parc Natural de S'Albufera , in consultation with Project S'Albufera , has produced a complete bibliography of S'Albufera de Mallorca publications, the earliest dated 1901. Copies of that list is available from The Director, Parc Natural de S'Albufera , Conselleria d'Agricultura i Pesca, Ca'n Picafort, 07458 Mallorca, Balearic Islands, Spain. The list

includes a high proportion of publications stemming from the work and activities of Project S'Albufera . Details of Project S'Albufera -generated publications are given below. Note that a single asterisk draws attention to publications which have appeared since the last Project S'Albufera report; a double asterisk draws attention to a publication cited before, but amended to achieve compatability with the full S'Albufera de Mallorca bibliography.

*A SSOCIACIO BALEAR D'AMICS DELS PARCS (ed.). 1990. Seguiment de l'avifauna del Parc, agost 1989-juliol 1990 . Palma.

** ASSOCIACIO BALEAR D'AMICS DELS PARCS (ed.). 1990. Parc Natural de S'Albufera de Mallorca: ornithological overview, August 1989-July 1990 . Palma.

*A SSOCIACIO BALEAR D'AMICS DELS PARCS (ed.). 1991. Seguiment de l'avifauna del Parc, agost 1990-juliol 1991 . Palma.

** ASSOCIACIO BALEAR D'AMICS DELS PARCS (ed.). 1992. Seguiment de l'avifauna del Parc, agost 1991-juliol 1992 . Palma.

*B ARRINGTON, R. 1993. Mediterranean secret. Country 94 (August 1993): 21.

*E STEVE-RAVENTOS, F. & ENDERLE, M. 1992. Psathyrella halophila spec. nov., eine neue Art aus der Sektion Spintrigerae (Fr.) Konrad & Maublanc vom Meeresstrand der Insel Mallorca (Spanien). Zietschrift fšr Mykologie 58: 205-209.

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FO X, R. J. P. 1992. Monitoring Environmental Change at S'Albufera Parc Natural: the role of aquatic invertebrates . M.Sc. in Conservation dissertation, University College London.

FR ONTERA I SERRA, M. & FORTEZA I PONS, V. 1991. Seguiment dels efectes de la paustura al parc natural de S'Albufera de Mallorca, 1990. Documents tecnics de Conservaci¢ 4. SECONA, Palma de Mallorca.

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HA FNER, H. & HOFFMANN, L. 1990. The Albufera de Alcudia (Mallorca): an assessment of the importance of this wetland for colonially nesting Ardeidae . Station Biologique de la Tour du Valat cyclostyled report.

HO WE, C. 1989. Albufera: Aspects of Hydrology, Vegetation, History and Management . M.Sc. in Conservation dissertation, University College London.

JU RADO ESTEVEZ, J. 1992. The usefulness of Landsat TM data for vegetation discrimination in S'Albufera de Mallorca - a marsh . M.Sc. in Environmental Remote Sensing dissertation, Centre for Remote Sensing and Mapping Science, University of Aberdeen.

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MA YOL, J. 1991. Plan d'us i gestio del Parc Natural de S'Albufera de Mallorca. Documents tecnics de Conservaci¢ 3. SECONA, Palma de Mallorca.

MA YOL, J. 1992. Plan for the use and management of the Natural Park of S'Albufera, Mallorca, 1990-94. Documents tecnics de Conservaci¢ 3. SECONA, Palma de Mallorca [English version].

*M cGOVERN, P. 1993. The use of Landsat Thematic Mapper Data for the detection of urban change in Mallorca (Bah¡a de Alcudia) .

M.Sc. in Environmental Remote Sensing dissertation, Centre for Remote Sensing and Mapping Science, University of Aberdeen.
NE WBOULD, P. 1989. The Albufera as a Global Monitoring Station . Earthwatch Europe cyclostyled report.
NE WBOULD, P. 1990. The Albufera, Mallorca, as a Global Observatory. Jornades del Medi Ambient de les Balears 2: 173-174.
NE WBOULD, P. 1991. Phragmites and Cladium on Albufera . Manuscript.
NE WBOULD, P. J., RIDDIFORD, N. J. and GRACE, E. 1989. Consumption of Phragmites australis at S'Albufera, Mallorca. In The Albufera as a Global Monitoring Station (Newbould 1989).
NE WBOULD, P. J. and RIDDIFORD, N. J. 1990. Monitoring for Global Change: The Earthwatch Europe S'Albufera Project . Earthwatch Europe, Oxford.
*N ICHOLSON, E. M. 1994. S'Albufera - a research framework for the study of Biodiversity. Earthwatch Corporate Environmental Responsibility Group Bull . 7: 11-13.
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NO BLET, J. F. 1992. Les chauves-souris du Parc Natural d'Albufera, Majorque, Iles des Baleares - Espagne . Report to Earthwatch Europe.
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PE RELLO COLL, G. 1992. Geografia y educacion ambiental: el parque natural de S'Albufera de Mallorca. Boletin de la Asociacion de Geografos Espanoles 14: 111-120.
*P ONS, G. 1993. Artr•podes de s'Albufera de Mallorca: Arachnida , Araneae . Boll. Soc. Hist. Nat. Balears 36: 91-98.
RI DDIFORD, N. 1991. Project S'Albufera: A new model for environmental research . Earthwatch Europe, Oxford.
RI DDIFORD, N. 1991. A small influx of the Long-tailed Blue Lampides boeticus at S'Albufera Natural Park, Mallorca. Bull. Amat. Ent. Soc . 50: 164.
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*U NIVERSITY OF DURHAM (ed.). 1993, M.Sc. Ecology Field Course, S'Albufera - Mallorca, 19-26 March 1993: Introductory Guide . Department of Biological Sciences, University of Durham.
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xx ANNEX 1

Further study of the growth of Phragmites by Alan Radermacher

Aim

To investigate the extent of infection of the reed Phragmites australis by the moth Archanara geminipuncta .

The investigation was carried out between 31st March and 2nd April 1993. It was hoped to make comparisons with my investigation as a volunteer in October 1992 and with Barry Goater's investigation in May 1992 (Radermacher 1993; Goater 1993).

Method

As in October (Radermacher 1993) but the minimum height sampled was 1 metre rather than 1.5 metres. A minimum height was used because sampling much lower becomes physically inconvenient especially in water and also the quantity of dead stems and debris increases and confuses the process. A lower minimum was employed now because we wanted to make sure that we sampled the young stems. In fact they were often shorter than one metre and many were therefore missed.

Sites 4 and 6/7 were not sampled.

Results

Site	Healthy	Infected	Dead	Young	Total
1	12	42	206	64	324
2	12	40	174	19	245
3	41	49	200	1	291
5a	43	44	170	63	320
5b	16	20	123	44	203

Site	% infected of mature living stems	% of stems that were dead (excl. young ones)	% of young stems
1	78	79	20
2	77	77	8

3	54	69	0.3
5a	51	66	20
5b	56	77	22

Comments on results

Site 1

In general very few `healthy' stems were found and the average density and height of growth was much lower than in October. There were very few `young' stems most of which were too short to be included in the sample.

Arthrocnemum and Juncus were present at two of the sites.

Fourteen `infected' stems were examined.

`Infected' as usual means that a side branch was visible. This site had the highest proportion of `dead' stems (79%) and often the `infected' stems were so damaged that there was no evidence of entry or exit holes. Nine of the stems showed no evidence of occupation, which was surprising, but perhaps the infected regions had decayed or been damaged beyong recognition. In five stems the present of frass showed evidence of occupation. All of these had entry holes (2-3 mm long) and one also had an exit hole (7-9 mm long).

None had pupae, pupal cases or caterpillars. At this stage it seemed that the investigation was too early to find such stages but what had happened to the 1 cm caterpillars so frequently found last October? The volunteers would be disappointed to find no evidence of living organisms. Negative evidence can be just as important, but it is hard to justify this to them.

Site 2

In general, as at the last site, many short young stems were not counted. Also there were many short dead thin stems which were not counted individually but estimated.

Twelve stems were sliced. Five had small `entry' holes in the middle or lower region of each internode. One of these had a pupal case and one had a 3 cm caterpillar at the lower end. Another had a 3 cm caterpillar but no entry hole could be found.

Site 3

There were very few young stems and many small dead stems. The `infected' stems gave a very high percentage of pupae. Twenty-two stems were sampled. All had infection holes. Eighteen had large holes, two had small holes only and two had both sizes. Sixteen contained pupal cases and two contained pupae which had either aborted or not yet emerged. The large holes were always at the top, the small holes were usually in the middle and sometimes at the bottom of each internode.

Site 5

In general there were few healthy and young stems but many dead. Many of the small dead stems were not counted individually but estimated. Often there were several levels of infection and one stem had two pupae, each in a different internode. Fifty samples were taken. Nineteen provided no evidence of infection. Eleven had clearly suffered bird damage. Eighteen had small holes, five had large holes as well. Seven had pupal cases and five had 3 cm caterpillars.

Conclusion

The most obvious conclusions are as follows:-

a) Much of October 1992's growth had died back. The overall density was reduced and views through the reeds were easier.

b) Very few young green stems were counted because they were often very short, not exceeding the 1 m minimum.

c) There was a great difference between the sites in terms of the stages of the life cycle found. Site 1 provided no pupae or caterpillars. Site 2 provided the greatest likelihood of finding a large caterpillar. Site 3 provided frequent and very predictable pupal cases at the base of the internodes.

d) There were no 1 cm caterpillars in the samples. These were found in great numbers last October. However when sampling casually while watching White-headed Ducks Oxyura leucocephala on the lagoon near the power station I did find several caterpillars of this size.

We therefore have internodes which show:-

1) 1 cm caterpillars in the centre of the internode.
2) Frass alone with a small `exit' hole.
3) Large 3 cm caterpillars.
4) Occupied pupae.
5) Empty pupal cases.

All stages were thus represented except the adult moth. The moth may have been present and laying but so far we have not been sampling flying moths.

Discussion

Further evidence of the life cycle can only be obtained by sampling the reeds at more frequent intervals during the year.

Questions remain about the growth rate and death rate of the reed. It seems that from the rhizome root stock rapid annual growth takes place up to a height of 5 m (tallest measured stem, 7 m - N Riddiford, unpubl. data).

Presumably the eggs are laid on the young stems. The caterpillar hatches and invades the soft young tissue of the reed. Did the 1 cm caterpillars found in October pupate and emerge in November, providing adults which laid eggs straight away, the eggs then hibernating over the winter and hatching in spring to invade the young stems? Possibly the 1 cm caterpillars over-wintered and

continued to develop in the spring, the large caterpillars and pupal cases found during the current study being a result of this development.

How synchronised are the broods? The presence of all stages of the cycle suggests a lack of synchronisation. If this is so there may be large caterpillars present throughout the year, at least in certain areas. These could provide worthwhile food for the Reed Bunting *Emberiza schoeniclus* over a sufficient period to explain the selection of the larger bill size compared to that of nominate race birds from mainland Europe. Reed Buntings were seen at the Watkinson hide attacking the reeds during this study period.

Many questions about the three organisms, *Phragmites* , *Archanara* and the Reed Bunting have yet to be answered.

Postscript

After a morning with Barry Goater on 14th April I realised that a number of my assumptions were wrong. Barry had visited S'Albufera in May 1992, two calendar months later than my recent visit. His knowledge, common sense and enthusiasm were of enormous value and brought the following amendments to my thoughts and findings.

It seems that my assumption that *Archanara geminipuncta* provided the main food for the Reed Buntings and passed through numerous unsynchronised life cycles during the year is wrong. The 1 cm caterpillars I found in large numbers in very precise positions in the stems in October are not *A. geminipuncta* and many of the pupal cases found then and in April are also not that species. What on earth happened to those 1 cm caterpillars? They were always found just above a side branch in the middle of the internode. The side branch was presumably caused by *A. geminipuncta* earlier in the year when its growth in the tip interfered with auxin secretion and removed its inhibiting effect from the lateral buds. It would take some time for this lateral growth to occur and it must be an opportunistic intrusion of the *A. geminipuncta* exit holes which explains these 1 cm caterpillars. It is I suppose just possible that they are extremely slow growing and that they did cause this side growth response throughout the summer and are now about to pupate.

At least I did bring back some classic internodes which had been infected by *A. geminipuncta* and checked by Barry (see Figure below).

----FIGURE------

The pupa is always `head up' and has a beak on the anterior end, which may serve to break the `window' for final exit. The pupa is parallel-sided and thin-walled. The wings are only about half the length of the case.

There should be no frass in the pupation internode because the whole reason for selecting a new internode is to be free from this. The frass often found must be from opportunistic organisms which enjoyed a large `window' by which to enter.

Another frequent insect which intrudes the stems is one which leaves a shallow oval `scorch' mark with a hole at the top end. Sometimes there were several of these per node and I really only examined them closely when I returned with stem sections (see Figure below).

---------Figure--------

There are no doubt many other organisms which enjoy life in these stems and are `waiting' to be examined. If they were easier to study, understand and compartmentalise, scientific investigations would not be so annoyingly fascinating!

References

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Appendix 1: State of stems recorded in each metre square

Site 1	Healthy	Infected	Dead	Young	Totals
1	2	5	10	2	19
2	1	7	16	1	25
3	2	10	19	9	40
4	1	3	12	12	28
5	0	7	21	6	34
6	0	1	28	4	33
7	5	2	23	12	42
8	0	4	35	5	44
9	0	2	25	4	31
10	1	1	27	9	38
Totals	12	42	216	64	334

Site 2	Healthy	Infected	Dead	Young	Totals
1	4	4	14	2	24
2	2	6	8	2	18
3	2	5	5	5	17
4	0	0	30	0	30
5	3	1	5	0	9
6	0	0	20	0	20
7	0	11	20	3	34
8	0	4	25	7	36
9	1	5	22	0	28
10	0	4	15	0	19
Totals	12	40	164	19	235

Site 3	Healthy	Infected	Dead	Young	Totals
1	0	20	20	0	40
2	1	20	20	0	41

3	0	20	20	0	40
4	1	20	20	1	42
5	4	20	20	0	44
6	9	0	20	0	29
7	8	3	20	0	31
8	7	6	20	0	33
9	3	10	20	0	33
10	8	0	20	0	28
Totals	41	119	200	1	361

Site 5a	Healthy	Infected	Dead	Young	Totals
1	2	14	7	6	29
2	2	4	26	3	35
3	0	4	35	0	39
4	8	2	5	0	15
5	4	0	10	0	14
6	0	3	20	3	26
7	2	1	11	3	17
8	3	3	25	6	37
9	1	1	17	4	23
10	8	7	8	16	39
11	5	5	6	22	38
Totals	35	44	170	63	312

Site 5b	Healthy	Infected	Dead	Young	Totals
1	0	4	18	7	29
2	1	6	14	3	24
3	8	0	22	0	30
4	3	2	20	1	26
5	1	3	26	5	35
6	2	0	9	12	23
7	1	5	14	16	36
Totals	16	20	123	44	203

ANNEX 2

Further study of the growth of *Phragmites*, October 1993 by Alan Radermacher

Aim

To investigate the extent of infection of the reed *Phragmites australis* by various moths found at larval stage in the hollow reed stems and the possible selection pressure this food source has on Reed Bunting *Emberiza schoeniclus* bill structure.

This is the third investigation I have carried out with volunteers and will hopefully give a fuller picture of the variety of moth infection. At first only *Archanara geminipuncta* was thought to infect the reeds but it seems that this behaviour is shared by several other species.

Method

The method was similar to that in April 1993 and October 1992 (Annex 1, this report; Radermacher 1993).

In May it was not possible, because of time limitations, to sample sites 4, 6 or 7 but in October 1993 we not only sampled all sites but sites 6 and 7 were sampled a month later by a Spanish volunteer Bernat Bergas from Ca'n Picafort.

Results

Site	Healthy	Infected	Dead	Young	Total
1	8	52	97	51	208
2	21	49	143	164	377
3	40	37	67	156	300
4	32	28	140	168	368
5	44	45	194	93	376
6/7(Oct)	29	58	207	128	422
6/7(Dec)	8	33	87	49	177

Site	% infected of mature living stems	% of stems that were dead (excl. young ones)	% of young stems
1	86	62	25
2	70	67	44
3	48	47	52
4	47	70	46
5	51	69	25
6/7(Oct)	67	70	30
6/7(Dec)	80	68	28

Comments on results

Site 1
This area was much less dense than a year ago when there were many tall healthy stems. Many of the `dead' stems were `infected'. The overall count per metre square was also lower than in October 1992. Twelve stems had suffered bird damage, one had a large caterpillar in occupation and two had large pupae. In three stems there were small (1 cm) caterpillars but no small pupae. In eleven stems there was infection in more than one internode.

Site 2
From the Gran Canal site, thirty one samples were taken. Bird damage was observed in six of these. Large (3 cm) caterpillars were observed in four stems and large pupae in another four stems. Two of the caterpillars appeared to be Archanara and the other two were different species. The pupae were not in good condition. In eight stems small (1 cm) caterpillars were found but there were no pupae of this species. Six stems showed infection at more than one internode.

Site 3
From this site twenty one samples were taken. Only two had suffered bird damage. No pupae of any kind were found but thirteen small (1 cm) caterpillars were counted.

Site 4
Thirteen samples were taken. Two had suffered bird damage. There were no large caterpillars or pupae but nine `small' caterpillars and two `small' pupae.

Site 5
Thirty five samples were taken. There was a high percentage of `dead' recorded. Nine stems had suffered bird damage. One large caterpillar ( Archanara ) was found, ten `small' caterpillars and two `small' pupae. Eight stems were infected at one or more levels.

Sites 6 and 7
Twenty four samples were collected. Eight had suffered bird damage. There was one `large' pupa but no large caterpillars. There were ten `small' caterpillars but none of their pupae. In four stems there was evidence of infection at more than one level.

Sites 6 and 7 (December)
Forty samples were collected by Bernat Bergas. Twenty two had

suffered bird damage. One `large' caterpillar was found and four `large' pupae. Ten `small' caterpillars were recorded and two `small' pupae. Nineteen stems showed infection at more than one level.

Conclusion

It seems clear than the small (1 cm) species does not leave any exit or entry holes or, if so, they are too small to see clearly. As in 1992 the position of the small caterpillar could be predicted with amazing precision despite no entry holes. There is only ever one small caterpillar per stem and it clearly affects the terminal bud growth pattern. The fact that the December sampling showed more pupae probably means than emergence continues throughout the winter, though this seems odd.

The large caterpillars were of three species (one is *Archanara*) but the other two were not identified. The exit-entry holes were variable in size and position. There were often many levels of infection. The most extreme being the Gran Canal (sample 7) in which five levels were infected.

Discussion and Recommendations

There is a great need for further samples to be taken at specific times throughout the year. This will help identify those species which can only be determined when adult. It would also determine the life cycle span, brood number, number of species, synchronicity, etc. Bernat Bergas, a barman from Ca'n Picafort and Cristina Moy… Company, a student from Binissalem showed great interest in sampling at other times of year. As the report states Bernat Bergas sampled on December 1st. Establishing such Spanish involvement is tremendously important for this Project. It must not be seen as a group of foreign scientists descending abruptly and disappearing with results. The Park authorities have been extremely helpful in finding Spanish volunteers (with one or two participating in every team), but Spanish scientist involvement in the studies would be a further step forward. We would then be able to establish a complete annual record of the reed caterpillars. My feeling is that the small (1 cm) caterpillar is the most abundant species. However I have never sampled at the optimum time for *Archanara geminipuncta* .

As I said in my last report (Annex 1, this report) it seems unlikely that the small caterpillar would provide worthwhile food for the Reed Buntings. I have little personal evidence of the birds feeding in the reeds. My only observation of a Reed Bunting actually damaging a reed was from the Watkinson hide in April 1993. Reed Buntings are being trapped, but too low a sample has so far been caught, ringed and measured to establish the full range of bill morphology differences, including variations between S'Albufera and visiting European populations and between sexes within each population. Further samples of measurements and observations of feeding behaviour are required to establish possible selection pressures, if any, which are in operation. Progress in this fascinating multi-faceted project is slow but steady.

Postcript (January 19th 1994)

Sites 3 and 4 were sampled by Bernat and Cristina on December 28th 1993.

Site	Healthy	Infected	Dead	Young	Total
3	31	22	128	25	206
4	43	29	142	29	243

Site	% infected of mature living stems	% of stems that were dead (excl. young ones)	% of young stems
3	42	71	12
4	40	66	12

Twenty eight samples were taken from site 3. Bird damage was found in seven. Thirteen small caterpillars were found and three pupae. No large caterpillars were found but one pupa was seen.

Infection at more than one level was found in nine stems.

Thirty six samples were taken from site 4, six of which had bird damage. Twenty small caterpillars and eight pupae were counted. No large caterpillars were found.

Infection at more than one level was observed in five stems.

There is clear consistency with the October sampling. It is surprising that there are still so many small caterpillars. Pupation has taken place but only very gradually.

Reference

Radermacher, A. 1993. A brief study of the growth of Phragmites . The Earthwatch Europe S'Albufera Project Report 4: 72-81.

ANNEX 3

Monitoring the changing population of *Euphorbia terracina* on the Turo de Ses Eres by Jo Newbould

Since 1989 there has been a noticeable change in the vegetation of the Turo de Ses Eres. In 1989 the ground flora consisted mainly of a grass sward with a scattering of flowering plants, including a few individual plants of *Euphorbia terracina* .

In April 1991, from the track leading to Ses Puntes, the area appeared more yellowish-green in colour than previously. On closer inspection the colour was seen to be due to *Euphorbia terracina* which had increased considerably in amount.

In April 1992 the *Euphorbia terracina* appeared to be spreading and increasing in density. It appeared not to be grazed. Since 1989 the number of rabbits *Oryctogalus cuniculus* has decreased. This may have been a consequence of the flooding in October 1990. The ponies which have been introduced do not appear to graze the *Euphorbia terracina* . Therefore it was decided that a detailed survey should be carried out, in such a way that it could be repeated in future years, to discover if the *Euphorbia terracina* is on the increase and if so, is it having any detrimental effect on other plants - especially the orchids? Two methods were employed.

Method 1 - Photographic monitoring

A photographic method, Earth Science Photo-monitoring and Documentation in Wales, by Drs. S. Campbell and M. Wood, 1992 was used as an example and modified to suit the different circumstances of the project.

Firstly it was necessary to establish a series of ground markers which could be relocated in future years. These are shown in Diagram 1.

FENO SURVEY MARKERS as used by Dr Terry Wells and kindly donated by him, were driven into the ground, the yellow survey head being left flush with the ground. The markers were positioned at Points 1, 2, 3, 4, 5 and 6. Between the Feno Survey Markers wooden stakes were hammered into the ground, again being left flush with the ground, at Points 1A, 1B, 2A, 2B, 4A, 4B, 5A, 5B, and also at right angles to all the Main Line pegs as shown by X in Diagram 1. The tops were then painted yellow.

Measurements (Diagrams 2 and 3) and additional plans (Diagrams 4, 5, 6 and 7) were made to facilitate the relocation of all the points, both Feno Markers and wooden pegs.

The periphery of the area occupied by *Euphorbia terracina* was recorded on black and white print film.

The camera used was a Canon EOS 600 with a SIGMA lens 28-70 Auto-focus.

The camera was mounted on a tripod at a height of 75 cm.

Photography started at Point 1E, with the tripod immediately in front of a large tussock of *Juncus acutus* and immediately above a small plant of *Schoenus nigricans* , at a position 5 metres south and 1 metre east of Point 1E. The tripod and camera were moved in a northerly direction towards Point 6.

Photographs were taken from a point near each marker post, i.e. 1E, 1AE, 1BE, 2E etc. to 6E along the eastern periphery. The western periphery was photographed from near point 6W moving the tripod and camera in a southerly direction, i.e. from 6W through to 1W, but with the camera still facing in a northerly direction (c.f. the eastern periphery).

Therefore the complete periphery was photographed in an anti-clockwise direction, starting at the south-east corner, but with the camera facing in the same (northerly) direction the whole way round.

A red/white surveying pole was placed on the east side of wooden pegs 1E, 2E, 3E, 4E, 5E and 6E, and a yellow rope-holding stake was placed on the east side of wooden pegs 1AE, 1BE, 2AE, 2BE, 4AE, 4BE, 5AE AND 5BE.

Information about all the photographs is given (Film 8. Black and white. HP5).

Description of location for each photograph

Film 8 Black and White. HP 5

No. 2 Camera position: 5 m south, 1 m east of 1E
Camera height: 75 cm

No. 3 T ripod position from north, immediately in front of large tussock of *Juncus acutus* , and immediately above a small plant of *Schoenus nigricans* ; another tussock of *J. acutus* to the west.

No. 4 Camera: 5 m south and 1 m east of 1AE
Facing north (yellow post at 1AE)
(red/white pole at 1BE)

No. 5 Camera: 5 m south and 1 m east of 1BE
Facing north (yellow post 1BE)
(red/white pole 2E)

No. 6 Camera: 5 m south and 1 m east of 2E
Facing north towards 2AE (yellow post at 2E)
(red/white pole at 2AE)

No. 7 Camera: 5 m south and 1 m east of 2AE
Facing north (yellow post 2AE)
(red/white pole 2BE)

No. 8 Camera: 5 m south and 1 m east of 2BE
Facing north towards 3E (yellow post at 2BE)
(red/white pole at 3E)

No. 9 Tripod from 2BE facing south

No. 10 Tripod: red/white pole at 2AE

No. 11 Camera: 5 m south and 1 m west of 3
Facing north towards 4

No. 12 Camera: 5 m south and 1 m east of 4
Facing north-east towards 4AE

No. 13 Camera: 5 m south and 1 m east of 4AE
Facing north towards 4BE, on north/ south path of Juncus ditch.

No. 14 Camera: 4 m south and 1 m east of 4BE
Facing north towards 5E

No. 15 Tripod: facing south from 4BE

No. 16 Camera: 5 m south and 1 m east of 5E
5E is on Rice Platf orm, 9 m west from the eastern edge and 1 m east of the wall.

No. 17 Camera: over east wall of Rice P latform, 1 m south of Asparagus stipularis .
Facing north

No. 18 Camera: 1 m from north-east corner of Rice Platform
Facing north (yellow post at 5AE)
(red/white pole at 5BE)
[Terry Wells' orchid plot with 3 pines in distance]

5B is difficult to find: by large Euphorbia terracina , and the post is broken

No. 19 Camera: 5 m south and 1 m east of 5BE
Facing north to 6 - red/white pole on left
6E - red/white pole on right
yellow post at 5BE
5BW is by a large rabbit hole.

No. 20 Camera: 5 m south and 1 m west of 5BW
Red/white post on left is at 6W
Red/white post on right is at 6

No. 21 Camera: 5 m south and 1 m west of 5BW
Facing north towards 5AW (red/white pole)
(yellow post at 5BW)

No. 22 Camera: 5 m south and 0.5 m west of 5W
Facing north towards 5AW
(yellow post is at 5W)

No. 23 Camera at corner of Rice Platform: 1 m west
(yellow post is at 4BW)
(red/white pole is at 5W)

No. 24 Camera in Juncus acutus at 4AW
Facing north towards 4BW (red/white pole)

No. 25 Camera in thick Euphorbia terracina : 5 m sou th and 1 m west of 4W
Facing north (yellow post at 4W)

(red/white pole at 4AW)

UNABLE TO FIND POINT 3W WHEN DOING THIS SET OF PHOTOS

No. 26 Camera: 5 m south and 1 m west of 2BW
Facing north (yellow post 2BW)
(red/white pole 5W)

No. 27 Camera: 5 m south and 1 m west of 2AW
Facing north (yellow post at 2AW)
(red-white pole at 2BW)

No. 28 Camera: 5 m south and 1 m west of 2W
Facing north towards 2AW (yellow post at 2W)
(red-white pole at 2AW)

No. 29 Camera: 5 m south and 1 m west of 1BW (yellow post)
Facing north towards 2W (red/white pole)

No. 30 Camera: 5 m south and 1 m west of 1AW (yellow post)
Facing north towards 1BW (red/white pole)

No. 31 Camera: 2 m south and 1 m west of 1W (yellow post)
Facing north towards 1AW (red-white pole)

32-37 PAN facing west, from south to north, with camera over rock on path going east from hill with Pine trees.

----- DIAGRAMS 1-7-----

Method 2 - Monitoring by co-ordinates

A more detailed study of the population at the southernmost extremity of its range was made using a system perfected by Dr Terry Wells on populations of Orchids.

Method

Starting from Point 1A at the southern end, six 10 m x 10 m quadrats were marked out either side of the Central 1-2 line, comprising two quadrats south of line A-B-C (i.e. from Point 1A towards Point 1) and four to the north (i.e. from Point 1A towards Point 2).

The position of each individual plant of Euphorbia terracina within a quadrat was given a unique co-ordinate by taking two measurements, each from a fixed point. Two 30m tapes were used with zeros at points A and B (Quadrats 1,3) A 1 and B 1 (Quadrat 5), B and C (Quadrats 2,4) and B 1 and C 1 (Quadrat 6) - see Diagram 8. The co-ordinate for each plant in Quadrats 1 and 3 is the distance from A to the plant and from B to the plant, similarly for Quadrats 2 and 4 the co-ordinate is the distance from B to the plant and from C to the plant, and so on.

In Quadrats 1 and 2 the measurements were made in a southerly direction from the permanent markers. In all the other Quadrats

the measurements were made in a northerly direction from the permanent markers.
Measurements were made to the nearest half-centimeter.

The following data were recorded for each *Euphorbia* plant:-

(i) Number of stems (D)
(ii) Length of longest stem (E)

After each plant had been recorded a small piece of paper was attached to the plant. This avoided duplication of records. When the recording of each Quadrat had been completed the pieces of paper were gathered up and taken away from the site.

Results

Details of co-ordinates were recorded on a computer data base from which it was possible to plot their location within the quadrat. The locations of *Euphorbia terracina* plants recorded in the first year of study, April 1992, which will form the basis for monitoring their population dynamics and change, are given in representational form below.

----------QUADRATS 1-6----------

ANNEX 4

Collection of mosses made in autumn 1993 at S'Albufera by R.C. Stern, Franklyn Perring and Nick Riddiford

Introduction

Between 26th October and 2nd November 1993, Project S'Albufera staff and volunteers collected a series of moss specimens from a wide range of habitats. Each specimen was allotted a reference letter and notes taken of the date, locality and habitat. Each specimen was taken in duplicate to provide two complete collections. One remained in Mallorca and the other was brought to Britain for determination by moss expert, R. C. Stern. The results of his determinations, along with habitat details, location, date of collection and reference letter [in parentheses] are given below.

Results

Barbula convoluta Hedw.
- Edge of track in shade of trees; Sa Roca. 26/10/93 [R]
- O n stony bank heavily shaded by trees; Sa Roca. 26/10/93 (with Bryum caespiticum) [O]
- E dge of track; Sa Roca. 26/10/93 (with Pseudocrossidium hornschuchianum) [S]

Barbula convoluta Hedw. var. commutata (Jur.) Husn.
- On the edge of track; Gran Canal. 26/10/93 [Q]

Barbula unguiculata Hedw.
- On bank of Gran Canal near entrance. 26/10/93 [Gi]
- Edge of track shaded by trees; Sa Roca. 26/10/93 [I]

Brachythecium rutabulum (Hedw.) Br. Eur.
- A mong leaf litter on heavily shaded woodland path; Sa Roca. 26/10/93 [J]

Bryum sp. and other mosses
- S eaward side of Pont des Anglesos. 26/10/93 [B]

(indeterminable because specimen in poor condition)

Bryum caespiticium Hedw.
- On stony bank heavily shaded by trees; Sa Roca. 26/10/93 (with Barbula unguiculata) [O]

Bryum capillare Hedw.
- Sandy waste ground; Sa Roca. 26/10/93 [T]

Bryum radiculosum Brid.
- On limestone at the edge of track shaded by trees; Sa Roca. 26/10/93 (with Didymodon tophaceus) [L]

Didymodon fallax (Hedw.) Zander
- On sandy ground on bank of Gran Canal at entrance to sea. 26/10/93 [C]
- Open position on sandy soil; Ca'n Picafort woods. 2/11/93 [A]
- On sandy ground; Ca'n Picafort woods. 30/10/93 [N]

Didymodon tophaceus (Brid.) Lisa
- On limestone at the edge of track shaded by trees; Sa Roca. 26/10/93 (with Bryum radiculosum) [L]

Gymnostomum calcareum Nees & Hornsch.
- On limestone on track under canopy of pines; Ca'n Picafort woods. 2/11/93 [F]

Pleurochaete squarrosa (Brid.) Lindb.
- Sandy soil, open position; Ca'n Picafort woods. 2/11/93 [V & U]

Pseudocrossidium hornschuchianum (Schultz) Zander
- Edge of track; Sa Roca. 26/10/93 (with Barbula convoluta) [S]

Scorpiurium circinatum (Brid.) Fleisch. & Loeske
- On bank of Gran Canal near entrance. 26/10/93 [Gii]

Timmiella barbuloides (Brid.) Monk.
- On stone at edge of narrow track near entrance to Gran Canal. 29/10/93 [K]

Tortella flavovirens (Bruch) Broth.
- On bridge of Pont des Anglesos. 26/10/93 [E]
- Bank of Gran Canal at S'Oberta. 26/10/93 [D]

Trichostomum crispulum Bruch
- On bridge of Pont des Anglesos. 26/10/93 [H]

? small Trichostomum crispulum Bruch
- Shady bank on sandy soil; Ca'n Picafort woods. 30/10/93 [M]

Note : Letters in square brackets comprise individual reference given to specimen at time of collection.

ANNEX 5
Invertebrate studies: moths by Nick Riddiford

Moths (Lepidoptera) are an important but poorly understood part of the environment. Their larvae, particularly, have a major impact on vegetation and Phragmites australis , one of the dominant plant species of S'Albufera marsh is known to support a wide range of moths in their larval stage. The problems of understanding the role of moths in any ecological system are immense, not least because of the difficulty of raising larvae to maturity to discover their specific identity. Even in European countries where the study of moths is most developed, the larval identity of some species has yet to be established!

As a starting point to the understanding of the S'Albufera moth community, Project S'Albufera has undertaken a trapping programme for adults. Because moths are mainly nocturnal, this has entailed the use of specially designed light traps. The visual spectrum of moths is different to that of humans and they are able to detect, and are attracted to, ultra violet. In Britain, three types of portable trap have been designed which attract moths to an ultra violet light source. Two of these, called the Skinner trap and the Robinson trap (after their designers) use a Mercury Vapour lamp and run off mains electricity. Another type, the Heath trap, uses an Actinic light. The last tends to be less effective, but can be run from a 12 volt car battery. The Heath trap is, therefore, more flexible because it does not rely on mains electricity or the availability of a portable generator.

Project S'Albufera uses all three types: the Robinson at Sa Roca, the Skinner running off a portable generator to sample other habitats, and the Heath to sample habitats where access with a generator is difficult (e.g. reedbeds). Prior to the start of the Project there was a Lepidoptera list for S'Albufera (Barcel¢ & Mayol 1980) but further baseline information was necessary, including for dates of occurrence, distribution and frequency. For the effective development of further studies, it was also considered important to establish a collection at the Parc which would be available to all as a permanent reference.

Trapping work began in 1990 and was continued in 1991 by Simon McKelvey. A further thrust to the study took place in 1992 with the involvement of Barry Goater, one of Britain's foremost lepidopterists and a specialist in Iberian moths. His role included the extension of the collection, confirmation and correction of identifications made previously and assessment of

the importance of S'Albufera for this group of invertebrates. Regular trapping of moths has continued since, with new specimens being taken to Mr Goater for identification and for preparation as additions to the Parc reference collection. Trapping periods have been restricted to the fieldwork periods of Project S'Albufera , late March to late May and late October-early November. The exception was some trapping work undertaken by Park warden, Andreu Muntaner in midsummer 1992.

By the end of 1993 the S'Albufera reference collection comprised three virtually complete boxes of Lepidoptera, with a further c100 specimens away in Britain for identification, preparation and subsequent addition to the collection. The total number of Lepidoptera recorded stands at 319 species (30 butterflies and 289 moths), and is still growing (by 25 species in 1993). Any specialist would immediately identify S'Albufera as a marshland, even if they did not know the site, from the composition of the list. It contains no fewer than eleven species of Mythimna , for instance, and a range of other species known to occur in or on Phragmites australis and other wetland flora such as Juncus and Scirpus . The list also demonstrates that our main focus has been on species of the reedbed. We now have a good knowledge of the moth fauna occurring within and at the edge of S'Albufera reedbeds, at least for the spring and late autumn periods. Further work is required, however, particularly in the following areas of study:

1. knowledge of the reedbed species at other times of year;

2. greater knowledge of the moth fauna of other S'Albufera habitats, particularly the dune systems;

3. further information for the smaller species.

Knowledge of reedbed species : we know from our applied studies that certain moth larvae have an impact on the productivity of one of S'Albufera's main reedbed plants, Phragmites australis (Newbould 1992); that they are a food source for the resident Reed Bunting Emberiza schoeniclus witherbyi (King 1993); that the Reed Bunting at S'Albufera, in common with other southern reedbed populations, has an exceptionally deep bill compared with more northern populations (King 1993 and in prep.; Riddington & Taylor, this report); that this specialised bill allows the Reed Bunting access to moth larvae within thick, tough Phragmites stems which are inaccessible to birds with weaker bills, including nominate race Reed Buntings and most other bird species occurring at S'Albufera; that Moustached Warblers Acrocephalus melanopogon , a species for which S'Albufera is internationally important, has a very specialised need for large, old reedbeds containing a lower, horizontal layer of broken reed vegetation (Taylor 1993); and that the actions of moth larvae and the activities of the Reed Buntings in breaking open stems for the larvae may weaken the Phragmites , thus contributing to the creation of the Moustached Warblers' specific habitat requirements.

We know the identity of one of the larvae, Archanara geminipuncta (Goater 1993) but now know that other species are also involved and at different times of year (Alan Radermacher, this report).

We need to identify these extra species and learn their life cycle at S'Albufera, including the times of year when they are adults, to fully understand the fascinating plant-insect-bird relationships which our studies are beginning to reveal. Thus knowledge of the reedbed species throughout the year is an essential long-term goal. We have already begun to develop this theme. Two local volunteers, Bernat Bergas Fiol and Cristina Moy… Company have been sampling Phragmites stems at regular intervals during the 1993-94 winter to learn more about larval activity and, possibly, to obtain pupating individuals to keep through till adult stage, so that we may confirm identity. The incentive for staff or other Mallorcan residents to undertake a year-round trapping programme calls for all regularly occurring individuals to be readily identifiable. This requires a comprehensive reference collection, which is still our main priority.

The moth fauna of other habitats : though our priority has been the moths of reedbed habitats, S'Albufera offers other interesting habitats, including fossil dunes and a length of coastal dune - a habitat prone to development elsewhere in the Mediterranean but protected at S'Albufera and thus an important, increasingly scarce, undisturbed ecosystem. Our knowledge of the moth fauna there stems from two spring visits, and is very incomplete. Further sampling of these habitats, including at other times of the year, is required.

Smaller species : British lepidopterists tend to divide moth species into two groups. The larger ones, mainly comprising the families Geometridae, Lasiocampidae, Noctuidae, Nolidae, Notodontidae, Sesiidae and Sphingidae, are known as the larger moths or "macros". The multitude of smaller species are known collectively as "micros". This division is entirely due to levels of difficulty in identification. Macros are generally much easier to identify than micros. Therefore, there are more identification books for macros and they are easier to use. Most micros require specialist knowledge, and identifications are often achieved by internal dissection. We were most fortunate to obtain the services of Barry Goater who, apart from his expertise in the identification of macros, is the acknowledged British expert for one family of micros, the Pyralidae. His ability is reflected in a S'Albufera list which includes fifty-seven Pyralid species. Clearly the Pyralid family is a significant part of the moth fauna, and we cannot afford to ignore families because they are small; at larval stage some of the species may have an important impact on aspects of the Parc ecology.

We can build on our knowledge of the micro moth fauna through the collection of specimens for later, specialist identification. However, it is my long-term aim to invite a specialist, or specialists, to join us during fieldwork with the objectives of preparing baseline information and reference material, assessing the importance of S'Albufera for these groups, and instructing us on species likely to be of relevance to our ecological work.

Invertebrate conservation and S'Albufera

The baseline data collected so far have highlighted the importance of S'Albufera for moths. By far the most significant

find was that of *Pelosia plumosa* (Arctiidae). This species, previously known from a very few localities in southern Spain, north Africa and southern Italy, is common and widespread at S'Albufera having been trapped at Sa Roca, Es Cibollar, alongside the Gran Canal, at Son Sant Joan and even in the Es Com£ coastal dunes. Of interest, too, was the closely related species *Pelosia obtusa*. Both live in dense reedbeds but co-exist successfully at S'Albufera. The international importance of S'Albufera is quite rightly recognised for its range of scarce or threatened bird species. It is worthy therefore to note that the abundant presence of the rare moth *Pelosia plumosa* is sufficient in itself to qualify S'Albufera as a site of highest international conservation status (B. Goater pers. comm.).

Assessment of the importance of S'Albufera for its moth fauna can also be gauged by the list of species already gathered and the steady, undiminished growth in that list. Resident species include a north African element, represented by species such as *Mythimna joannisi* and *Zebeeba falsalis*, as well as more typical Mediterranean-European species. One endemic sub-species, *Eilema caniola torsteni*, is known to occur, while species not included for the Balearic Islands by Calle (1983) and thus apparently first records include *Hadena bicruris*, *Mythimna riparia*, *Mythimna l-album*, *Mythimna joannisi*, *Simyra albovenosa*, *Acronicta tridens*, *Trachea atriplicis*, *Archanara geminipuncta*, *Archanara dissoluta*, *Chilodes maritimus*, *Athetis hospes*, *Ctenoplusia accentifera*, *Ophiusa tirhaca*, *Grammodes bifasciata* and *Schrankia costaestrigialis*. *Mythimna joannisi* is rare in Europe, known only from a few localities in south-east Spain and from Corsica. *Archanara dissoluta* appears to be new not only for the Balearic Islands, but for the whole of Spain. *Clytie illunaris* has been recorded from Ibiza but is apparently new for Mallorca. Calle (1983) only gave information for Noctuidae, so other families may also include new species for the Balearics, and there are undoubtedly further new species awaiting confirmation among specimens taken to Britain. Work so far has shown that many of these species are probably resident at the Park, though migrants certainly also occur. Further systematic trapping will be necessary to reveal fully the status of moths occurring at S'Albufera.

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ANNEX 6
Lepidoptera (Heterocera) recorded at S'Albufera Natural Park in 1992-93 by Barry Goater

This paper presents the results of moth trapping at S'Albufera Natural Park during the periods 18th-30th May 1992, 21st-31st October 1992 and 20th October-4th November 1993. The May 1992 captures were made by the author, all subsequent captures by N. Riddiford. The silk moth *Antheraea pernyi* was identified by Dave Moon. All other identifications were by the author.

Results

COSSIDAE
Zeuzera pyrina
1992: Son Sant Joan, 24/5, female at mercury vapour (m.v.) light; Sa Roca, 24/5, male at m.v. light.

TINEIDAE
Trichophaga tapetzella
1992: Bred in some num bers from barn owl pellets.

OECOPHORIDAE
Agonopterix alstroemeriella
1992: Sa Roca, 23/5/92, by B. Goater.

ETHMIIDAE
Ethmia bipunctella
1992: Sa Roca, 18/5, one at m.v. light.

TORTRICIDAE
Acleris variegana
1992: Sa Roca, 18/5, two at m.v. light; few seen subsequently in same locality.
1993: Sa Roca, 20/10 and 4/11, singles at m.v. light.
Rhyacionia buoliana

1992: Sa Roca, 18/5, one at m.v. light.

PYRALIDAE

Acigona cicatricella
1992: Sa Roca, 29/5, one male at m.v. light.

Calamotropha paludella
1992: Track by Gran Ca nal, 28/5, several at m.v. light.

Angustalius malacellus
1992: Sa Roca, 23/5, one at m.v. light.

Pediasia contaminella
1992: Sa Roca, 19/5, two at m.v. light; few seen subsequently on same site.

Schoenobius gigantella
1992: Sa Roca, 20/5, two females at m.v. light. Es Cibollar, 23/5, two females at m.v. light; Son Sant Joan, 24/5, female at m.v. light; track by Gran Canal, 28/5, several of both sexes at m.v. light.

Elophila nympheata
1992: Sa Roca, 29/5, one at m.v. light.

Parapoynx stratiotata
1992: Sa Roca, 20/5, one female at m.v. light; 21/10, one female at m.v. light.

Cataclysta lemnata
1992: Track by Gran Ca nal, 28/5, two males at m.v. light.

Hellula undalis
1992: Es Com£, 27/10, one at m.v. light.

Pyrausta cespitalis
1992: Sa Roca, 22/10, one at m.v. light.

Sitochroa palealis
1992: Sa Roca, 18/5, one netted by day; Es Cibollar, 23/5, one at m.v. light.

Sclerocona acutellus
1992: Sa Roca, 18/5, five at m.v. light and seen regularly in small numbers for rest of period; Es Cibollar, 23/5, several at m.v. light; Son Sant Joan, 24/5, one at m.v. light.

Ebulea testacealis
1992: Sa Roca, 18/5, one at m.v. light and regular in small numbers for rest of period; Es Cibollar, 22/5, two at m.v. light. Sa Roca, 28/10, one at m.v. light.

Mecyna asinalis
1992: Sa Roca, 19/5, one at m.v. light and a few subsequently; track by Gran Canal, 28/5, one at m.v. light.

Udea ferrugalis
1992: Entrance track, 23/10, one at m.v. light.

Palpita unionalis
1992: Son Sant Joan, 24/5, one at m.v. light. Sa Roca, 31/10, one at m.v. light.

Dolicharthria punctalis
1992: Es Com£, 20/5, two at m.v. light and a few subsequently; Son Sant Joan, 24/5, one at m.v. light.

Nomophila noctuella
1992: Sa Roca, 29/5, one at m.v. light; 25/10, one at m.v. light.

Hydriris ornatalis
1992: Sa Roca, 21/10, 22/10 (2), at m.v. light.

Hypsopygia costalis
1992: Sa Roca, 24/10, one at m.v. light.

Orthopygia glaucinalis
1992: Es Com£, 20/5, one at m.v. light; Es Cibollar, 23/5, one at m.v. light. Sa Roca, 30/10, one at m.v. light.

Pyralis farinalis

1992: Sa Roca, 18/5, one on wall of building.
Endotricha flammealis
1992: Es Com£, 20/5, one at m.v. light.
Therapne obsoletalis
1992: Sa Roca, 18/5, one at m.v. light and a few subsequently; Es Com£, 20/5, three at m.v. light.
Lamoria anella
1992: Es Cibollar, 23/5, two at m.v. light.
Oncocera semirubella
1992: Sa Roca, 18/5, several netted by day; Es Cibollar, 22/5 & 23/5, several at m.v. light; track by Gran Canal, 28/5, one at m.v. light. Common in sandy places throughout S'Albufera.
Pempelia numidella gelinella
1992: Sa Roca, 18/5, two at m.v. light and subsequently in small numbers.
Nephopteryx rhenella
1992: Sa Roca, 19/5, two at m.v. light and up to three per night subsequently.
Dioryctria mendacella
1992: Sa Roca, 18/5, two at m.v. light; Es Com£, 20/5, one at m.v. light.
Epischnia illotella
1992: Sa Roca, 18/5, one at m.v. light; a few later in the period.
Acrobasis obliqua
1992: Sa Roca, 19/5, two at m.v. light; Es Com£, 20/5, two at m.v. light; Es Cibollar, 22/5, one at m.v. light. Widespread in small numbers.
Myelois circumvoluta
1992: Sa Roca, 18/5, two at m.v. light; track by Gran Canal, 28/5, one at m.v. light.
Ectomyelois ceratoniae
1992: Sa Roca, 26/5, one at m.v. light.
Euzophera osseatella
1992: Sa Roca, singlet ons at m.v. light, 25/5 & 26/5.
Homeosoma sinuella
1992: Sa Roca, 19/5, one at m.v. light.

LASIOCAMPIDAE
Dendrolimus pini
1992: Sa Roca, 30/5, pale male at m.v. light.

ATTACIDAE
Antheraea pernyi
1993: Sa Roca, 21/4, one male at m.v. light. Identified from photograph by Dave Moon.

THYATIRIDAE
Tethea ocularis
1992: Sa Roca, 18/5, o ne at m.v. light and a few subsequently.

GEOMETRIDAE
Microloxia herbaria
1992: Es Com£, 20/5, one at m.v. light.
Chlorissa ? faustinata
1992: Sa Roca, 23/10, two at m.v. light.
1993: Sa Roca, 23/10-4/11, several taken at m.v. light.
Cyclophora puppillaria
1992: Entrance track, 23/10, one at m.v. light.
Scopula submutata
1992: Sa Roca, 21/10, one at m.v. light.

Scopula emutaria
1992: Sa Roca, 18/5, two at m.v. light and a few later in the period; Es Cibollar, 22/5 & 23/5, one each night at m.v. light; Son Sant Joan, 24/5, one at m.v. light; track by Gran Canal, 28/5, one at m.v. light.

Scopula minorata ochroleucaria
1992: Sa Roca, 18/5, two at m.v. light; a few subsequently. Sa Roca, 23/10, one at m.v. light.

Idaea ochrata
1992: Track by Gran Ca nal, 28/5, one at m.v. light.

Rhodometra sacraria
1992: Sa Roca, 21/10, one at m.v. light.

Orthonama obstipata
1992: Sa Roca, 18/5, one at m.v. light. Sa Roca, 21/10 (female) and 25/10 (male) at m.v. light.

Catorhoe basochesiata
1992: Sa Roca, 21/10 & 23/10, singles at m.v. light.
1993: Sa Roca, 27/10, one at m.v. light.

Costaconvexa polygrammata
1992: Sa Roca, 18/5, one at m.v. light; Son Sant Joan, 24/5, one at m.v. light.

Thera firmata ulicata
1992: Es Com£, 20/5, three at m.v. light. Sa Roca, 23/10, one at m.v. light.

Horisme vitalbata
1992: Es Com£, 20/5, one at m.v. light.

Horisme scorteata
1992: Sa Roca, 19/5, one at m.v. light.

Eupithecia breviculata
1992: Es Cibollar, 22/5, one at m.v. light.

Semiothisa aestimaria
1992: Sa Roca, 18/5, three at m.v. light and regularly in small numbers for rest of period; track by Gran Canal, 28/5, one at m.v. light.

Petrophora binaevata
1992: Es Com£, 27/10, several at m.v. light.

Pachycnemia hippocastana ria
1992: Sa Roca, 20/5, one at m.v. light. 27/10, two at m.v. light.

Menophra abruptaria
1992: Es Com£, 20/5, one at m.v. light; Sa Roca, 26/5, one at m.v. light.

Menophra japygiaria
1992: Sa Roca, 4/11, one at m.v. light.

Peribatodes rhomboidaria
1992: Es Com£, 20/5, three at m.v. light.

Aspitates ochrearia
1992: Sa Roca, 22/5, one at m.v. light; Es Cibollar, 23/5, one at m.v. light.

SPHINGIDAE

Macroglossum stellatarum
1992: Track by Gran Cana l, 28/5, one at m.v. light.

Hyles euphorbiae dahlii
1992: Sa Roca, 18/5, three at m.v. light; Es Com£, 20/5, one at m.v. light, and one or two on most subsequent nights; Es Cibollar, 22/5, one at m.v. light and three on 23/5; Son Bosc, 29/5, c20 larvae of various sizes on Euphorbia terracina .

Hyles livornica
1992: Sa Roca, 18/5, one at m.v. light; Es Com£, 20/5, one at m.v. light; Es Cibollar, 22/5, one at m.v. light; Son Sant

Joan, 24/5, two at m.v. light.

Deilephila elpenor

1992: Es Cibollar, 22/5, one at m.v. light; Son Sant Joan, 24/5, one at m.v. light.

NOTODONTIDAE

Furcula bifida

1992: Sa Roca, 26/5, one at m.v. light.

Cerura iberica

1992: Sa Roca, 18/5, six at m.v. light, several more on subsequent nights; Es Com£, 20/5, one at m.v. light. Genitalia checked.

ARCTIIDAE

Pelosia obtusa

1992: Sa Roca, 18/5, three at m.v. light; Es Cibollar, 22/5 & 23/5, several at m.v. light; Son Sant Joan, 24/5, several at m.v. light. One of the more interesting resident species in the reedbeds.

Pelosia plumosa

1992: Sa Roca, 18/5, two at m.v. light and fairly common subsequently; Es Com£, 20/5, two at m.v. light; Es Cibollar, 22/5 & 23/5, several at m.v. light; Son Sant Joan, 24/5, one at m.v. light; track by Gran Canal, 28/5, three at m.v. light. An obscure but extremely interesting species, known from a few localities in southern Spain, north Africa and southern Italy. Like its congener, living in dense reedbeds. New to Balearic Islands.

Eilema caniola torsteni

1992: Es Cibollar, 23/5, one at m.v. light; Son Sant Joan, 24/5, one at m.v. light. Sa Roca, 24/10, one at m.v. light. Endemic subspecies.

Apaidia mesogona

1992: Es Com£, 20/5, three at m.v. light.

Spilosoma urticae

1992: Sa Roca, 18/5, three at m.v. light and regularly for rest of period; Es Com£, 20/5, one at m.v. light; Es Cibollar, 22/5 & 23/5, one each night at m.v. light; Son Sant Joan, 24/5, three at m.v. light; track by Gran Canal, 28/5, several at m.v. light.

NOLIDAE

Meganola albula

1992: Es Cibollar, 22/5, one at m.v. light; Son Sant Joan, 24/5, one at m.v. light.

Nola squalida

1992: Sa Roca, 18/5, four at m.v. light and seen commonly during rest of period at m.v. light and house lights; Es Cibollar, 22/5, five at m.v. light, 23/5, several. Sa Roca, 21/10, one at m.v. light.

1993: Sa Roca, 29/10, one at m.v. light.

NOCTUIDAE

Agrotis spinifera

1992: Sa Roca, 29/5, one at m.v. light.

Agrotis ipsilon

1992: Sa Roca, 18/5, one at m.v. light; track by Gran Canal, 28/5, one at m.v. light.

Agrotis exclamationis

1992: Track by Gran Ca nal, 28/5, one at m.v. light.

Agrotis trux

1992: Sa Roca, 22/10 & 24/10, singles at m.v. light.

Ochropleura leucogaster

1992: Sa Roca, 18/5, one at m.v. light; Es Es Cibollar, 23/5, one at m.v. light; track by Gran Canal, 28/5, one at m.v. light.

Noctua pronuba

1992: Sa Roca, 18/5, one at m.v. light and in small numbers subsequently; Es Com£, 20/5, one at m.v. light; Es Cibollar, 22/5, one at m.v. light.

Noctua comes

1992: Entrance track, 23/10, one at m.v. light; Sa Roca, 24/10, one at m.v. light.

1993: Sa Roca, 29/10, one at m.v. light.

Peridroma saucia

1992: Es Cibollar, 23/5, one at m.v. light; track by Gran Canal, 28/5, one at m.v. light.

Xestia xanthographa

1992 and 1993: Sa Roca, October of both years, on several dates.

Discestra sodae

1992: Sa Roca, 18/5, one at m.v. light and a few more during following fortnight; Es Cibollar, 22/5 & 23/5, two at m.v. light each night; track by Gran Canal, 28/5, one at m.v. light.

Mamestra oleracea

1992: Sa Roca, 18/5, one at m.v. light and present in small numbers subsequently; Es Com£, 20/5, two at m.v. light; Es Cibollar, 23/5, two at m.v. light; Son Sant Joan, 24/5, two at m.v. light; track by Gran Canal, 28/5, several at m.v. light.

Hadena bicruris

1992: Es Cibollar, 22/5, one at m.v. light. Not recorded by Calle for Balearic Islands.

Hadena confusa

1992: Son Sant Joan, 24/5, one at m.v. light.

Mythimna albipuncta

1992: Sa Roca, 19/5, one at m.v. light.

Mythimna vitellina

1992: Son Sant Joan, 24/5, one at m.v. light.

Mythimna obsoleta

1992: Sa Roca, 18/5, common at m.v. light; Es Com£, 20/5, fairly common; Es Cibollar, 22/5 & 23/5, fairly common; Son Sant Joan, 24/5 fairly common; track by Gran Canal, 28/5, fairly common at m.v. light. The commonest species on S'Albufera during the May 1992 period of study.

Mythimna riparia

1992: Sa Roca, 18/5, one at m.v. light and a few more during the next fortnight; Es Cibollar, 23/5, one at m.v. light; track by Gran Canal, 28/5, two at m.v. light. Calle gives no record for the Balearic Islands.

Mythimna l-album

1992: Sa Roca, 22/5, one at m.v. light; Es Cibollar, 23/5, one at m.v. light. No record in Calle for the Balearic Islands.

Mythimna joannisi

1992: Es Com£, 20/5, one at m.v. light; Es Cibollar, 22/5 two at m.v. light, 23/5, one; Son Sant Joan, 24/5, one at m.v. light; track by Gran Canal, 28/5, two at m.v. light. Known from a few localities in SE Spain and on Corsica, but not recorded by Calle for the Balearic Islands.

Calophasia platyptera

1992: Track by Gran Canal, 28/5, one at m.v. light. Sa Roca, 22/10, one at m.v. light.

Trigonophora flammea
1993: Sa Roca, 28/10, one at m.v. light.
Blepharita spinosa
1992: Entrance track, 23/10, one at m.v. light.
1993: Sa Roca, 1/11, one at m.v. light. Genitalia slide M01 (male).
Xanthia gilvago
1993: Sa Roca, 26/10 & 4/11, singles at m.v. light.
Simyra albovenosa
1992: Track by Gran Canal, 28/5, one at m.v. light. Calle gives no previous record for the Balearic Islands.
Acronicta tridens
1992: Sa Roca, 22/5, one at m.v. light. No previous record for the Balearic Islands, according to Calle.
Cryphia pallida
1993: Sa Roca, 31/10, one at m.v. light. Genitalia slide M02, male.
Trachea atriplicis
1992: Sa Roca, 22/5, one at m.v. light. Calle gives no record for the Balearic Islands.
Nonagria typhae
1992: Sa Roca, 18/5, one f. fraterna at m.v. light; Son Sant Joan, 24/5, one of the typical form at m.v. light.
Archanara geminipuncta
1992: Pupae and occasional larvae locally common in stems of Phragmites australis at S'Albufera, the subject of a detailed investigation. Moths emerged between 12th and 26th June. Calle gives no previous record for the Balearic Islands.
Archanara dissoluta
1992: Es Cibollar, 23/5, one at m.v. light; track by Gran Canal, 28/5, one at m.v. light. Apparently new to both the Balearic Islands and mainland Spain.
Photedes pygmina
1992: Entrance track, 23/10, one at m.v. light.
Sesamia nonagrioides
1992: Sa Roca, 18/5, five at m.v. light and several subsequently; Es Cibollar, 22/5 & 23/5, one each night at m.v. light; track by Gran Canal, 28/5, several at m.v. light.
Rhizedra lutosa
1992: Sa Roca, several in October, at m.v. light.
Platysenta viscosa
1993: Sa Roca, 28/10, one at m.v. light.
Hoplodrina ambigua
1992: Sa Roca, 18/5, five at m.v. light and common subsequently; Son Sant Joan, 24/5, one at m.v. light; track by Gran Canal, 28/5, one at m.v. light.
Spodoptera cilium
1992: Sa Roca, October , several taken at m.v. light.
Spodoptera littoralis
1992: Entrance track, 23/10 at m.v. light.
1993: Sa Roca, 28/10, at m.v. light.
Spodoptera exigua
1992: Sa Roca, 23/5, one at m.v. light.
Chilodes maritimus
1992: Sa Roca, 18/5, two at m.v. light and regularly in small numbers subsequently; Es Com£, 20/5, two at m.v. light; Es Cibollar, 22/5, two at m.v. light, 23/5, one; Son Sant Joan, 24/5, one at m.v. light; track by Gran Canal, 28/5, several at m.v. light. Typical form and abs. nigrostriata , wismariensis and bipunctata all recorded. Calle gives no record for the Balearic Islands.

Athetis hospes
1992: Sa Roca, 18/5, three at m.v. light and fairly frequent subsequently; Es Com£, 20/5, one at m.v. light; Es Cibollar, 22/5 & 23/5, one each night at m.v. light; Son Sant Joan, 24/5, one at m.v. light; track by Gran Canal, 28/5, three at m.v. light. Calle gives no record for the Balearic Islands.

Heliothis peltigera
1992: Mouth of Gran Ca nal, 30/5, one flying by day.

Eublemma ostrina
1992: Sa Roca, 22/5, one at m.v. light.

Eublemma parva
1992: Sa Roca, 21/10, 23/10 & 30/10, singles at m.v. light.

Eublemma cochyloides
1992: Sa Roca, 22/10, at m.v. light.

Emmelia trabealis
1992: Es Cibollar, 22/5, two at m.v. light; Son Sant Joan, 24/5, three at m.v. light; track by Gran Canal, 28/5, one at m.v. light.

Zebeeba falsalis
1992: Es Com£, 20/5, four at m.v. light; Es Cibollar, 22/5, one at m.v. light.

Eutelia adulatrix
1992: Es Com£, 20/5, one at m.v. light; Es Cibollar, 23/5, one at m.v. light; track by Gran Canal, 28/5, three at m.v. light.

Autographa gamma
1992: Sa Roca, 29/5, one at m.v. light.

Ctenoplusia accentifera
1992: Es Cibollar, 22/5, one at m.v. light; Calle gives no record for the Balearic Islands, but a specimen exists in the Project S'Albufera collection.

Ophiusa tirhaca
1992: Es Com£, 20/5, one at m.v. light. No record in Calle for the Balearic Islands.

Clytie illunaris
1992: Track by Gran Canal, 28/5, one at m.v. light. Calle records the species from Ibiza but not Mallorca.

Dysgonia algira
1992: Sa Roca, 18/5, one at m.v. light; Son Sant Joan, 24/5, one at m.v. light; track by Gran Canal, 28/5, one at m.v. light.

Grammodes bifasciata
1992: Sa Roca, 18/5, one at m.v. light. Calle gives no record for the Balearic Islands.

Aedia leucomelas
1992: Es Cibollar, 22/5, one at m.v. light; Son Sant Joan, 24/5, one at m.v. light; track by Gran Canal, 28/5, four at m.v. light.

Tyta luctuosa
1992: Sa Roca, 18/5, one at m.v. light and several subsequently; Es Cibollar, 22/5, four at m.v. light.

Lygephila craccae
1992: Sa Roca, 18/5, one at m.v. light and a few later in the period.

Pechipogo plumigeralis
1992: Track by Gran Ca nal, 28/5, two at m.v. light.

Nodaria nodosalis
1993: Sa Roca, 31/10, one at m.v. light.

Schrankia costaestrigalis
1992: Sa Roca, 18/5, one at m.v. light. Unrecorded by Calle for the Balearic Islands.

A few species remain to be identified.

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XX

ANNEX 7

Sampling of Odonata larvae and other aquatic fauna at S'Albufera, Mallorca in October 1992 by Ed Cross

Introduction

I made two visits with Earthwatch teams to S'Albufera, Mallorca in 1992 to study freshwater life. These were in April and October. On both visits we looked at which freshwater animals (fauna) occurred in which habitats.

The aims of this work were to study which species occurred in which habitats, and to attempt to quantify the density of their populations. These aims applied particularly to Odonata (dragonflies). The study did not include any counts of microfauna.

During the late summer, many of the shallow water habitats at S'Albufera normally dry up (including open marshes like Tancat de Sa Roca and Ses Puntes, and densely vegetated areas such as Es Ras and Es Rotlos). Part of the sampling in October was designed to investigate re-colonisation of Tancat de Sa Roca after the return of water to that marsh in the last week of September.

Note : In this report, the term `dragonflies' is taken to include both branches of this order, i.e. dragonflies proper (Odonata: Anisoptera) and damselflies (Odonata: Zygoptera).

Methods

Three methods were used to sample the freshwater life:

- Ten-sweep sampling - making ten 1 m long sweeps with a water net. A fine mesh net was used in April, but a coarser mesh was used in October, so that there was less mud in each sample.

- 1 m 2 counts - isolating 1 m 2 of marsh with a plastic and metal frame, then counting all the animals within that area.

- 400 cm 2 counts - isolating a 400 cm 2 area of marsh with a 225 mm diameter plastic pipe, and counting all the animals within that area.

The last two methods allowed us to make some estimates of populations per unit area, but neither of these could be used in sites with deep water. Therefore, in the canals, we only used ten-sweep sampling.

Results

The results of the April sampling are presented in Tables 1 and 2 and the October results in Tables 3 and 4. The results for *Odonata* larvae are divided into three groups: *Zygoptera*, *Libellulidae* (= Anisoptera : *Libellulidae*) and *Aeshnidae* (= Anisoptera : *Aeshnidae*). Please note that *Sphaeroma* are labelled ` Isopoda ' in the April results.

Identifying *Odonata* larvae and other freshwater fauna to species level requires considerable expertise and time. Therefore the totals for the counts comprise groups of similar species. A key to abbreviations and Spanish terms used in the Tables is given in Appendix 1.

----------Tables 1-4----------

Limitations of results

There are several reasons why I am cautious about the conclusions which may be drawn from the results. These are:

Groups of species

The family *Libellulidae* includes several species of disparate distribution and status. For instance, the family includes *Sympetrum striolatum* (which occurs throughout much of Europe and is common at S'Albufera) and *Selysiothemis nigra* (which is rare in Europe and one of the species which the reserve aims to conserve). Therefore, a site containing one *Libellulidae* larva/m^2 may be at least as valuable for conservation as another containing 50/m^2 if the larva from the first site happens to be a rare species.

Also, over a period of years, a site may contain the same density of larvae, but hide annual variations in the species composition.

Sample size

The more samples taken at one site, the more accurate the estimate of numbers/m^2.

Figure 1 shows how the average number of *Chironomidae* (fly) larvae per sample varied after different numbers of samples had been taken in Tancat de Sa Roca on 20/10/92. If just five samples had been taken, the estimate would have been 1.4; after 10 samples, it would have been 1.1. The fluctuation in the average number per sample decreases the more samples are taken, until there is little change between 25 and 30 samples. This indicates that a total of 30 samples was an acceptable minimum to ensure an accurate estimate for this species group at this site, while estimates made from fewer than 25 samples may be unreliable.

-------Figure 1----------

Variations in sampling methods and location of sites
Differences in the meshes of nets used in ten-sweep sampling in April and October may mean that comparisons of numbers caught are misleading. Also, results in April suggest ten-sweep sampling and the more intense 1m 2 counts differed in how effective they were in catching the various types of Odonata larvae.

The October sample locations at most sites were close to the April sample locations. The exception was Es Colombar. In April, an open pool beside the track in the north of the marsh was sampled. In October, the sampling was done beside the boardwalk to the Xisco Lillo hide. The October sampling is therefore labelled Es Colombar (bw).

Odonata results

Aeshnidae

In April 1992, Aeshnidae made up 16% of the total catch of larvae of the ten-sweep sampling, but no Aeshnidae were among the 211 larvae caught in October 1992. Only one Aeshnidae larva was found in October. This individual was well-developed and might have been Aeshna cyanea (which is not known to occur in Mallorca).

Two notable sites where Aeshnidae were absent in October, but quite common in April, were Es Ras and Siguia (Cam¡ de Ses Puntes).

In October, The commonest dragonfly on the wing is Aeshna mixta . In April, adult Aeshna isosceles , Anax imperator and Anax parthenope are quite common. While the Aeshna mixta could be migrants, the other three species probably breed on the reserve. Indeed, one Anax imperator larva was found in Tancat de Sa Roca in April.

So, where were the Aeshnidae in October, and were they present as eggs or larvae?

In the UK, some Aeshnidae larvae take two or three years to develop from egg to flying adult, but development may be much faster in a Mediterranean climate. Perhaps eggs or very small larvae were present but undetected, and developed fast enough to emerge as adults in the following spring/summer?

The one Aeshnidae larva found in Tancat de Sa Roca was over 20 mm long. It seems unlikely to have grown to this size in the three to four weeks since water returned to the marsh. Therefore it may have spent the late summer in one of the canals or ditches bordering the marsh. These are deeper bodies of permanent water which connect directly to the pools in the marshes once water

levels rise.

Libellulidae

These were numerous in most shallow water habitats in April, but in October were only found in Tancat de Sa Roca. None was found in the samples at Tancat de Sa Roca on 20/10/92 and 23/10/92, but on 28/10/92 there were about 50/m 2 . The largest of these was about 5 mm in length. Libellulidae species (e.g. Sympetrum striolatum) were egg-laying in October, so perhaps the larvae we found had developed from eggs laid since water returned to the marsh. Alternatively, some eggs may have survived in damp mud or vegetation.

No other Libellulidae larvae were found using the 400 cm 2 counts, but in April some were found in Es Ras, Es Rotlos and Ses Puntes using ten-sweep sampling.

Zygoptera

These were the commonest larvae in both April and October. In October, they were numerous in deep water habitats (Canal d'en Pujol), but were absent from Tancat de Sa Roca and Es Colombar. One was found in Es Ras in October, but none was present in April. They occurred in Es Rotlos and Ses Puntes during both visits.

Site results

Tancat de Sa Roca

The area we have studied most closely is in the south east corner of this marsh. In April we found about 200 Odonata larvae/m 2 , comprising about 25% of the fauna by number. The most found in October was 52/m 2 , comprising 13% of the fauna by number.

The October sampling showed an increase in the numbers of many fauna over an eight to nine day period. All the types of fauna found were more numerous in the last set of samples than the first, but the trend was less clear in Chironomidae , adult beetles and the `brown larvae' (which may also have been a Chironomidae type). Some of the inconsistencies may be explained by the middle sample set, which was from a site 40 m apart from the other two. The most rapid increases were seen in Gammarus and Hemiptera , and the eight faunal groups (including Libellulidae) which were found in the last set but absent from the first. These figures indicate rising populations following the return of water to Tancat de Sa Roca. These increases may be attributable to one or more of three strategies:

Arrivals of adults or larvae re-colonising recently renewed water bodies by swimming or (for adults) flight;

Emergence of adults or larvae from the newly flooded mud;

The hatching of eggs laid before or after the water returned to the site.

Ses Puntes

The corner of Ses Puntes which was sampled is located close to a connection with Siguia (Cam¡ de Ses Puntes). There were similarities between the fauna caught in both these sites in October, demonstrated for example by samples from both of

Zygoptera , fish and Sphaeroma .

Other species groups

Chironomidae and `brown larvae'

Chironomidae and (probably) `brown larvae' are Dipterans . Combined, they made up 35-75% of the fauna in October samples at Tancat de Sa Roca. They were absent from Es Ras, and found in low numbers in Es Rotlos and Es Colombar. These sites were mainly soft-bottomed, and had more mature and denser vegetation than Tancat de Sa Roca. The average densities in April and October in Tancat de Sa Roca were very similar.

I have found Chironomidae larvae alive in mud of dried ponds elsewhere, so their population may be less affected by the drying of the marsh than, for example, species of Odonata .

Gammarus and Spaheroma

Both these groups occurred in low numbers in shallow water sites in October and, as in April, Sphaeroma was particularly scarce in Tancat de Sa Roca and Es Ras.

Of the deep water sites, Siguia (Cam¡ de Ses Puntes) had more Sphaeroma than Gammarus . Canal d'en Pujol, which was clear of Phragmites and other emergent vegetation, had high populations of both groups.

N.B . Sphaeroma are labelled ` Isopoda ' in Tables 1 and 2.

Coleoptera

In Tancat de Sa Roca, the density of Berosus larvae, other Coleoptera larvae (in October these were all Hydroporidae) and Coleoptera adults was greater in October than April. Several examples of adult Coleoptera were collected for identification.

Ephemeroptera

Es Rotlos was the only site where this order was found in October and one of only four sites where it was found in April.

Hemiptera

During both visits, Hemiptera were found in Es Ras and Siguia (Cam¡ de Ses Puntes) but not in Es Rotlos. They occurred at a high density in the last 400 cm 2 sampling in Tancat de Sa Roca (over ten times the density found in April). In contrast, they were not found in Ses Puntes in October but were there in April. Their absence from Ses Puntes in October could be because sampling was done early in relation to any re-colonisation process. However, this did not apply for Zygoptera (see earlier notes).

A second unidentified Hempitera caught in Tancat de Sa Roca is labelled `HemiII' in Tables 3 and 4.

Corophium

These were confined to Canal d'en Pujol, where they were common.

Asellus

In October, these were found in Siguia (Cam¡ de Ses Puntes) and Es Rotlos; also in very high numbers in Es Ras (about 470/m 2 from ten samples). The label `Otra Isop.' in April's results is now

thought to refer to *Asellus* .

Pisces

In October, these were most numerous in Ses Puntes, but fish were also found in Es Colombar, Tancat de Sa Roca and Es Ras. The pattern was similar in April.

Other October encounters

Tabanidae : one larva of this Dipteran was found in Siguia (Cam¡ de Ses Puntes).

Astacura : small examples were found in Es Ras and Canal d'en Pujol.

Talitridae : two were found in Tancat de Sa Roca (these are known in English as Bankhoppers and are semi-terrestrial).

Ceratopogonidae : larvae of this biting midge were found in Es Colombar and Tancat de Sa Roca. The larvae are about 7 mm long and very thin. They swim quite quickly with rapid S-shaped wiggles.

Microfauna: representatives of Cladocera , Ostracoda , Copepoda and Acari were found in Tancat de Sa Roca.

Conclusions

In October 1992, fewer sites were sampled for aquatic fauna than in April, but more information was collected about population densities. This was because our work concentrated on using the 400 cm 2 sampling method. Also in October, more specimens were collected for identification, and this has led to some progress in naming the fauna. Only a small selection of Odonata species was flying, and only one near-mature larva was found, so little progress was made in identifying which species use which water bodies.

Tancat de Sa Roca was dry until late September. The results show that between 20/10/92 and 29/10/92, the fauna on this site increased in terms of number of individuals and diversity of species. This may be because of re-colonisation and expansion of populations into newly available water bodies as rising water levels re-flooded that part of the marsh.

Zygoptera larvae were present in a wide range of habitats in October (although not in Tancat de Sa Roca), but no Aeshnidae larvae were found during sampling and Libellulidae were only caught at one site.

If this is a regular pattern, an anomaly exists which I am currently unable to explain between the lack of larvae found in October and the generally more numerous and diverse Odonata populations found in April.

[EDITORS' NOTE : a better label for the Siguia (Cam¡ de Ses Puntes) site of this paper is Siquia de Ses Puntes]

Appendix 1: Translations of terms used in Tables

agua	- water
al lado de	- beside
blando	- soft
cami	- road, track
circa de	- near to
denso	- dense
disp., disperso	- sparse
E (este)	- east
fecha	- date
flujo	- flow
fondo	- bottom
mues., muestra	- sample
N (norte)	- north
nada	- nothing, none
nivel	- depth
numero en mapa	- number on map

o	- or
O (oeste)	- west
otra	- other
peq., pequeno	- small
plantas aquaticas	- water weeds
rapido	- rapid
S (sur)	- south
siguia	- ditch, canal
situacion	- site
solido	- solid
suave	- gentle
torre (la)	- tower (the)

Abreviations used in Tables

Aeshni.	- Aeshnidae
Anne	- Annelida
Anur	- Anura
Arach	- Arachnida
Ber	- Berosus
Chir	- Chironomidae
Clad	- Cladium
Cole adult	- adult Coleoptera
Cole larva	- Coleoptera larva
Crus	- Crustacea
Culic	- Culicidae
Dytis	- Dytiscidae
Ephe	- Ephemeroptera
Gamm	- Gammarus
Hemi	- Hemiptera
Isop	- Isopoda
Junc	- Juncus
Libell	- Libellulidae
Moll	- Mollusca
Ner	- Nereis
otra Isop	- Isopoda (another type, as yet unidentified)
Phrag	- Phragmites
Pisc	- Pisces
Zygopt	- Zygoptera
Dipt	- Diptera
Sphae	- Sphaeroma
Hydro	- Hydroporidae (Coleoptera)

ANNEX 8
Invertebrate studies: spiders and beetles by Nick Riddiford

In the spring and summer of 1992, members of the Balearic Invertebrate Study Group undertook preliminary studies of spiders (Arachnida: Araneae) and two beetle families (Coleoptera: Carabidae and Tenebrionidae) at S'Albufera. This was done using pitfall traps set in five characteristic S'Albufera habitats: a wet area among Tamarisks, periodically inundated Salicornia steppe (both at Es Cibollar), a meadow covering a fossil sand dune at Es Ras, within the pine woodland on the fossil dune system at Ses Puntes, and within pine woodland on the coastal dunes of Es Com£. As pitfall traps do not collect all species, additional information for spiders was collected by direct captures.

The results of both these studies were published in 1993. They are summarised below.

1. Spiders

PUBLICATIO N CITATION
Pons, G. 1993. Artr•podes de s'Albufera de Mallorca: Arachnida , Araneae . Boll. Soc. Hist. Nat. Balears 36: 91-98.

AUTHOR DET AILS
Guillem Pons: Institut d'Estudis Avan‡ats de les Illes Balears (CSIC), Carretera de Valldemossa, km 7.5 (07071) Palma de Mallorca.

ENGLISH TITLE
Arthropoda from S'Albufera de Mallorca: Arachnida , Araneae .

ENGLISH SUMMARY
The spider fauna of the Balearic wetland zone, S'Albufera de Mallorca has been studied for the first time. A preliminary checklist of the species recorded from spring and summer 1992 is given. The spiders were collected by means of pitfall traps. 53 species were recorded, 15 of them new records for the Balearic Islands: Hyptiotes paradoxus , Anelosimus pulchellus , Theridion pinastri , Ostearius melanopygius , Eucta isidis , Pachygnatha clercki , Textrix denticulata , Phrurolithus nigrinus , Clubiona neglecta , Micaeria formicaria , Runcinia lateralis , Bianor albobimaculatus , Icius subinermis , Marpissa canestrinii and Pellenes arcigerus .

EDITORS' NOTE
The summary has been lightly edited to improve the English text.

FURTHER INFORMATION
The paper outlines the status of the fifteen species new to the Balearic Islands. Most have a wide faunal distribution, but Eucta isidis is described as a very rare species with few Spanish records. The material collected during this study has been deposited in the Arachnological collection of the Museu de la Naturalesa de les Illes Balears (MNCM); and a reference collection is also to be lodged at S'Albufera Natural Park.

2. Beetles

PUBLICATIO N CITATION
Palmer, M. and Vives, J. 1993. Carabidae i Tenebrionidae (Coleoptera) de s'Albufera de Mallorca: Dades preliminars. Boll. Soc. Hist. Nat. Balears 36: 65-76.

AUTHOR DET AILS
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Joan Vives: c/Sant Antoni 73, 08221 Terrassa.

ENGLISH TITLE: Carabidae and Tenebrionidae (Coleoptera) from S'Albufera de Mallorca: preliminary records.

ENGLISH SUMMARY: A first checklist is presented of Carabidae and Tenebrionidae from S'Albufera de Mallorca (Mallorca, Balearic Islands). The checklist is based on three months' sampling with pitfall traps. Carabidae and Tenebrionidae are the most abundant Coleoptera at S'Albufera. Forty-three species, including five new records for the Balearic Islands and three confirmations of previously doubtful records are listed. The rarity of endemic forms (only one species) suggests recent isolation of Carabidae at S'Albufera and, by association, Mallorca generally. In contrast most Tenebrionidae species are endemics. Carabidae

beetles show a significant correlation between their abundance and soil moisture. Tenebrionidae beetles, on the contrary, do not show a well defined pattern. This taxocenosis shows high abundance and diversity values. The most abundant species have small micro-geographical and seasonal niches which scarcely overlap.
These indices are frequently found in communities with high stability, but in this case they can be related to two basic features of wetlands: fluctuations of the abiotic environment and high productivity.

EDITORS' NOTE
The summary has been lightly edited to improve the English text.

FURTHER INFORMATION
The five new species for the Balearic Islands are *Bradycellus harpalinus* Serville, *Dyschirius normandi* Puel, *Emphanes tenellus* (Erichson), *Poecilus kugelani aeneus* Dejean and *Princidium bipunctatum* Linn. The three previously doubtful species confirmed by this study are *Chlaenius (Chlaenites) spoliatus* Rossi, *Brachinus plagiatus* (Reiche) and *Acupalpus meridianus* Linn. The material collected during this study has been deposited in the entomological collection of the Museu de la Naturalesa de les Illes Balears (a small reference collection of beetles, mainly comprising Carabidae and Tenebrionidae, prepared by the Balearic Invertebrate Study Group, was lodged at S'Albufera Natural Park in 1992).

ANNEX 9

Ornithology: ringing studies by Dr Roger Riddington and Roy Taylor

Introduction

The ringing work carried out in October-November 1993 was designed to consolidate samples of local/resident Mallorcan species (e.g. Moustached Warbler *Acrocephalus melanopogon*) but also to collect data to address two specific questions, on which this summary report concentrates. These two individual research topics were: i) bill morphology of the local subspecies of Reed Bunting *Emberiza schoeniclus witherbyi* , and ii) body condition of migrant passerines.

The Reed Bunting study continues work by previous Earthwatch teams (see King 1993, Goater 1993, Radermacher 1993 and this report). This interdisciplinary research seeks to examine the interaction between Reed Buntings and one or more species of lepidopterous larvae, including *Archanara geminipuncta* , within *Phragmites* reed-stems at S'Albufera. The work attempts to determine the extent to which Reed Buntings are able to exploit this food resource, and whether the phenology of the larvae may explain, at least in part, evolution of a morphologically distinct subspecies of Reed Bunting. The subspecies *witherbyi* is distinguished from more widespread European forms by having a particularly deep, conical bill, with a markedly decurved culmen. During the autumn migration, local Reed Buntings are joined by slimmer-billed migrants, presumably from northwestern Europe, and this facilitates direct comparison of different forms.

Assessment of the body condition of migrant passerines is a field technique which is still being developed, and therefore fieldwork (such as that carried out here at S'Albufera) is valuable simply in a methodological context, in terms of the potential to revise and improve techniques. In addition, recording body condition of regular migrant passerines is an important indicator of the value

of S'Albufera as a migration stop-over and re-fuelling location for south-bound migrants in autumn. Such data strengthen the Parc 's claim to be of international importance to such migratory populations, and enhance the chances of opposing future development which may harm the site.

Study Area and Methods

Between 24th October and 5th November 1993, ringing occurred on all days with suitable weather conditions. From 24th-31st October, mist-netting was carried out during the mornings within reedbeds and scrub at Es Colombar, with up to 136 m (410') of netting opened. From 1st-5th November the main morning site was Ses Puntes, again in reedbed and scrub habitats with a maximum of 136 m of net opened. Evening mist-netting at reedbed roosts was carried out at three sites - Es Colombar, Es Rotlos and Ses Puntes - during the two weeks, using 33-60 m (100-180') of nets and tape-lures to attract birds. In addition, on three mornings, mist-netting was carried out near the reception centre at Sa Roca, as a large flock of migrant Siskins Carduelis spinus had gathered there and the prospect of catching a reasonable sample appeared good.

All birds trapped were ringed with a standard metal ring (issued by ICONA, the National Institute for the Conservation of Nature, in Madrid) bearing a unique number. In addition to recording the age and sex (where possible) of all captures, the following biometrics were taken: wing-length (maximum chord), fat score (based on the amount of fat visible in the tracheal pit), muscle score (an assessment of the extent of the pectoral muscle, based on the shape of the keel), number of retained juvenile greater coverts (in first year birds) and weight. For Reed Buntings only, four measurements of the bill were recorded: bill length, from the tip to the feathering on the forehead; bill length, from the tip to the base of the skull; bill depth; and bill width. Both depth and width were measured at the proximal end of the nostril.

Results and Discussion

A total of 631 birds was caught during the two weeks, of 33 species (see Appendix 1).

Bill morphology of Reed Buntings, Emberiza schoeniclus

Fifty-three Reed Buntings were caught during the fortnight and bill measurements obtained for 51. A distinction between thick-billed local birds (Emberiza schoeniclus witherbyi) and slimmer-billed migrants (E. s. schoeniclus) was extremely obvious in the hand, and the majority of individuals could be assigned "resident" or "migrant" simply by eye with a high degree of accuracy. The most obvious difference visually was in bill depth. This is borne out by the data (Fig. 1) which show a clear division between a cluster of slim-billed individuals, with bill depth around 4.9 mm, and a group of thicker-billed birds, centred on 6.4-6.6 mm. The hypothesis that this merely reflects sexual differences (with the larger males having deeper bills, and females, which are smaller, having slimmer bills) is discounted

(Fig. 2) since within each sex a similar distinction is apparent between thick- and thin-billed birds, presumably reflecting residents and migrants. The division is less obvious when the sexes are separated, not least because the sample sizes are inevitably about half that of both sexes combined. If we assume that birds with a bill depth <5.4 mm are migrants, then the 11 migrants caught comprised 10 females and 1 male. If birds with bill depth >5.7 mm comprised residents, then 26 residents were males, 12 were females. The split of residents suggests that there is some sexual component to bill depth, since there are twice as many males as females. Another possibility is that there may be a sex bias in the trapping method, with more males attracted to tape lures than females, although we have no data to support this. The high number of migrant females suggests that more females migrate this far south in winter, consistent with the general hypothesis that in many species (passerine and non-passerine) females winter farther south than males. Males, which are larger, are better able to withstand colder climates farther north, and are thus able to return to their breeding grounds earlier in spring, to begin territorial defence.

When considering bill length, there is a much less obvious division between residents and migrants (Fig. 3). Differences here seem to be determined by sex to a greater degree (Fig. 4), with females having shorter and males longer bills (although differences are slight).

In conclusion, these data repeat previous findings (e.g. King 1993) that local Reed Buntings are indeed morphologically distinct from migrant ones, having markedly deeper (though not longer) bills. However, sex differences should clearly also be taken into account when analysing differences in this subspecies. The hypothesis that this thicker bill has evolved in order to exploit reedbed larvae is plausible, and indeed seems intuitively sensible. A way to test this would be to measure local Reed Buntings not relying on this food source during the time it is available - for example, farmland-breeding birds. Unfortunately, this is not an option because Mallorcan Reed Buntings breed exclusively in reedbeds (Mayol 1990). A parallel option which may be worthy of consideration would be to measure the bills of other resident passerines which feed in the reedbeds and might potentially exploit the larvae (for example Great Tits *Parus major*) which could then be compared with measurements from woodland-dwelling populations elsewhere in Mallorca.

Body condition of migrant passerines

From the range of species trapped in reasonable numbers, Siskins *Carduelis spinus* were chosen for further analysis because this species can reliably be aged and sexed in the hand. Furthermore, body condition can also be related to the extent of post-juvenile moult. This can be assessed by recording the number of retained (juvenile) greater coverts, a feature which shows considerable individual variation.

From 83 Siskin captures, 75 different individuals were ringed and measured (eight individuals were caught twice). Of these, 56 (75%) were first-years (i.e. hatched in 1993). A high proportion of young birds is to be expected in autumn in a small passerine species with a short lifespan, but it also illustrates the fact

that a greater proportion of young birds are likely to move away from their breeding grounds than adults. Siskins, like many passerines, are sexually dimorphic in body size, with males being slightly but significantly larger than females (Fig. 5); wing length being one of the single most accurate indicators of body size. Body size itself tends to be a reliable indicator of dominance, other things being equal, and we might reasonably assume that for these Siskins, in an unfamiliar location, males would be dominant over females. This would be particularly true at a "central place" foraging site: that is, a feeding site where resources are strongly clumped, so that individuals are likely to compete for the best feeding spots. Such a situation existed to some extent at S'Albufera in autumn 1993, for a flock of over 100 Siskins were concentrated in a small area feeding, along with other finches and sparrows, on the seeds of fat hen Chenopodium album . Although not as clumped as, for example, at a bird table, where intra-specific competition is very clear, this food resource was probably sufficiently discrete to produce a situation of the most dominant individuals securing the best foraging sites, with least dominant birds confined to less productive areas.

If we assume that there was intra-specific competition among the Siskins at S'Albufera, we may hypothesise that dominants would carry less fat and more muscle reserves than sub-dominants. Since carrying fat is costly (for example it increases body-weight, which in turn means that more energy is required for flight; one consequence of this is that predation may be mass-dependent), it would be expected that dominant birds, which are more assured of a constant food supply, would carry least fat. Less dominant birds, which are least assured of food resources and therefore experience the most "variable" environment, would carry most fat. In contrast, one would assume that dominant birds would carry more muscle, since there are no obvious disadvantages of high muscle reserves: it is only under extreme circumstances that protein reserves in muscle would be metabolized to produce energy (e.g. during a long migration). High muscle reserves are therefore presumably a good indicator of condition and a high dominant status. It is believed that body condition at the time of the post-juvenile moult may affect the degree to which this moult (a partial moult in many passerines species - i.e. involving only head and body feathers) is completed, since moult is an energetically expensive process. Thus if a bird is in good condition, more of its feathers will be replaced and vice versa. Since a variable number of greater coverts are replaced in many species (including Siskins) and these are typically easily identified, this may prove to be a useful indicator of body condition at the time of the post-juvenile moult.

The observed body condition of Siskins trapped at S'Albufera partly supports the difference predicted (Fig. 5). Fat scores are significantly lower in young males, the more dominant sex, suggesting they are anticipating less variation in their feeding environment than females. The latter are carring more fat to "buffer" them, to guard against times when they are prevented from obtaining sufficient resources by more dominant individuals. However, there are no differences in pectoral muscle scores, which suggests that real differences in condition and dominance between the sexes may in fact be rather small. Since fat scores vary on a day-to-day basis, the differences between sexes may become more or less pronounced according to fluctuation in

resource availability. The fact that the differences in size are rather small (although consistent) may mean that dominance hierarchies are not so well developed or consistent as in species where dimorphism is greater. Also, the resource distribution at this site may contribute to the differences observed in condition.

There is a parallel difference between the sexes in retained juvenile greater coverts, males having fewer retained juvenile greater coverts than females, although the difference is not significant (with a two-tailed test). This suggests that males were already dominant over females at the time of the post-juvenile moult, and that there was sufficient resource clumping to stimulate differences in the extent to which juvenile feathers were replaced.

In conclusion, the data collected at S'Albufera illustrate the potential value of recording measures of body condition and moult, and how these might be interpreted within a wider framework encompassing concepts such as competition, environmental variability etc. Ideally, these data would be combined with comparable records from elsewhere in the wintering range (e.g. Britain), to judge the values of alternative migration strategies. Assessing the value of S'Albufera as a stop-over or wintering site, for species such as Siskins, is important in the context of the conservation status of the site. This is hard to estimate with just one sample, and this may be another reason for extending the Earthwatch work beyond the boundaries of the Park, to achieve samples of certain species across different habitats and areas.

Acknowledgement

The School of Environmental Sciences, University of East Anglia, is gratefully acknowledged for permitting Dr Riddington to participate in Project S'Albufera .

-------FIGURES 1-5--------

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Appendix 1: List of species ringed, and numbers caught

SPECIES	TRAPPED	*RETRAPS
Mallard Anas platyrhynchos	3	
Kestrel Falco tinnunculus	1	
Coot Fulica atra	2	
Barn Owl Tyto alba	1	
Scops Owl Otus scops	2	
Swallow Hirundo rustica	2	
White Wagtail Motacilla alba	42	
Dunnock Prunella modularis	2	
Robin Erithacus rubecula	52	7
Bluethroat Luscinia svecica	1	
Redstart Phoenicurus ochruros	1	
Stonechat Saxicola torquata	5	1
Blackbird Turdus merula	2	1
Song Thrush Turdus philomelos	4	
Cetti's Warbler Cettia cetti	30	11
Fan-tailed Warbler Cisticola juncidis	1	
Reed Warbler Acrocephalus scirpaceus	3	
Great Reed Warbler Acrocephalus arundinaceus	1	
Moustached Warbler Acrocephalus melanopogon	145	26
Blackcap Sylvia atricapilla	7	
Sardinian Warbler Sylvia melanocephala	20	4
Chiffchaff Phylloscopus collybita	129	3
Great Tit Parus major	8	1
Starling Sturnus vulgaris	4	
House Sparrow Passer domesticus	7	
Tree Sparrow Passer montanus	1	
Chaffinch Fringilla coelebs	7	
Serin Serinus serinus	6	
Greenfinch Carduelis chloris	2	
Goldfinch Carduelis carduelis	3	
Siskin Carduelis spinus	83	8
Reed Bunting Emberiza schoeniclus	53	3
**Black-headed Weaver Ploceus melanocephalus	1	

*`Retraps' denote individuals which were recaptured during the study, having been ringed at S'Albufera previously. Such recaptures contribute enormously to the knowledge of resident species in particular (Moustached Warbler is a pertinent example in this case), where with sufficient data many aspects of population biology may be examined and understood. This forms a vital scientific function in the understanding of particular elements in an ecosystem, on which sound conservation policies and strategies must be based.

**The Black-headed Weaver belonged to the race P. m. capitalis . It occurs no closer to Mallorca than sub-Saharan West Africa, so it may have been an escape from captivity.

Coot *Fulica atra* habitat choice and time budgets by Nick Riddiford

To increase our knowledge of the way bird species use various S'Albufera habitats, volunteers were set the task of observing flock activity and feeding behaviour of Coots *Fulica atra* in three habitats, Tancat de Sa Roca, Gran Canal and Es Cibollar (comprising the open habitats in front of the Bishop 1 Hide). Coots were chosen for initial research in this field because they were abundant at all three sites and indeed constituted a major component of the avifauna of all open, wet habitats at S'Albufera throughout the year. The sites were selected because they were open, possessed good vantage points for observation and were habitats of different depth and water chemistry. At Tancat de Sa Roca the number of Coots visible during the period study varied between 38 and 65 (mean 48.8), observations were made from the CIM hide and the habitat comprised shallow, open fresh water with no perceptable flow and with sparse emergent vegetation grazed by horses and cattle. At Es Cibollar the sample size was lower, ranging from 12 to 24 (mean 18.3) Coots, observations were made from the Bishop 1 Hide and the habitat comprised shallow brackish water surrounded by clumps of tall emergent vegetation and divided by a vegetated earth bank from a lagoon of deeper brackish water, neither water body with perceptible flow; grazing by horses was introduced during the study. The sample size on the Gran Canal ranged from 7 to 51 (mean 22.2), observations were made from the Tower Hide or from Sa Roca Bridge and the habitat comprised deep, open fresh water, slow-flowing, fed from two streams reaching the Park through agricultural land (thus potentially carrying agricultural chemical run-off) and with emergent vegetation virtually confined to the canal banks.

Methods

Two methods were employed, both based on techniques widely used to measure feeding behaviour and time budgets (e.g. Altman 1974...). The first was entitled "Flock Activity". Volunteers were instructed to sweep the entire area within their view with binoculars, describing the activity of each bird at the moment of encounter, then moving immediately to the next individual until the activity of all individuals visible had been described. A standard recording form was drawn up to allow them to record their results. An example of this is given in Appendix 1.

The second method required volunteers to select a single Coot and record the number of "pecks" in each minute during a fifteen-minute period. A standard recording form was drawn up to allow them to do this. An example of the form is given in Appendix 2.

All observations were conducted between 29th March and 22nd April 1993. Volunteers were encouraged, wherever possible, to collect data from the three sites consecutively to minimise variations in factors such as weather and time of day.

Results

Sample sizes were too small to draw any firm conclusions. The

data collected suggested a much higher rate of feeding at Tancat de Sa Roca compared with Es Cibollar. Thus peck rates of individual Coots at Tancat de Sa Roca were higher than at Es Cibollar for all directly comparable counts (n=4) and averaged higher at 22.57 pecks per minute (n=5) compared with 18.95 (n=10) at Es Cibollar. Also, data for flock activity showed a higher proportion feeding at Tancat de Sa Roca (71%, range 64-76%, n=6) compared with Es Cibollar (64%, range 54-69%, n=4). Study of individual feeding behaviour at the Gran Canal was not strictly comparable because birds were diving rather than feeding from the surface and there was also difficulty in assessing what constituted a "peck" following a dive. Flock activity data there indicated a large variation in proportions feeding, though feeding rates were generally low (36%, range 6-82%, n=10).

Discussion

This was very much a preliminary study, designed to determine its suitability for non-specialist volunteers and to reveal and overcome difficulties encountered in practice. Patterns were apparent, in particular suggesting striking differences in feeding rates and behaviour between sites. However, far more data points are required to confirm or refute these findings, and to relate differences in foraging behaviour to time of day, time of year and weather conditions.

The data collected, however, did confirm that the study can be done successfully by non-specialist volunteers, provided guidance is given and problems addressed. Problems which this first study revealed included how to quantify feeding rates of diving birds, and the pecking behaviour once vegetation has been brought to the surface; how to tackle the problem of collecting fifteen minutes consecutive data for one individual, particularly at Es Cibollar where feeding birds frequently forage into tall emergent vegetation and out of sight; and the need to understand the effects of weather in the collection and interpretation of results. Factors which may effect results include wind speed and direction, sunshine or cloud, amounts of cloud, temperature, exposure of birds to wind, and state of water surface (smooth, rippled, rough etc.).

Observations also revealed a number of factors which deserve further investigation. They included i). Feeding rates of Coots foraging linearly compared with those foraging in one place. Do those moving steadily forward forage at a faster rate? ii). Differences in feeding rates in relation to whether vegetation or invertebrates are being taken, iii). Differences in foraging behaviour in relation to habitat, iv). Feeding rates of isolated birds compared with those in groups.

This information can be collected with modification to the type of data collected. Normal feeding rate methodology, with additional notes on the mobility or otherwise of the foraging bird, would be sufficient to compare feeding rates of Coots foraging linearly and those foraging in one place. An amendment of the Flock Activity form to include habitat headings is required to look at differences in foraging behaviour in relation to habitat. Headings should record whether in open water, among vegetation in water, walking/standing in shallow water or on dry land. Feeding rates of isolated birds compared with those in

groups can be assessing using current methodology of peck rates per minute but with an additional note made of whether additional Coots or other species are in close proximity.

Food item studies are probably too specialised for volunteer-based data collection. They are, however, of importance in widening our understanding of Coot foraging behaviour and the inevitable next step in applying the results to understand time budgets and habitat choice.

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Appendix 1: Flock Activity Recording Form

FLOCK ACTIVITY

Method: sweep entire area with binoculars, describing activity of each bird at moment of encounter, then moving immediately to next individual until activity of all individuals visible has been described.

SPECIES:
DATE: START TIME:
OBSERVERS: SITE:

ACTIVITY	NUMBER OF INDIVIDUALS
1. Feeding	
2. Swimming	
3. Resting	
4. Preening	
5. Sleeping	
6. Diving	
7. Flying	
8. Fighting	
9. Displaying	
10. Mating	
11. Walking	
12. Other	

Weather:
- Wind (Direction & Force)
- Dry or Wet
- Visibility
- Cloud Cover
- Temperature

Appendix 2: Feeding Activity Recording Form

COOT: FEEDING ACTIVITY

Method: select one Coot and record the number of "pecks" in each minute during a fifteen-minute period.

DATE: START TIME:
OBSERVERS: SITE:

MINUTE	NUMBER OF PECKS
1	
2	
3	

4

5

6

7

8

9

10

11

12

13

14

15

WEATHER:
Weather:
  Wind (Direction & Force)
  Dry or Wet
  Visibility
  Cloud Cover
  Temperature

ANNEX 11
White-headed Duck Oxyura leucocephala observations by Nick Riddiford

At the request of the Park authorities, Earthwatch Europe volunteers set out to observe the activities and location of White-headed Ducks Oxyura leucocephala released into the Park. The release was part of a wider White-headed Duck population recovery programme, with releases also occurring or being planned in other areas considered to lie within its historical Mediterranean range (J. Mayol, pers. comm.). The aim of our study was to investigate the impact of the release and adaptations by the ducks to S'Albufera habitats.

The rationale for a population recovery programme was two-fold. Firstly the White-headed Duck is a globally endangered species with declining populations, including extinctions as a breeding bird in many parts of its historical range (Collar & Andrew 1988, Mountfort 1988). A second, more recent, threat to the viability of the species has come from a closely related American species,

the Ruddy Duck Oxyura jamaicensis , originally introduced in England but, with population growth, expanding to reach several European countries in the last few years, and even Morocco (Gantlett 1994). In Spain, where the two species have come into contact, the Ruddy Duck has proved dominant and hybridisation has occurred. Hybridisation threatens extinction for the White-headed Duck.

Ironically, the Ruddy Duck problem emerged just as Spanish conservationists were beginning to see the fruit of efforts over a number of years to save their erstwhile declining White-headed Duck population. Dedicated work in southern Spain had demonstrated that protection of the species, particularly at breeding and feeding sites, did reverse the downward population trend (Torres, Arenas & Ayala 1986; Arenas & Torres 1992).

In addition to protection measures, the Spanish authorities established a captive breeding scheme, based at the Coto Do¤ana, Andalucia. It was this successful scheme which supplied the S'Albufera ducks (as well as some destined for Italy). There have been no Balearic records of Ruddy Duck and this, plus the protected status of the Parc Natural de S'Albufera were among the factors which influenced its choice as a release site.

Thirty-six ducks were flown from Coto Do¤ana and released directly into the Parc on 31st March 1993. Four different open water habitats were chosen. Ten birds were released at Mar Petite, a large, undisturbed and well-established lagoon deep in the reedbed at Es Colombar, eight at the newly created lagoon at S'Amarador, eight on the Gran Canal and six on the smaller Canal Loco. Four were wing-clipped and placed on the fenced lagoon at Sa Roca to initiate an on-site captive breeding programme - already achieved successfully for Red-crested Pochard Netta rufina .

Earthwatch Europe team members assisted with the releases and a plan was formulated to follow this up with observations of activities. Observers were asked to divide activities into four categories: preening (P), swimming (S), diving (D) and inactive (I). Observers were also asked to note any inter-specific or intra-specific interactions. Unfortunately, observations were severely hampered by the elusive nature of the ducks and fieldwork soon diverted from observing to merely locating. Some information was, however, collected and the results are presented in Table 1. Table 1 demonstrated a range of activities, including diving for food, at the two canal sites during the first three to four days. None was seen at the other two sites after the initial release. Observations at the two canal sites, conducted from an excellent vantage point (the Tower Hide) indicated that birds could secret themselves for considerable periods within reeds lining the water body. Observation positions were poorer at the other two sites, and it is possible that secretive birds were overlooked. On the other hand, canal site birds frequently sat (during the first four days) and/or dived in the middle of the water body and thus in full view.

If the lagoon absences were real rather than an artefact of observation difficulties, food availability may have been the cause. White-headed Ducks are thought to feed predominantly on aquatic vegetation which they obtain by diving (Cramp & Simmons 1977). Both canal sites have an established aquatic vegetation.

S'Amarador lagoon, however, is very recent and is unlikely to have an established aquatic flora yet. Mar Petite, at least in October 1993, had an extremely sparse macrophytic vegetation amounting to a few clumps of emergent Juncus . The bottom of the Mar was covered by brown and blackish algae (which questions the quality of the water there, and should be investigated). Coot Fulica atra is another diving species which includes a substantial amount of vegetable matter in its diet (Cramp & Simmons 1979). Parallel observations indicated a much higher population density of Coots on the two canals (30-100 visible on the Gran Canal at all times from the Tower Hide, 20-35 on Canal Loco, compared with less than 10 on all visits to S'Amarador and Mar Petite. Abundant Yellow-legged Herring Gulls Larus cachinnans , attracted in their hundreds to the newly created island in the middle of S'Amarador lagoon, may also have been a factor in the rapid disappearance of White-headed Ducks there - and to a noticeable absence of other water birds at that site.

Interactions between White-headed Ducks were not seen and the only observation of interactions with other species occurred on 1st April at Canal Loco when on two occasions a Coot changed swimming direction in deference to a White-headed Duck; a surprise considering the renowned aggression of the former species.

The mystery of the whereabouts of released birds was partly solved when eleven, rapidly decreasing to three, were found on one of the ponds at the Depuradora (water purification plant) at the south-east edge of the Park. Up to three were also found at the western end of the Gran Canal (near the Iron Bridge), loosely associating with non-breeding Coot. About three-quarters of the population, however, remained unaccounted for. Dispersal cannot be ruled out for on 3rd April one was seen swimming determinedly towards the Mediterranean at the Pont dels Anglesos, just 100 m from the sea.

Only time will tell whether the apparent loss of released birds was real. Observations at the Depuradora suggest that the some birds at least were spending the day away from more enclosed areas, and may have returned to the Parc to feed nocturnally. The long-term success of such a release may, however, depend on better knowledge of their feeding habits and needs. Research in this area is strongly recommended.

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Table 1: Observations of White-headed Ducks Oxyura leucocephala

	L O C A T I O N							
No. released 31.3.93	Mar Petite 10		Canal Loco 6		Gran Canal 8		S'Amarador 8	Sa Roca 4
No. seen, (activities)								
31.3.93				2 (PISD)				0
1.4.93	0	3 (SID)		4 (SDP)		0		1 (P)
2.4.93	0	2 (DPI)		3 (SIPD)		0		
3.4.93	0	2 (DS)		2 (S)		0		
5.4.93		0		0				4 (ID)
6.4.93		0						2 (SD)
9.4.93		0		0				4 (DSP)
10.4.93						0		2 (PS)
17.4.93								1 (D)

KEY
Code for Activities (given in parentheses):

D	Diving	I	Inactive
P	Preening	S	Swimming

Notes
1. Activities are presented in order of observation.
2. Dives lasted from 2 to 28 seconds.

Annex 12
A short-term investigation into the ecology of the small mammals

at S'Albufera, May 1993 by Rob Strachan

Introduction

The Parc Natural de S'Albufera comprises an area of 1700 ha. The main ecotype is an extensive wetland dominated by beds of *Phragmites australis* and *Cladium mariscus* growing in fresh and partly saline water. These are interspersed with flowing water courses, canals, dykes and a number of open pools. Raised tracks criss-cross the park and connect drier areas of former farmland and a small range of "fossil dunes" carrying some Aleppo Pines *Pinus halepensis* and heathland/short grassland vegetation. Sluices control the water table to some degree but much of the wetland experiences a period of drying-out over the summer months.

Against this background the habitats of S'Albufera support a number of small mammal species, themselves prey to a number of avian and larger mammal predators.

To date few mammal studies have been carried out in the park apart from limited investigations to confirm which species are present (Bowey 1993, Noblet 1993) and the habitats in which they occur (Barcel¢ & Mayol 1980).

Among the rodents, two species of rat and three species of mice have been identified in the park. No vole or shrew species has ever been recorded.

The three species of mice were Wood Mouse *Apodemus sylvaticus*, House Mouse *Mus musculus* and Algerian Mouse *Mus spretus*.

The Parc Natural de S'Albufera provides an opportunity to carry out studies of the ecology of these mice species in an extensive wetland habitat, to investigate distribution, relative abundance, preferred habitat, partitioning of resources and niche separation. Most of the previous studies on these species have taken place among woodland, hedgerows or farmland habitats (or the urban environment in the case of the House Mouse) and have concentrated on single species ecology. The social behaviour and spatial organisation of the Wood Mouse was reviewed by Flowerdew (1991), Montgomery & Gurnell (1985) and Wolton & Flowerdew (1985). A review of the habitat requirements and the social organisation of the House Mouse was provided by Berry (1991).

Bowey (1993) made preliminary investigations of the habitat utilisation by the different mice species within the park but was limited by the availability of traps to three full trapping nights. Nevertheless, four habitat types exhibiting various degrees of wetness were briefly examined and the initial results suggested a discernible difference in the occurrence of the mice at these sites related to degree of wetness. However, the differences could as equally be attributed to habitat structure and food availability.

Identification of the Mice of S'Albufera

The three species which occur at S'Albufera are the Wood Mouse

Apodemus sylvaticus , House Mouse Mus musculus and Algerian Mouse Mus spretus .

Adult Wood Mice can easily be separated from the other species by their appearance and size. However, identification of juvenile Wood Mice and the separation of the two Mus species is more difficult and usually requires examination/measurement in the hand. Identification notes are given below.

Apodemus sylvaticus - Wood Mouse.

Tail slightly longer than head and body length. Feet, eyes and ears are prominent being proportionately larger than in the other mice. Underparts white contrasting with the rich brown dorsal coat. Juveniles much greyer with greyish underparts.

Adult head and body length, 80-110 mm; Tail 75-115 mm; Hindfoot 20-24mm; Ear length 15-17 mm. Mean adult weight 28 g.

Mus musculus (syn. domesticus) - House Mouse.

Variable colour but generally greyish-brown (can be sandy, reddish or black) normally lacks any contrast to underparts. Eyes, ears and hindfeet small. Tail thicker and more prominently ringed than in Wood Mice and is about equal to head and body length.

Upper incisors show characteristic notch on wearing surface (when viewed in profile). - see Figure 1.

Head and body length, 75-95 mm; Tail 70-95 mm; Hindfoot 17-19 mm; Ear length 12-15 mm. Mean adult weight 16 g.

Mus spretus (syn. spicilegus) - Algerian Mouse.

Smaller and more slender than House Mouse with white underparts contrasting with sandy or greyish brown upperparts. Feet and slender tail pink with white hairs. Tail slightly longer than head and body length.

Upper incisors without distinctive notch.

Head and body length, 70-85 mm; Tail 75-90 mm; Hindfoot 15-17 mm; Ear length 11-14 mm. Mean adult weight 11 g.

Figure 1 depicts the relative size and appearance of the three mice species.

-------Figure 1--------

Essential Equipment for Small Mammal Studies

The Longworth Trap

Since its design in the 1940s this trap has become the standard equipment for small mammal studies. The trap consists of two parts: a tunnel in which the door tripping mechanism is housed and a spacious nest box for food and bedding material. The nest box when attached slopes upward at the back to prevent rain getting in and allow urine and condensation to drain away so the bedding remains dry. Successful trapping depends upon where and how the traps are placed and the availability of food in the area. Bait laid outside and in the tunnel entrance increases the chances of the trap being encountered and entered by the small mammals.

The fieldwork

In this study an attempt was made to gain information on the co-existence of the three mice species in a wetland environment and build upon the initial survey work carried out at S'Albufera in October 1992 by Keith Bowey.

Objectives

1. To determine the relative distribution and abundance of the small mammal species in selected habitats at the Parc Natural de S'Albufera by small scale intensive live trapping.

2. To carry out a preliminary investigation into the niche separation of these small mammals.

Methods

1. Three trapping sessions using up to 28 Longworth small mammal live traps were carried out for periods of four nights, three nights and three nights respectively.

2. Trapping session one involved a 40 m X 40 m grid in an area of late successional dry reedbed with scrub along the boardwalk leading to the Xisco Lillo hide. The scrub was dominated by Tamarisk Tamariscus but was replaced in some areas by low bushes of shrubby Arthrocnemum . Open areas were grassy or were dominated by a dense stand of Aster tripolium and Galium aparine .

The grid was marked out using surveying tapes and a sighting compass with trapping points marked at 10 m intervals by labelled coloured tags. At each trapping point a Longworth trap (baited with oats, maize, apple and mealworms) was set on the ground. In addition, six of the trapping points had a second trap set 70-100 cm above the ground in the branches of bushes or lashed to interconnecting reed stems.

See Figure 2 for location map of study site and Figure 3 for the habitat plan and trap layout.

3. Trapping session two involved extending the above grid by running a 100 m transect due west into a dense stand of *Phragmites* / *Cladium* with subsiding surface water. The original grid was modified to provide traps at alternate trapping points, seven of which included traps placed in a high position. See Figure 4 for habitat plan and trap layout.

4. Trapping session three took place on a fossil dune "island" which was surrounded by open water or emergent reedbed. Traps were placed at 10 m intervals along a 200 m transect through a narrow band of mixed *Juncus acutus* and shrubby *Arthrocnemum* which fringed the dune. In addition four traps were set at the corners of a 10 m square amongst damp *Juncus acutus* at the northern end of the dune. See Figure 2 for the location map of study site and Figure 5 for habitat plan and trap layout.

5. At each trapping site, habitat details were recorded and a detailed map drawn up showing the trapping points.

6. Once set the traps were inspected twice a day, in the early morning and in the late evening.

7. Closed traps were taken to a processing point within the grid or adjacent to the transect and the trap opened in a large polythene bag. Captured animals were then examined in the hand to identify the species, noting whether the animal was a new individual or a marked recapture, its sex, breeding condition, Adult or Juvenile, and its body weight (placed in a smaller bag and weighed to the nearest 0.1 g using a 50 g pesola balance). All data were recorded on a standard recording form.

   New animals were individually marked by clipping a small patch or patches of fur from different parts of the body (fine scissors). The marking code would allow combinations - see record sheet (Appendix 1).

8. Each animal was released at the site of capture and the trap was rebaited and reset in its original position.

9. The movements between traps of recaptured animals were then plotted on a map of the grid or transect.

Survey Dates

Trapping Session 1: 2.5.93 - 6.5.93 (i.e. 4 nights)
Trapping Session 2: 6.5.93 - 9.5.93 (i.e. 3 nights)
Trapping Session 3: 9.5.93 - 12.5.93 (i.e. 3 nights)

Results

1. SUMMARY TABLES OF CAPTURES

Study Site A. Xisco Lillo

Table 1. Summary of captures, Study Site A: Xisco Lillo - Session 1.

Species		Day 1		Day 2		Day 3		Day 4		*MNA
		am	pm	am	pm	am	pm	am	pm	
Apodemus	new	4	0	1	0	1	0	1	0	7
	recapture	-	0	4	0	5	0	4	0	
M.musculus	new	2	1	1	0	0	0	0	0	4
	recapture	-	1	2	1	1	1	2	1	
M.spretus	new	2	0	2	1	0	0	0	0	5
	recapture	-	0	2	1	4	0	2	1	
Rattus		0	0	0	0	0	0	1	0	1
Trap round Totals		8	2	12	3	11	1	10	2	

Table 2. Summary of captures, Study Site A: Xisco Lillo - Session 2.

Species		Day 5		Day 6		Day 7	*MNA
		am	pm	am	pm	am	
Apodemus	new	0	0	0	0	0	7
	recapture	5	2	4	0	6	
M.musculus	new	0	0	0	0	0	4
	recapture	2	0	0	0	0	
M.spretus	new	0	0	0	0	0	5
	recapture	1	0	1	0	1	
Rattus		1	0	1	0	2	5
Trap round Totals		9	2	6	0	9	

Table 3. Summary of captures, Study Site B: Lone Pine Fossil Dune - Session 3.

Species		Day 1 am	Day 1 pm	Day 2 am	Day 2 pm	Day 3 am	*MNA
Apodemus	new	4	0	3	0	1	8
	recapture	-	0	3	0	6	
M.musculus	new	0	0	0	0	1	1
	recapture	-	0	0	0	0	
Trap round Totals		4	0	6	0	8	

*MNA - Minimum number alive (an estimation of population density)

2. CALCULATION OF TRAPPING SUCCESS

Table 4. Summary of Trapping Success

Session	No. of trap nights	Total captures	Success rate
one	(26 x 4) 104	41	39.4%
two	(28 x 3) 84	24	28.3%
three	(24 x 3) 72	18	25.0%

3. TRAPPABILITY OF THE SMALL MAMMALS AT S'ALBUFERA

Two measures of the trappability of the different mice species are presented in Figure 6.

------Figure 6--------

4. EFFECT OF TRAP POSITION (VERTICAL STRATIFICATION) AT STUDY SITE 1 (XISCO LILLO)

Table 5.

Species	Total Captures (morning trap rounds only) Ground trap (n = 20)	High trap (n = 7)	Percentage High (NB: 26% of traps high)
Apodemus	30	4	11.8%
M. musculus	10	0	0%
M. spretus	7	9	56.3%

No high positioned traps caught mice during the day, all were empty in the evening trap rounds.

5. BIOMETRIC DATA

Population Structure for each species.

Table 6. Summary of breeding condition (May 1993).

Xisco Lillo Species	M A L E S			F E M A L E S			
	TL	TA	Juv.	Juv.	Perf.	Preg.	Lact.
Apodemus	4				1	1	1
M. musculus	2				1		1
M. spretus	1	1			3		
Lone Pine							
Apodemus	4		1	1			2
M. musculus							1

(TL - testes large; TA - testes abdominal; Juv. - juvenile; Perf. - perforate; Preg. - pregnant; Lact. lactating)

Table 7. Summary of Body weight frequency (in g).

Xisco Lillo Species	M A L E S		F E M A L E S	
	mean	range	mean	range
Apodemus	26.4	23-31.5	24.6	19-31.5
M. musculus	16.4	14-17.2	14.9	14-16.0
M. spretus	12.2	12-12.5	11.6	11-12.5
Lone Pine				
Apodemus (juvs excluded)	24.9	17-31.0	27.7	26-30.1

6. DISTRIBUTION AND HOME RANGE - TRAP REVEALED MOVEMENTS

The trapping results provide data on the distribution of captures at each point on the trapping grid/transect and give information on the relative distribution of the different species in relation to their habitat preferences/microhabitat assocations.

The area over which each individually marked animal moved between traps is termed the "trap-revealed" movement to distinguish it from "normal" movement. These can be mapped out to depict home range area and the distances moved between traps.

Figure 7 shows the trap-revealed movements of the Apodemus males at Study Site 1 (Xisco Lillo).

Figure 8 shows the trap-revealed movements of the Apodemus females at Study Site 1 (Xisco Lillo).

Figure 9 shows the trap-revealed movements of M. musculus at Study Site 1 (Xisco Lillo).

Figure 10 shows the trap-revealed movements of M. spretus at Study Site 1 (Xisco Lillo).

Figure 11 shows the trap-revealed movements of the mice at Study Site 2. (Lone Pine).

Table 8. Maximum Home range estimates.

Species	*Minimum Convex Polygon (calculated area sq. m)	Observed Range (length m)
Xisco Lillo		
Apodemus male C	1120	82
Apodemus female E	760	90
M. musculus male D	220	43
M. spretus female AC	150	35
Lone Pine		
Apodemus male D		50
Apodemus female B		42

* Minimum Convex Polygon - this joins the peripheral points of trap capture by straight lines to create a convex polygon. This is best plotted on to graph paper and the area estimated by counting the number of graph paper squares within each.

Discussion

1. Trapping results, trappability and success

Session 1 (Xisco Lillo) : the trapping grid adjacent to the boardwalk to Xisco Lillo hide proved highly successful with 41 captures from 104 trap nights, a success rate of 39.4%.

The overnight capture rate was fairly consistent for the four nights and the number of new captures of the trappable population of mice had stopped by the third (Mus spp.) or fourth day and no new mice were encountered in the grid during Session 2 (see Tables 1 & 2 and Figure 6).

Captures during the hours of daylight represented less than 18% of the trappable population and these always proved to be traps that were placed on the ground in dense cover and always involved either of the Mus species. From this it can be inferred that the Wood Mouse is nocturnal in its foraging behaviour. The two Wood Mice which were recaptured in the reedbed transect on the evening trap round of Day 5 are though to have entered the traps soon after release that morning since they were in the same traps.

Session 2 : the modification and extension of the Xisco Lillo grid provided additional information on the use of habitat and size of home range for the three mice species. However the trapping success was lower at 28.3% and the number of individuals captured was reduced. The reason for this seems to have been excessive trap disturbance by Brown Rats Rattus norvegicus with up to 50% of the traps being overturned or moved, their doors closing in many cases. In addition many of the traps had also been marked with strong smelling rat urine which may well have dissuaded the mice from entering. By Day 7 a total of five rats had been caught, the first appearing on Day 4. This suggests that they had been attracted into the site by the scattered bait at the trapping points. From this it can be concluded that where there may be a foraging rat population, such as along the canal banks, a four night trapping period is the best length of time to sample the small mammal population (there were no new mouse captures after this time and disturbance until then was minimal).

Session 3 : trapping at the Lone Pine fossil dune gave a 25% success rate which suggests that only a small population of rodents occurred at the site since the recapture percentage was high by Day 3 (i.e. 6/8 trappable Wood Mice). The species composition at this site was poor consisting of a small number of Wood Mice and a single House Mouse encountered over the three nights.

No animals were encountered during the evening trap rounds which suggests that the cover provided by the Juncus / Arthrocnemum was insufficient for diurnal foraging since there would be a high predation risk from avian predators.

2. Population Estimates

Rather than use one of the methods for calculating the population size in a given area by comparing the proportions of those marked to those recaptured it was decided to present the figure for the actual number of animals encountered in each trapping session. This is termed the Minimum Number Alive (MNA) and it provides a measure of the population size in the study area when there is a high sampling effort/trap density and where 50% or more of the traps remain empty on any trapping occasion. In addition, the MNA represents the true figure for the trappable small mammal population when samples taken later during the trapping period

consist mainly of recaptured rather than new animals, as found in Session two at Xisco Lillo.

Thus, the trapping grid adjacent to the Xisco Lillo boardwalk covering an area of approximately 2400 m 2 was found to support a minimum of 7 Wood Mice, 5 Algerian Mice and 1 House Mouse.

This comparison of results suggests that the Wood Mouse is far more abundant and widely distributed than either of the other two mice species, being equally at home among damp reedbed and drier more open habitats.

The House Mouse is probably also widely distributed but less common than the Wood Mouse.

The Algerian Mouse appears to be the most specialised in its habitat requirements and therefore has a restricted distribution although it may be numerous in its optimum/preferred habitat (as yet to be determined although at study site 1 a dense vegetation structure with vertical stratification is important - see Table 5).

3. Population Structure

Table 6 summarises the population structure for each species for May 1993 and will be a useful baseline for future comparisons and seasonal variation. Each species was shown to be sexually active with most (or all) males in breeding condition and most females were "perforate" (i.e. had recently been mated) or lactating (i.e. had a nest with young). In each study area, the ratio of males to females for each species was probably 1:1. The Lone Pine site showed a slightly larger proportion of males in the Wood Mice. Here one female was found to overlap her home-range with three males suggesting a shortage of breeding-age females in the small population. Such a situation may arise through the mortality of potential breeding individuals when a population becomes isolated or fragmented and immigration from outside is difficult. The Lone Pine fossil dune has been in effect an "island" since 1992 when the water table was maintained by sluices to surround the dune with surface water and emergent reedbed. The movement of mice to and from the "island" may now be restricted compared to previous years when the adjacent area dried out. Another indication that the Lone Pine study site may be showing an island population is the fact that one of the male Wood Mice had a body weight of 17 g but was in breeding condition; this is about 10 g lighter than most sexually active males (see Table 7).

4. Relative Densities

As explained above, both study sites had an effective trapping area of 2400 m 2 or 0.24 ha. Density estimates for each of the mice species can be calculated as MNA x 4.167. This gives the figures of 29/ha (Xisco Lillo) and 33/ha (Lone Pine) for the Wood Mouse and these compare very favourably with woodland and hedgerow populations in Britain (40/ha in mixed deciduous, 20/ha in coniferous but seasonal fluctuations with up to a staggering 200/ha after a good deciduous seed crop in autumn/winter - Flowerdew 1991). In arable land, figures given for the seasonal

variation in density are 0.5/ha in summer to 17.5/ha in winter (Green 1979).

For the House Mouse the Density estimates are 16.7/ha (Xisco Lillo) and 8.3/ha (Lone Pine - assuming a pair in the study area). This compares with recorded populations in open grasslands of 50-70,000/ha (Berry 1991). Tattershall (pers. comm.) carried out an experiment to introduce House Mice into a British Oak *Quercus* wood by creating a hayrick with supplementary feeding. An identical situation was created in a farm outbuilding as a control. The results showed that whereas the population placed in the outbuilding flourished and spread, the woodland population died out and was replaced by the larger Wood Mouse. From this experiment it was concluded that the House Mouse is a poor competitor against the Wood Mouse, with evidence that there was even some predation by the Wood Mouse on the House Mouse nestlings. Competition between the different species may explain their relative abundance and distributions.

The Density estimate for the Algerian Mouse at study site 1 was 20.8/ha assuming uniform habitat, however as Figure 10 shows the species was localised to a particular habitat configuration.

5. Spatial distribution and Home Range

One of the most striking results of plotting the trap captures on a map of the grid or transect is the lack of range overlap between *Apodemus* and the two *Mus* species. This may partly be due to habitat configuration/preference and partly to competition. The Wood Mouse shows a slight preference for the more open areas at ground level although with a canopy covering above. Under the cover of darkness it probably forages widely over open ground and at study site 2 it is thought to traverse the open areas of the dune (this would need confirmation by grid trapping). The House Mouse and the Algerian Mouse seem to be dependent on very dense cover where they also show some diurnal activity (see Table 1 and Figures 9 & 10). As shown in Table 5 the Algerian Mouse is far more arboreal than the House Mouse with 56% of its captures in the high placed traps despite the fact that these higher traps formed less than a quarter of the available traps. This nocturnal foraging in the branches of bushes, shrubs and among reed stems may be a way in which the Algerian Mouse avoids direct competition with the House Mouse.

From the trap revealed movements the Home range sizes have been calculated. Thus, for the Wood Mouse the Minimum Convex Polygon gave areas of 1120 m^2 (males) and 760 m^2 (females) in the late successional reedbed habitat of Study Site 1 (Xisco Lillo). This compares with typical home-range areas for Deciduous woodlands of between 1200-12,000 m^2 (males) and 80-4000 m^2 (females) and much larger areas for sand dunes c24,000 m^2 (males) and c14,000 m^2 (females) - data from Flowerdew (1991).

It therefore seems likely that longer periods of study with a trapping grid extending over a much larger area would increase the respective trap revealed areas for this species in this wetland habitat.

The calculated maximum home-range areas for the House Mouse and the Algerian Mouse were 220 m^2 and 150 m^2 respectively. These

compare with typical House Mouse home-range areas of 120 m 2 in some grasslands down to less than 5 m 2 in farm buildings (data from Berry 1991). It therefore seems likely that the determined home range sizes and density estimates for these two species are near to the correct ones.

6. Resource Partitioning

The Dietary requirements for the three species are as yet unknown and require further investigation but it is likely that there is a great deal of overlap in the food items taken. All three species will take a wide variety of invertebrate prey as well as fruit and seeds. The invertebrate component in the diets is probably high at S'Albufera, featuring Insects and Isopods. In the Fossil Dune habitat it was noted that there was a high predation on terrestrial snails by the Wood Mice (Snails are scarce elsewhere so this may be opportunistic foraging on a locally abundant food item).

The preliminary findings of this present study indicate that the three species may be partitioned in their foraging strategies with Wood Mice favouring open ground and covering a larger home range, House Mice tending to favour areas of dense cover and feeding on fallen fruits/seeds and terrestrial invertebrates and Algerian Mice also favouring dense vegetation cover but tending to forage above the ground in branches/stems for the same types of items.

Differences in the Activity patterns of the three species may further separate any direct competition for potential food but this is still to be determined.

7. Recommendations for Further Research

- A number of fixed site trapping grids should be identified and established for the long-term monitoring of the population fluctuations in different seasons and years. This may then be used to construct a picture of the species composition and use of different habitats with changes in water level and season.

- Further investigation should be carried out into the three-dimensional aspect of mice activity including sampling of potential food availability at different heights in the habitats of the study sites.

- Activity patterns for the three species may be determined by a programme of checking traps every 1-2 hours throughout a 24 hr period. This would need to be a site where the three species co-exist in high numbers such as near Xisco Lillo.

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ANNEX 13

Study of the life cycle of the Albufera Marsh Frog *Rana ridibunda perezi*

by Nick Riddiford and Sara Hawkswell

Rana (ridibunda) perezi is an endemic subspecies (or, according to some authorities, full species) of the Marsh Frog which is a very numerous, visible and vocal part of the marshland environment at S'Albufera. Yet we know very little about it. Attempts to estimate population size by University College London's Ecology and Conservation Unit only served to demonstrate how difficult it was to establish suitable methodologies, and the best results probably underestimated frog densities by a considerable margin (Wood 1991). This problem has not yet been solved and may require more specialist and prolonged study than can be currently achieved during Project S'Albufera fieldwork periods.

Nevertheless, more information was needed and it was decided that even the collection of simple life cycle data would be useful and could act as a baseline and focus for later more in-depth studies. Thus, in April 1993, a study of the life cycle of the Marsh Frog was initiated to investigate the habitats, distribution and densities of spawn (eggs), tadpoles (larval stage) and adult frogs at S'Albufera.

Methods

Two distinct techniques were employed. The first used the quadrat methodology established by UCL (Wood 1991) but, was repeated hourly throughout two 24-hour periods to collect extra information relating to temporal activity. The quadrat selected was immediately south-east of the Santa Margalida Bridge (where the Cam¡ de Ses Puntes meets the main entrance track). The quadrat was 25 x 25 m, subdivided into four equal squares (12.5 x 12.5 m): sub-quadrats A, B, C and D. A tall bamboo pole at the centre of the main quadrat acted as a visual guide to observers for assessing the position of the four sub-quadrats. Observations were made by two observers, one recording frog activities in sub-quadrats A and C, the other in B and D. Observations were made for three consecutive five-minute periods in each hour, the results being entered on a standard recording form (see Appendix 1).

The second technique investigated distribution in relation to habitat, with levels of abundance assessed aurally by estimate of frog chorus, and visually by numbers and size of frog. In addition, information was sought of breeding activity using nets and random searching. Volunteers were asked to collect data from as many distinct habitats as possible, in all parts of the Park. The methodology for this was set out in an instructions sheet and a recording form was devised (see Appendices 2 and 3).

Results and Discussion

24-hour study

Observations were made over two 24-hour observation periods, 8th-9th April and 26th-27th April 1993, both 24-hour periods beginning at 0800 hrs. Nearly all entries for frog activities on both occasions were for chirps, croaks or general chorus. Few frogs were seen or heard moving. On 8th-9th April, there were at least two records of frog activities in every hour-period. The frogs were least vocal in the afternoon, from 13 to 17 hrs. From 19 hrs, coinciding with dusk, a general chorus sprang up. This was most intense from 00 hrs to 05 hrs when calling was recorded from each sub-quadrat in each five-minute period. A general chorus was also noted at that time from adjacent parts of the marsh. There was less noise from dawn, but still considerable vocal activity throughout the morning hours (of 8th), with continuous chorus or chirping recorded in each five-minute period from at least two sub-quadrats every hour until 12 hrs. The weather was fine throughout, sunny by day and clear by night until 0115 hrs when a thick low-lying mist developed, not clearing until after 0415 hrs.

Far fewer frogs were recorded on 26th-27th April. However, figures are not directly comparable because this second 24-hour period was marred by disturbance and weather. The time chosen unfortunately coincided with work to improve the entrance track to the Park. Throughout the daylight hours, from before 09 hrs to 18 hrs, there was a continuous flow of heavy vehicles and for much of the time noisy road-mending machinery was operating very close to the study site. There was clear evidence that frogs fell quiet at the passing of heavy lorries and the noise that these and heavy machinery made also drowned any sounds which might have been coming from the marsh. To compound matters, cattle had been introduced to the site and invaded the quadrat because they were given fodder there; and during the evening, when disturbance was no longer a factor, rain set in which was heavy at times and persisted intermittently until the early hours of the morning. The volunteers who braved the rain did at least establish that, apart from the occasional croak, the frogs remained silent in such weather conditions. The maximum frog activity occurred at 22 hrs when sounds were recorded in two of the three five-minute periods from each sub-quadrat, comprising chirps and a brief burst of chorus.

Distribution, Habitats and Life Cycle

Records at individual sites were collected between 2nd and 23rd April. The recording form was designed to collect data relating to a wide range of factors, including distribution, use of habitat, levels of abundance, levels of activity in relation to factors such as weather and habitat, and life cycle. Five main marshland habitats were recognised: areas of standing, Open Water; Dense Reedbeds; Sparse Reedbeds (reedbeds in this particular study including *Phragmites*, *Cladium* or any other tall emergent marshland vegetation); Wet Pasture (which could include low, emergent, grazed reedbed plants); and Canals. A total of 128 records was collected, 14 from open water sites, 32 from dense reedbeds, 27 from sparse reedbeds, 13 from wet pastures and 42 from canals. Further refinement of the data, relating frog frequency to habitat type, is presented in Table 1.

Records were obtained from virtually every accessible part of the

Park. The exception was the Salinas in the south-east corner, which casual observations suggest contained few or no frogs. This was an area of brackish water. The only part of the Park with predominantly brackish or salt water was Es Cibollar. Visits to this area produced only two records of frogs, in contrast to all other areas visited, and both records were at sites at the north-west edge of Es Cibollar adjacent to fresh water areas.

Otherwise, frogs were distributed throughout the Park and, as Table 1 demonstrates, in all five habitat types, including in dense reedbeds. Individual sample sizes were too small to make precise habitat comparisons. However, the figures suggest that frogs occurred in greatest abundance or were most vocal in sparse reedbeds. This may indicate that some vegetation cover was preferred for breeding or to reduce predation on otherwise conspicuous, calling individuals. The most frequent habitat type where frogs were not detected was dense reedbeds. The occurrence of calling frogs in similar habitats elsewhere indicated that dense reedbeds were not *de facto* unsuitable and absences may have been due to observer bias, such as problems of seeing through dense vegetation or hearing over the noise of the wind. Wind noise in reedbeds may be a limiting factor for the frogs, too, because it was the only habitat type where noisy or constant chorus was not noted.

Though frogs were heard at the majority of sites sampled, they were only seen at 29 (23% of sites). It was not possible to detect any differences in pattern of occurrence or habitat preference for the three size categories. A larger sample size is needed to confirm or refute this. Though the level of calling suggested that breeding was imminent, the study failed to find any tadpoles or spawn, despite diligent searching. This suggests a slightly later start to egg-laying. However, the possibility that egg-laying occurred in more impenetrable sites and was overlooked cannot be ruled out.

The 1993 study made some progress in understanding the distribution, life cycle, habitat use and temporal activity of the Marsh Frog at S'Albufera. However, larger sample sizes are needed and much more information is needed for other times of year. This has proved impossible in the past because *Project S'Albufera* fieldwork is confined to specific periods. However, progress is about to be made in overcoming this hurdle because Nicole Smith of Playa de Muro has kindly volunteered to collected standardised data at other times, beginning in winter 1993-94.

Reference

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Table 1. Frog frequency in relation to habitat

	F R E Q U E N C Y			
	None	Occasional	Frequent/Several	Noisy/Constant
OW	4	2	5	3
DR	10	13	9	0
SR	3	2	11	11
WP	1	2	5	5
C	8	20	11	3

Key:
OW = Open Water DR = Dense Reedbed SR = Sparse Reedbed
WP = Wet Pasture C = Canal

Appendix 1: Recording form for 24-hour quadrat activity study

X post

Date Time A B

Recorders C D

Weather --gate--

Activities: General Chorus, Chirping, Croaking, Jumping, Other (please specify)

First Five minutes

	Activity	Time	Notes
A			
B			
C			
D			

Second Five minutes

	Activity	Time	Notes
A			
B			
C			
D			

Third Five minutes

	Activity	Time	Notes
A			
B			
C			
D			

Appendix 2: Study of the Life Cycle of S'Albufera Marsh Frog *Rana ridibunda perezi* - instructions sheet

Aim: to establish the habitats, distribution and densities of frog spawn (eggs), tadpoles and adult frogs.

METHOD
Choose a well-defined site and habitat (canal, wet grazed meadow, reedbed etc.) and look for evidence of spawn, tadpoles and adult frogs.

STEP ONE: on arriving at the site, and before disturbing the water, record the following initial data.

1. general description of habitat and location on map.
2. estimate of frog chorus (none, one, several, many).
3. size of any frog seen (small, medium, large).
4. any breeding activity (e.g. mating, egg-laying).

5. any evidence of tadpoles or spawn visible.

STEP TWO: any spawn seen - estimate of amount (e.g. 20 cm across).
2. estimate of tadpole numbers (none, 1 c10, c100).
3. length of tadpoles (only one figure necessary if all about the same size).
4. stage of development of tadpoles (no legs, front legs only, four legs).

STEP THREE: in some areas, e.g. reedbeds, you may need to enter the water to search for tadpoles. Please work in teams of at least two and be careful about deep water and getting lost!

Please record negative results (i.e. none seen in this locality) and details of vegetation (e.g. mainly Phragmites or mainly Cladium) if known.

Appendix 3: Study of the Life Cycle of S'Albufera Marsh Frog Rana ridibunda perezi - recording form

Rana ridibunda perezi - S'Albufera Marsh Frog

You will need to work in teams of at least two for safety and should take the following equipment per person:

Muslin pond nets to sweep water for tadpoles.
Whistle for communication.
Notepad
Wellies/Waders (boots - long or short) depending on site.
Containers for samples

Date:
Time:
Recorder(s):
Location:
(please mark on map overleaf)
Grid Reference:

Access route:
(again mark on map)

Weather
Wind: Calm Light Moderate Fresh Strong
Cloud: None Little(<25%) Some(<50%) Mainly Complete Cover

Habitat:
Open Water Dense Reedbeds Sparse Reedbeds Wet Pasture Canal

Presence of Frogs

Frog Chorus:

None Occasional (1 or 2) Frequent/Several Noisy/Constant

Size of Frogs seen:

Small Medium Large

Breeding Activity:

Mating Egg Laying

Spawn Present? Yes/No
If present estimate of diameter

Tadpoles present? Yes/No

If present No. of tadpoles: <10 10-100 >100
Length of tadpoles (estimate in mm)
Stage of development: No legs Front legs only Four legs

ANNEX 14

A preliminary checklist of taxa and associated ecological types at the Parc Natural de S'Albufera , Mallorca by Nick Riddiford and Max Nicholson

Advantage was taken of the welter of information already gathered to put together a first list of the animals and plants of S'Albufera. This list, published in August 1993 (Riddiford & Nicholson 1993), demonstrated the state of knowledge of S'Albufera biota after six years as a designated conservation area (as the Parc Natural de S'Albufera) and after five years' fieldwork by Earthwatch Europe's Project S'Albufera . The list was derived from a computerised database, and comprised records obtained as a result of the work of Project S'Albufera , data obtained by the Park authorities and published material both during and prior to the establishment of the Parc Natural . The taxa were all recorded within the boundaries of the 1708 ha Parc or the abutting marine environment comprising part of the coastal strip of Alcudia Bay.

Though a large amount of information has already been gained it should be noted that this is an incomplete and provisional list which will be refined and updated (indeed over 200 further species, mainly of previously poorly studied groups, had been added by the end of 1993). The preparation of a list now, however, demonstrates both the amount of information available and identifies areas or groups for which more knowledge is required. The most complete lists are for most vertebrate groups,

molluscs and flowering plants and ferns. Other groups reasonably well represented include lichens and butterflies and moths. However, for these and other groups more information is needed before the list can be considered relatively complete.

The first list comprises 1,350 taxa of species rank. Of these, 587 fall in the section Flowering Plants and Ferns, 301 in Butterflies and Moths (Insecta: Lepidoptera) and 229 in Birds, leaving fewer than 250 for all other groups. The totals strongly reflect the interests of participating observers. Nevertheless, it is creditable that at least a start has been made on several of the most neglected and difficult groups.

The widening spread of attention has also opened the way to discoveries of examples of co-evolution, such as that between the Twin-spot Wainscot moth Arachanara geminipuncta , its host plant Phragmites australis and its predator, the thick-billed Reed Bunting Emberiza schoeniclus witherbyi .

The provisional nature of the list is clearly acknowledged. Scrutiny of it may well indicate certain insufficiencies or shortfalls in recording which would repay early efforts at correction. The longer term aim is to have a working list which underscores the high Biodiversity value of the site, gives the precise distribution of taxa and provides a basis for understanding their role in the various ecological communities. The work so far has produced a provisional draft for an eventual model Biodiversity Site Checksheet describing S'Albufera in terms intended to be matched by other major research sites for the field study of Biodiversity, to serve the fast expanding more general Biodiversity Programme. It is meant to indicate the type of presentation which can best serve to bridge the gap between specific continuing survey, monitoring and research projects on a variety of ecological sites worldwide and the major programme of study designed to integrate biodiversity into global environmental policies and practice.

To achieve this, we envisage the following framework (headings only):

SUMMARY DESCRIPTION OF THE BIODIVERSITY PROTECTED SITE, PARC NATURAL DE S'ALBUFERA , MALLORCA, SPAIN

1. Administration and Title
2. Protected Area Status
3. International Status
4. Map Reference
5. Breakdown of component habitat types
6. Ecological types represented and their distribution
7. Basic climatic data
8. Exposure to pollution
9. Legacy of any past human uses or influences
10. Present scale of human visiting and uses/disturbance
11. Scope and dates of Management Plan
12. Numbers and composition for Protected Area staff
13. Current threats and planned changes
14. Major events hitherto affecting the protected area

Appendix 1: Summary of species data held (up-dated to include records obtained after publication of the First List)

Higher Plants	596 taxa (590 species) recorded, 380 taxa represented by identified specimens stored at the Parc Natural de S'Albufera in a herbarium and 210 as photographs or slides.
Bryophytes	16 species recorded, no specimens.
Algae	8 species recorded, no specimens.
Fungi	66 species recorded, no specimens.
Lichens	36 species recorded, 29 represented by specimens stored at the Parc .
Birds	229 species recorded.
Other vertebrates	47 species recorded of fish (19 species), mammals (21), reptiles (5) and amphibians (2).
Spiders	53 species recorded, all represented by specimens stored at the Museu de la Naturalesa de les Illes Balears (MNCM), Palma.
Lepidoptera	319 species recorded, 110 represented by specimens stored at the Parc .
Coleoptera	43 species recorded, all represented by specimens stored at the Museu de la Naturalesa de les Illes Balears (MNCM), Palma.

Other Insecta	73 species (of 8 species) recorded, 18 species represented by specimens stored at the Parc .
Molluscs	63 species recorded, all represented by specimens stored at the Parc .
Other Invertebrates	17 species recorded, no specimens.

Data for the Insecta (other than Lepidoptera) and Invertebrates generally are sparse and frequently not backed up by specific records. Additional information is known to be held, particularly within Mallorca, and is being actively sought with the considerable help of Parc Director, Joan Mayol.

Appendix 2: Order of presentation

The taxa, in order of presentation, have been arranged under the following headings:

Flowering Plants & Ferns	Spermatophyta & Pteridophyta
Mosses	Bryophyta: Musci
Liverworts	Bryophyta: Hepaticae
Seaweeds	Thallophyta: (Algae)
Lichens	Thallophyta: Lichenes
Fungi	Thallophyta: Fungi
Mammals	Chordata: Mammalia
Birds	Chordata: Aves
Reptiles	Chordata: Reptilia
Amphibians	Chordata: Amphibia
Fishes	Chordata: Pisces
Molluscs	Mollusca
Spiders	Arthropoda: Arachnida: Araneae
Ticks	Arthropoda: Arachnida: Acarida
Dragonflies	Arthropoda: Insecta: Odonata
Crickets & Grasshoppers	Arthropoda: Insecta: Orthoptera
Stick-insects	Arthropoda: Insecta: Phasmida
Webspinners	Arthropoda: Insecta: Embioptera
Sucking Lice	Arthropoda: Insecta: Anoplura
Bugs	Arthropoda: Insecta: Heteroptera
Butterflies & Moths	Arthropoda: Insecta: Lepidoptera
Flies	Arthropoda: Insecta: Diptera
Bees, Wasps & Allies	Arthropoda: Insecta: Hymenoptera
Beetles	Arthropoda: Insecta: Coleoptera
Crustaceans	Crustacea
Segmented Worms	Annelida
Jellyfish & Allies	Cnidaria: Hydrozoa
Anemones	Cnidaria: Anthozoa

ANNEX 15

Ecotourism in Mallorca: S'Albufera by Max Nicholson and Nick Riddiford

One of the stated objectives of Project S'Albufera is "to serve as a focus for education of residents and visitors of all age-groups and levels and to help in creating environmental awareness and commitment". We were afforded an opportunity in 1993 to pass on expertise gained in this area in the form of a submission to the European Community Model of Sustainable Tourism (ECOMOST Project, DGXXIII) entitled Ecotourism in Mallorca (Nicholson & Riddiford 1993). The document, published and guided by Earthwatch Europe, encompassed aspects of ecotourism for the whole of Mallorca. The Parc Natural de S'Albufera is a major element in any treatment of ecotourism in Mallorca (and indeed the western Mediterranean) and was therefore the subject of detailed submission within the document. The sections pertaining to S'Albufera are of direct relevance to the Project and are thus repeated here.

1. Introduction

1.3 Especially during the last decade, Mallorca has put much effort into protecting its wildlife treasures and enabling visitors as well as native inhabitants to find and enjoy them. Specially favoured sites have been acquired, protected and managed in the interests of wildlife, especially by the highly professional SECONA (Servei per la Conservaci¢ de la Natura) under the Conselleria d'Agricultura of the Balearic Islands Government. SECONA has saved from development and made accessible to visitors a number of the most important natural habitats on the island, including the great marsh and dune area of S'Albufera on the bay of Alcudia. The rich coastal country around Cala Mondrag¢ in the south and several other notable areas have also been saved. SECONA is vigorously supported unofficially by the Grup Balear d'Ornitologia i Defensa de la Naturalesa and by a fast growing number of the Mallorcan people who, unlike so many in the Mediterranean, are not obsessed with shooting wildlife indiscriminately. Mallorca is indeed a leader in southern Europe in ensuring that all its school children are involved during their eduction in field demonstration of ecology, zoology and botany, by specially qualified teachers at the Parc Natural de S'Albufera. This has paid off in follow-up of these interests, at the University of the Balearic Islands: a Mallorcan with this background is now the co-ordinator for the International Waterfowl and Wetlands Research Bureau's Mediterranean Wetlands Monitoring Network. The director of the Parc Natural, J. Mayol, has published several important texts such as the Birds of the Balearic Islands (English translation 1990).

2. Resources available in Mallorca

2.4 One of the most important aspects of eco-tourism is the demand it brings for fuller knowledge and understanding, not only of the fauna and flora to be found, but also of the interactions between interesting ecological communities. To provide such a base of explanation and interpretation calls for intensive and comprehensive field studies, and in this respect, Mallorca is making great progress. This is especially evident in the vigorous international S'Albufera Research Project, supported by scientists and volunteers from

Earthwatch since 1990. Earthwatch Europe is an international foundation based in Oxford, England, with offices in Madrid. Already, some 1250 accurately identified species of animals and plants on the dunes and wetlands have been logged and many new facts about their life patterns have been revealed through a fast-growing series of published research papers.

4. The Parc Natural S'Albufera

4.1 In any treatment of eco-tourism, special attention must be given to the official centres which have recently been established at substantial cost and to high professional standards, starting with the wetland and dunes of S'Albufera, fronting the bay of Alcudia. Created long ago by fluctuations in the Mediterranean sea-level and the closing by sand dune systems of shallow lagoons and marshes, S'Albufera experienced various land use developments, including encroachments of hotel and other tourist developments. In 1985, it was designated and largely acquired as a Parc Natural by the Balearic government, through its conservation agency SECONA, backed by the national ICONA, in Madrid.

4.2 S'Albufera is the largest and most important wetland in the Balearic Islands, comprising approximately 2500 ha in area. Though the cataloguing of the wildlife of S'Albufera is not yet complete, research, particularly since the establishment of the Park, has demonstrated the richness of S'Albufera plants and animals. The taxonomic group attracting the most conservation interest (for reasons of diversity, specialisation and rarity of certain species) is the birds, although there are many interesting species in other groups, particularly the flowering plants and invertebrates. Sixty-five bird species are known to breed in the Park and eight of these are species of restricted world range or considered threatened by loss of habitat. Thus, S'Albufera is of international importance for these species and particularly for the Moustached Warbler *Acrocephalus melanopogon* which occurs here in higher densities than at any other known site. S'Albufera is also of strategic importance for birds migrating between Europe and Africa as well as providing a winter haven for birds fleeing the cold weather of Northern Europe. For the birdwatcher the site has the further attraction of its renown for rarities - over 75 vagrant species have been noted.

4.3 The value of the site for birds and birdwatchers was a major factor in prompting the adoption of S'Albufera as a protected area. S'Albufera Natural Park was created by Balearic Government decree on 28th January 1987. Management of the Park was assigned to the Conselleria d'Agricultura i Pesca, but with formal involvement of a number of bodies including the local authorities and the Balearic Government's Conselleria de Turisme (Ministry of Tourism).

4.4 The conservation significance of its creation as a Park was quickly demonstrated by its declaration as a Special Wild Bird Protection Area under the European Directive 7/409/CEE: by its addition to the Ramsar Convention list of wetlands of international importance; and by its inclusion in the network of littoral sites by the organisation Eurosite, on the

occasion of European Environment Year.

4.5 A detailed Park management plan was finalised and approved in 1990. The function of the Park were considered to be:

1. The conservation and restoration of the natural and cultural values of S'Albufera.
2. The development of educational and scientific activities and facilitating the contact of Man with nature.
3. The harmonisation of the Park in its socio-economic context.

To achieve the second function, the Park has a declared objective to encourage nature (or Eco) tourism, offering facilities and help to stimulate and assist visitors towards this goal.

5. Visitor use of Parc Natural de S'Albufera

5.1 All visits to S'Albufera are free with minimal restrictions and are allowed seven days a week between 0900h in the morning and 1700h in the afternoon, extending to 1900h in the summer.

5.2 From a modest start S'Albufera now receives at least 100,000 visitors per year, and the trend continues to be upward. About half use that part of the beach within the Park, with no restrictions other than the prohibition of vehicular access and construction of tourist-related structures. This ensures that S'Albufera Park foreshore is the only "natural" beach remaining between Ca'n Picafort and Alcudia and offers an attractive alternative to other heavily urbanised beaches.

5.3 A Reception Centre, car park and, from December 1993, a fully operational modern Interpretation Centre greets visitors who enter the wetland part of the Park. About 50,000 visitors registered with the Reception Centre in 1992, comprising roughly equal numbers of tourists and Balearic nationals. There are marked seasonal variations in the frequency and type of tourist visits. Not surprisingly, very few tourists visit in winter when most of the tourist industry closes down locally. Significantly, the Park also receives relatively few visitors in mid-summer. Heat, the drying out of some of the wetland habitats and associated difficulties in locating the Park's birds then are all factors.

5.4 The Park is most popular in the autumn and, above all, in the spring. Fundamentally this is due to influxes of British tourists attracted by S'Albufera's fame for birds, particularly Mediterranean species which are difficult or impossible to see in Great Britain. Though birdwatchers form the largest group, naturalists of other persuasions also visit, particularly in spring when there is an abundance of spectacular flowers, including a range of orchid species.

5.5 Another well represented group of visitors are those attracted by the possibility of an enjoyable local walk, in restful surroundings, particularly on cool or cloudy days when sunbathing is not an option.

5.6 One other group of visitors represented in the Park are the scientists. Researchers, teachers and students come to S'Albufera from Mallorca and beyond to learn more about a fascinating ecosystem of particularly high scientific and conservation value. Each year, five or six University groups, mainly from Britain, undertake periods of study. Further, the international organisation, Earthwatch, has established a detailed ecological project assessing environmental change, and the long-term ecological well-being of the Park. Scientific visits may have little quantitative and economic relevance, but are seen as very important to the island from a scientific and a cultural point of view. The involvement of local volunteers in collaboration with the University of the Balearic Islands, pioneered particularly by the Earthwatch project, is also considered within Mallorca as of utmost interest and importance to the Balearic people.

5.7 The scientific work also makes a significant contribution to understanding the Park and its environment, and the information thus gained has a large impact on the interpretation of S'Albufera for visitors. The leading role in this has been played by Earthwatch Europe's Project S'Albufera whose scientists and volunteers have investigated an enormous range of subjects during the last five years including:

- the ecology, behaviour, numbers and distribution of bird species.

- the role and effects of grazing on the management of the Park.

- the use by visitors of various parts of the Park, and preparation of display material.

- aspects of the watershed using satellite imagery ("Remote Sensing").

- the distribution of freshwater invertebrates in relation to water quality and salinity.

- study of the bats and other mammals.

- the inter-relationship between moth larvae infestation of reeds and predation of larvae by locally specialised Reed Bunting Emberiza schoeniclus .

- research into the historical archive, geology and the cataloguing of all plant and animal species supported by reference material of specimens and photographs.

These data have been extensively used in the continuing management of the Park and will contribute to the development of interpretative materials and facilities for visitors for years to come. Such baseline studies should be an essential feature of developing a natural park for sustainable tourism.

6. The Parc Natural de S'Albufera as a Model for Sustainable

Tourism

6.1 The Parc Natural de S'Albufera is the jewel in the crown of conservation in the Balearic Islands and has become the model upon which it is planned to develop other natural areas in Mallorca in the future (a development currently held back mainly be financial restraints). From an economic standpoint, the Park authorities recognise three important elements of benefit to the tourist industry.

1. The diversification of facilities on offer to the tourist in general which, as well as giving an extra option to the beach, provides a large green space in which to walk, cycle and relax.

2. The provision of an added attraction to the island for a specific tourist group, the eco-tourist, whose fundamental motive for selecting the islands as a holiday destination is the existence of a natural area of the quality and interest of S'Albufera, fully protected and managed positively for naturalists.

3. Although S'Albufera cannot claim to be a major destination for the 8 million tourists who visit Mallorca each year, the concentration of nature enthusiasts in spring and autumn is playing an increasing role in extending the tourist season, at least in north-east Mallorca.

4. Improving the "image" factor. The existence of a large Park alongside a large conglomeration of tourist developments belies the topical image within the Island of environmental degradation or "Balearization". Instead the image becomes one of intense economic development for tourism co-existing and, hopefully, co-operating with and supporting a protected zone of highest, internationally recognised environmental value. Although it is impossible to quantify such an image in economic terms, one only needs to browse the tourist brochures and leaflets for this part of Mallorca to see how much the image is exploited commercially. Many visitors, including those who do not yet get round to visiting the Park, may be influenced by this image when choosing their holiday destination.

6.2 In a very short period S'Albufera has become a major site within the Mediterranean for the promotion of conservation and respect for and interest in the environment, applying to all strata of visitors. Its well-structured educational programme, enthusiastically led by three teacher-naturalists, introduces the environment to every schoolchild in Mallorca; its facilities attract an increasing flow of birdwatchers and naturalists; and its developing interpretation programme, guided by informed and detailed ecological research, brings an understanding and appreciation of conservation and the environment to a large reservoir of tourists, many of whom had not initially been drawn to Mallorca for the quality of its wildlife. It has become a model for future ventures within the Balearic Islands and is one of the finest examples anywhere of what can be done in areas of high tourist concentrations, and particularly within the Mediterrranean region.

9. Conclusions

9.1 Mallorca has the rare distinction of combining high natural qualities and resources for eco-tourism with an outstandingly well developed infrastructure and tourist service base. Added to these, its enlightened authorities have invested wisely and substantially in protected areas, serviced by excellent professional staff, and have also provided attractive facilities to encourage visiting people and groups to see, enjoy and learn about the island's wildlife and ecology.

9.2 The bringing together of these attractions coincides with the recognition of the need to take tourism upmarket, by catering more for tourists with special interests and scaling down of large developments for high volume/low margin consumers, who have so altered the landscape in many areas and have harmed Mallorca's reputation abroad.

9.3 It is hoped that the new facilities and services at S'Albufera will now emerge as a model for European developments in eco-tourism and will help to restore and reinforce the leading role which Mallorca has enjoyed in the tourist realm.

ANNEX 16
S'Albufera: display materials for the new Visitor Centre by Hannah Bonner

The new visitor centre at S'Albufera is being created in a renovated 19th Century building that was once part of a paper mill. There is a large (2 x 2.5 m) arched window to either side of the entrance. Joan Mayol, the director of the park, wished to place diorama-type displays in them which would give visitors a first taste of what they might encounter in the marsh. The goal was to convey information in a colourful, three-dimensional way which would appeal to visitors of all ages and levels of knowledge.

Each display shows a cross section of part of a canal or pond. There is an underwater portion (made of pƒpier mach,), a clear sheet of plexiglass representing the surface of the water, and a small above-water area with plants which are typical of that ecosystem.

The first display shows a freshwater environment with a stand of Phragmites reed. Emerging from the cane is a Purple Gallinule Porphyrio porphyrio , while a Moustached Warbler Acrocephalus melanopogon clings to one of the stalks. A Coot Fulica atra floats on the "water", and under it an Eel Anguilla anguilla and a Little Grebe Tachybaptus ruficollis swim about. A Purple Heron Ardea purpurea , a Pond Terrapin Emys orbicularis and a variety of smaller creatures and plants complete the scene.

The second display is similar but depicts a more saline environment. The plants involved are Tamarisk Tamariscus , Rush Juncus and Glasswort Arthrocnemum . The animals include two Black-winged Stilts Himantopus himantopus , a Kentish Plover Charadrius alexandrinus , a Yellow Wagtail Motacilla flava , a Shoveler Anas clypeata , a Flamingo Phoenicopterus ruber , a Kingfisher Alcedo atthis and a Viperine or Water Snake Natrix maura .

The creatures themselves were made using a wire armature covered with plastic bandages to create the basic shape and then adding an outer layer of pƒpier mach, or self-hardening clay to provide the detail. Some of the plants were dried and painted, suchs as the reedmace Typha , whereas others, such as the Phragmites , had to be created from scratch using stiffened, painted fabric.

The preparatory stage of the project took place before the arrival of the Earthwatch group (Team I). The volunteers assisted

in all the final tasks of creating artificial and modified plants, painting and varnishing plants and animals and assembling and adding details to the display. Nick Riddiford, along with park ornithologist Pere Vi‡ens, provided expert advice which was essential to the accuracy of the final models.

ANNEX 17 Project S'Albufera participation in the new Parc Natural de S'Albufera Visitor Centre display by Nick Riddiford

The new S'Albufera visitor centre, scheduled to be officially opened in early Spring 1994, occupies the old paper mill, a fine example of its type which has been renovated sensitively to retain its architectural style. The centre piece of this welcome new Park resource is an exhibition. Project S'Albufera scientists and volunteers were pleased to respond to Park requests to participate in the preparation of this exhibition and this was done in the form of providing photographs, text and translation facilities.

The focus of the exhibition comprises a series of panels on which are portrayed, in photography and sound, the many facets and images of S'Albufera. The Parc Natural de S'Albufera receives large numbers of visitors from several European countries (and smaller numbers from other parts of the world). The inevitable language problem such a range of visitors imposes, prompted a reliance largely on photography and sound to present and interpret the Park's many natural wonders and assets. Text has been kept to a minimum.

Eight subjects were chosen to represent and interpret the Park in its many moods, colours and images. One of these, entitled SCIENCE AND THE PARK, was dedicated to the work of Project S'Albufera . Photographs were made available illustrating many aspects of the Project's work. The accompanying text, produced in Spanish and English, is given below. A list of all eight subjects is given in Appendix 1.

Spanish version

UN PARQUE PARA LA CIENCIA

Un Espacio Protegido es un lugar ideal para conocer la din mica de la Naturaleza. S'Albufera atrae investigadores de todo el Mundo.

El ejemplo m s importante es el PROYECTO S'ALBUFERA DE EARTHWATCH EUROPE apoyado con voluntarios de Mallorca y de otras partes del Mundo que llevan trabajando desde 1989. Este importante proyecto internacional se desarrolla para creer una estaci¢n de

seguimiento de los cambios ambientales a nivel global. Se basa en estudios y muestreos permanentes con el objectivo de comprender la composici¢n y dinamismo de los diferentes tipos de ecosistemas. Ejemplos de estos estudios son:

(1)
COMPRENDER LOS ECOSISTEMAS: Hidrolog¡a, meteorolog¡a, especies animales y vegetales.

(2)
ECOLOGIA DEL HUMEDAL: Estudios de carrizales, invertebrados acu ticos e interacciones entre plantas e insectos.

(3)
ECOLOGIA DEL SISTEMA DUNAR: Estudios de comunidades vegetales, endemismos y poblaciones de mam¡feros.

(4)
SEGUIMIENTOS: Estudios de orqu¡deas, de im genes a trav,s de sat,lite y censos ornitol¢gicos.

English version

SCIENCE AND THE PARK

A protected natural area is ideal for research aimed at increasing our knowledge of the natural environment. S'Albufera attracts scientists from all over the world, interested in its ecology.

The most important project is by EARTHWATCH EUROPE, conducted since 1989 with the help of volunteers from Mallorca and world-wide. The aim of this international project is to establish a station for monitoring environmental change on a global scale, focusing its studies on the structure, function and dynamics of the distinct ecosystems. Some of the specific areas of work are:

(1)
UNDERSTANDING THE ECOSYSTEMS: Collecting biological, hydrological and meteorological data.

(2)
WETLAND ECOLOGY: Reedbed studies, aquatic invertebrates and insect-plant interactions.

(3)
DUNE ECOLOGY: Studies of plant communities, endemics and populations of small mammals.

(4)
SPECIFIC STUDIES: Orchid research, remote sensing using satellite imagery and ornithological census.

Appendix 1: The exhibition "Images of S'Albufera": subject titles (in English)

Panel 1: THE OSPREY
Panel 2: THE CYCLE OF LIFE
Panel 3: PATHWAYS OF THE SKY AND SEA
Panel 4: KNOWING HOW TO LISTEN
Panel 5: MAN, AN ALBUFERA SPECIES
Panel 6: SCIENCE AND THE PARK
Panel 7: NATURE'S COLOURS
Panel 8: VAST EXPANSE TO INTRICATE DETAIL

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