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PREFACE

This report is a compilation of the results and findings of the field research undertaken by A Rocha staff and visiting scientists to the Cruzinha field study centre in 2003. We are grateful to all those who have been part of the centre's life for a short or long period this year, and for their contributions to a better understanding of the Ria de Alvor and surrounding environments.

In 2002 A Rocha was contracted to survey areas of council-owned land entering into the proposed Bio-Parque initiative, implementing Natura 2000 in the Serra de Monchique. The botanical inventory and mapping is described in the abridged account included in this report. The fieldwork was immediately followed by the devastating forest fires of August and September, affecting 78% of the Monchique district, one of the key flashpoints of the country. Discussions have subsequently opened up on working towards more sustainable forestry policies in Portugal, and A Rocha hopes to contribute from its several years of research on the comparative biodiversity of different forest and woodland types in the south of the country. The monitoring of post-fire vegetation recovery in the Serra de Monchique will be an important part of our ongoing scientific contribution.

Another significant piece of work reported on here is the water quality study completed by Chris Boyes early in the year. This preliminary study has helped define relevant methodologies, whilst providing some initial data and questions for further study. By way of follow-up, another European Voluntary Service volunteer, Ben Carpenter, joined us in June to provide a first characterisation of the invertebrate communities of the estuary and marshes. The health of the aquatic ecosystem is in this way being explored, with relevance to future implementation of the European Framwork Directive. As we look at possibilities for management of the water regime in the dyked marshlands, the work of Edinburgh University's Environmental Management MSc group, who for the second consecutive year spent a week with us in the Spring, became very relevant. An article based on a poster presentation of their work is included in this report.

The establishment of a Geographic Information System to support these studies and their application has long been considered a priority. This year the first phase of this development was realised through the award of ArcGIS software from the Conservation Grant scheme of ESRI. We took delivery of the system in time to benefit from the expertise of Stephanie and Eric Orndorff, A Rocha USA members who travelled over in the autumn to set up the software and provide training in its use. The next Observatory Report will provide an update on the building and use of this system, as well as the first map products arising from it. We are grateful to both the Orndorffs and ESRI for this development.

A Rocha's programme of bird studies continued through the year, with a weekly ringing session in the grounds of the centre, Storm Petrel ringing in the late Spring off Almadena (led by Rob Thomas with the help of Marielle Smith of Cardiff University), and fortnightly wader counts on the Ria de Alvor. We again benefited from the eagle eye of Willem Scheres, who visited us in …., and who in this report has provided a review of past seabird records from our study area. Complementing this is a more in-depth look at Gannet movements off the coast at nearby Carvoeiro by another frequent visitor from the north, Manfred Temme.

We look forward to the Ria de Alvor being confirmed as a European Natura 2000 site in 2004. In the meantime A Rocha has started to work towards a management plan as a means of implementing this legislation. The first part of this plan – a description and evaluation – was completed and became an integral part of the Lagos and Portimão's Intermunicpal Commission's report launched at a press event on World Wetlands Day, 1 February. We see this as a step forward, and intend to follow this process through the months, years and uncertainties ahead. Thank you for your interest and support of our scientific programme that helps make the protection of this environment a possibility into the future.

The Editor

PRELIMINARY SURVEY OF BATS ON QUINTA DA ROCHA

Chris Boyes

Introduction

The aims of this study were to determine which species of bat feed, and perhaps roost, on Quinta da Rocha and assess their distribution between the different habitat types. This represents the first study of this taxonomic group made by A Rocha, in a region where there is little information on the distribution and abundance status of bat species present. The Portuguese Red Data Book gives information on the status and population trends of species known in continental Portugal (SNPRCN, 1990). Palmeirim & Rodrigues (1992) provide a national overview of the status of cave-dwelling bats, and a more specific study for the south of the country is described by Rainho (1996). Other relevant studies are summarised in the annual reports on the national implementation of the Agreement on the Conservation of Bats in Europe (eg ICN, 2001).

Methods

Identification of bat species encountered

Using an electronic 'bat detector' the ultrasonic calls of bats, usually inaudible to humans, may be heard. Bat calls have a number of characteristics such as frequency, structure, amplitude and repetition rate. The structure may comprise a constant frequency (CF) of call, or frequency change ('modulation' – FM), or various combinations of the two. A useable, although limited, degree of species identification is possible by differences in these call characteristics, which may be perceived by ear or revealed through computer analysis. Visual clues such as size, shape and flight style are also useful.

In this study the echolocation and social calls of bats were heard using a Batbox III bat detector[1], and occasionally by ear alone for calls below the range of the detector. Some species were identified in the field after learning to recognise them from two reference CDs of bat calls (Barataud, 1996; Briggs *et al.*, 1998) or with an identification key of call characteristics and visual clues for the bat species of Portugal compiled from details in literature (Barataud, 1996; BCT, 2001 & 2002; Briggs & King, 1998; ICN, 2002a; Tupinier, 1997). Attempts were made to identify more difficult or unfamiliar calls by comparing recordings made from the bat detector with calls on the reference CDs. Recordings of some calls were analysed on computer using sound analysis software[2] to determine pulse rate and rhythm. In this way calls were either identified to a specific species or a group of possible species, or otherwise remained unidentified.

Study of distribution between habitats

During August, September and early October 2002, a series of transects were walked through habitats of Quinta da Rocha thought likely to be important for feeding and commuting bats:

- the main track from the EN125 to the headland (21 August; 5 and 18 September);
- fields for cattle grazing, with abandoned olive/carob/almond groves (27 August; 11 and 24 September)
- scrub of typical *matos* and abandoned vineyard (22 August, 9 September, 2 October);
- Pine woodland (3, 10 and 20 September);
- Estuarine – western marsh and sand flats (29 August, 13 September, 3 October).

Each transect route was surveyed with the bat detector three times, once for each frequency range: 20-35 kHz, 35-60 kHz, 60-120 kHz. During the transect walk a count was made of 'bat passes' heard on

[1] The Batbox III is a heterodyne type detector from Stag Electronics, Steyning, West Sussex, U.K.

[2] Spectrogram 2.3 is a freeware programme available from http://www.winsite.com/info/pc/win95/sounds/gram23.zip

the detector, ie sequences of echolocation calls registered indicating a bat in transit (Fenton, 1970). The species making the pass was recorded, or appropriate details noted for possible identification later. Bat passes are not a measure of the actual number of individual bats heard, but are an index of relative activity or relative abundance (BCT, 2001). Transects were begun 90 minutes after sunset, by which time all bat species should have emerged. Transect routes varied in length, between 0.8 km and 2.1 km, but all were completed in approximately 45 minutes. Weather conditions at the start of the transect were recorded, and transects were not undertaken when conditions were unfavourable for bats (such as strong winds and rain).

Ad hoc observations and search for roosts

In addition to the transect walks, there were around 30 *ad hoc* sessions of bat observation between May and November 2002. These were mainly in Cruzinha's grounds and on the main *Quinta* tracks, at evening and early morning, and covered the complete range of frequencies. Some of these occasions were used in trying to locate roosts by observing the direction bats were flying and then moving in the appropriate direction – bats fly away from their roost after emerging in the evening, and toward it when they return shortly before dawn.

Results (1) – species detected

A minimum of seven and maximum of ten different species of bat were recorded in the survey, of which six were identified to species level (Table 1).

Rhinolophus ferrumequinum Greater Horseshoe Bat

This species was recorded on one evening on the edge of the pinewood. Its large size and distinctive call made it unmistakable. It is likely to be under-recorded as its call is known to be very directional and of low amplitude, and the Batbox III detector is less sensitive at the high frequencies which horseshoe bats use. It is widespread within Portugal, though has only been sporadically recorded in the south. It roosts and hibernates in caves and buildings. As an endangered and apparently declining species within Portugal, and indeed Europe as a whole, this is a significant record for the study area.

A further record of a horseshoe bat *Rhinolophus* sp. on the track (see below) might refer to this species.

Pipistrellus pipistrellus Common Pipistrelle

Only recently has it been recognised that two species of Pipistrelle have been confused under the name *Pipistrellus pipistrellus*. Originally identified from their different echolocation frequencies, and later confirmed by DNA studies, they have been separated into *Pipistrellus pipistrellus* (Common Pipistrelle, echolocates at about 45kHz) and *Pipistrellus pygmaeus* (Soprano Pipistrelle, echolocates at about 55kHz). There are slight morphological differences between them and it is thought that the Common Pipistrelle forms smaller, more mobile colonies and is more of a generalist feeder than the Soprano.

Both species are abundant and widespread throughout Europe, although the presence of the '46kHz phonic group' (ie *P. pipistrellus*) has yet to be officially confirmed in Portugal (ICN, 2002b). It is therefore significant that during this study *P. pipistrellus* was recorded twenty times in almost all habitats, although only two were during transects.

As the Common Pipistrelle, Soprano Pipistrelle and Schreiber's Bat have similar calls sometimes at the same frequencies, it was not always possible to distinguish between them. In such cases they were recorded as 'Common Pipistrelle or Soprano Pipistrelle', 'Common Pipistrelle, Soprano Pipistrelle or Schreiber's Bat' and 'Soprano Pipistrelle or Schreiber's Bat', (see below), and it is likely a number of the former represent the Common Pipistrelle.

Pipistrellus pygmaeus Soprano Pipistrelle
Although common and widespread in Portugal, this was the least frequently recorded of the three Pipistrelle species present in the study area. Positively identified on a single occasion, it is distinguished from the Common Pipistrelle on the basis of call frequency, and from Schreiber's Bat by its smaller size. Calls recorded as 'Common Pipistrelle or Soprano Pipistrelle', 'Common Pipistrelle, Soprano Pipistrelle or Schreiber's Bat' and 'Soprano Pipistrelle or Schreiber's Bat' may represent a number of Soprano Pipistrelles. It is possible that the Soprano Pipistrelle accounts for many of the second category, as it is thought to be more of a riparian specialist than the Common.

Soprano Pipistrelle is considered to be a non-threatened species in Portugal but its population trend is unknown; in the UK, where it is also thought to be at low risk, the last 20 years saw a decline in numbers of around 60%.

Pipistrellus kuhlii Kuhl's Pipistrelle
This was the species encountered most frequently and was recorded in all habitats, especially seen foraging around street lamps on the main track. It is a non-threatened species across Portugal. Present in southern Europe, it is known to be spreading northwards. It typically roosts in crevices in walls and roofs of buildings.

It is possible to confuse this species with Nathusius' Pipistrelle (*Pipistrellus nathusii*), having similar sounding echolocation calls at the same range of frequencies, but their different social calls (heard occasionally) allow them to be identified. Nathusius' Pipistrelle has not been reported in Portugal since 1910 and in this study all social calls indicated Kuhl's Pipistrelle. Therefore all the echolocation calls characteristic of these species were attributed to Kuhl's Pipistrelle.

Pipistrelle sp – Chris Boyes

Miniopterus schreibersii Schreiber's Bat
Positively identified on just one occasion foraging by a street lamp on the main track. Visual clues – flight style and noticeably large size – allowed confident differentiation from the Common Pipistrelle and Soprano Pipistrelle, which have similar calls at the same frequencies. Calls typical of these species heard without visual clues were grouped together as 'Common Pipistrelle, Soprano Pipistrelle or Schreiber's Bat' when at 49-52kHz and 'Soprano Pipistrelle or Schreiber's Bat' at 53-56kHz (see below), therefore a number of these may also represent Schreiber's Bat.
Schreiber's is the most abundant cave dwelling bat in Portugal, although it is a vulnerable and declining species, as in other parts of Europe where large colonies have become extinct. The

Schreiber's Bat maternity colonies of the Algarve and south-west Alentejo are the smallest in Portugal, due to the high degree of disturbance their underground roosts suffer.

Tadarida teniotis European Free-tailed Bat
This species was recorded on just four occasions: twice foraging over scrub at the margins of the pine woodland, and briefly at Cruzinha and crossing the main track. It was heard and identified by ear alone as its call is below the range of the detector but audible to humans. It flies fast and straight in open areas, often at treetop height, making it difficult to observe directly. It is unmistakable in Europe. The bat often roosts in crevices in cliffs.

This species is the only member of the Molossidae family (free-tailed bats – having a rat-like tail protruding beyond the tail membrane) to be found in Europe, and is present in the south of the Iberian peninsula and around the Mediterranean coast. As a rare species in Portugal, its presence is significant for the study area.

Rhinolophus **sp.** Greater, Lesser, Mediterranean or Mehely's Horseshoe Bat
During an *ad hoc* observation session on the main track, the CF call (warble sound) characteristic of horseshoe bats was detected briefly at around 37kHz. As this is not a frequency used in the main part of their calls, which are between 60–112kHz, the particular species of horseshoe bat could not be determined.

Four of the five European horseshoe species are present in Portugal, all of which are endangered and declining, and this record represents one of these. The Mediterranean horseshoe has not been reported in the south of the country, and is hence the least likely; it could also be another record of the Greater Horseshoe discussed earlier.

Pipistrellus pipistrellus*/*Pipistrellus pygmaeus Common Pipistrelle or Soprano Pipistrelle
Recorded when bats were observed to be Pipistrelle sized, hence ruling out Schreiber's Bat, and having levelled FM calls at frequencies which may be used by both the Common Pipistrelle and Soprano Pipistrelle. This category was recorded on six *ad hoc* observation sessions, at Cruzinha, on the main track, in the fields, and on the Abicada peninsula.

Pipistrellus pipistrellus*/*Pipistrellus pygmaeus*/*Miniopterus schreibersii Common Pipistrelle, Soprano Pipistrelle or Schreiber's Bat
Recorded when levelled FM calls were heard at frequencies shared by Common Pipistrelle, Soprano Pipistrelle and Schreiber's Bat, and the bat was not seen in order to note its size. This category was detected many times in most habitats, especially around the estuary where a total of 31 bat passes were recorded during the transect. Many of these probably represent the Soprano Pipistrelle as it is known to be more of a riparian specialist.

Pipistrellus pygmaeus*/*Miniopterus schreibersii Soprano Pipistrelle or Schreiber's Bat
Recorded when levelled FM calls were heard at frequencies shared by the Soprano Pipistrelle and Schreiber's Bat, and the bat was not seen in order to note its size. This category was detected less frequently than the above and distributed differently throughout the habitats: detected at the estuary only once, absent from scrub, and present in the pine woodland.

Nyctalus **sp.** Leisler's, Noctule or Greater Noctule
Heard in the grounds of Cruzinha on one occasion. The call resembles 'chips' and 'chops', ie alternating FM & CF, which is characteristic of *Nyctalus* sp. flying in the open. These bats roost in tree hollows and commonly feed around woodland. Leisler's Bat is fairly widespread across Portugal but rare and vulnerable; the Noctule and Greater Noctule are also rare and only reported sporadically. The presence of a rare species that is vulnerable or not well known, is significant for the study area.

***Eptesicus serotinus*/*Nyctalus* sp.** Serotine, Leisler's, Noctule or Greater Noctule
Heard on several occasions on the track and scrub. Levelled FM calls between 20-35kHz: Serotine in all situations, and *Nyctalus* sp. when in cluttered environments. The bats detected here most likely represent Serotines, which are widespread, abundant, and non-threatened in Portugal, being one of the commonest Portuguese species. They tend to roost in houses, trees and rock crevices, and often feed in open areas such as pasture, parkland and suburban gardens.

Eptesicus serotinus*/*Nyctalus* sp./*Hypsugo (Pipistrellus) savii Serotine, Leisler's, Noctule, Greater Noctule or Savi's Pipistrelle
A levelled FM call, with irregular rate and rhythm, heard at 40kHz in a field habitat. It was possibly Savi's Pipistrelle or a harmonic of a Serotine, Leisler's, Noctule or Greater Noctule, although not an exact match with calls on reference CDs. Savi's Pipistrelle is rare and not well known in Portugal.

Results (2) - Search for roosting sites

In this study the species regularly observed in good light and in significant numbers, and so able to be tracked, were the Common Pipistrelle, Soprano Pipistrelle and Kuhl's Pipistrelle. Whilst the observations indicate that no roosts for these species are located in the study area, a good picture of the routes they use for commuting has been built up.

In general it was found that at dusk they fly west or south-west from the Abicada peninsula to Quinta da Rocha, and upon reaching the hedge line of the main track, they turn and follow it south, or continue westward across the *Quinta* – in both cases possibly heading to feeding sites on the western marsh.

In the early morning before dawn, they fly north-east from Quinta da Rocha, and northward from Abicada, suggesting that roost sites are possibly in vicinity of Figueira; all three species use buildings as roosts and the Common Pipistrelle is known to feed usually within 5 km of its roosts, with females travelling an average of 1.8 km to feed in pregnancy, and 1.3 km during lactation.

Discussion

Diversity of species
It can be seen that Quinta da Rocha supports bat species with different habitat preferences (eg woodlands and open areas) and which roost in different places (eg buildings, caves and trees). Both rare and common, endangered and non-threatened species were found.

No species of the *Myotis* genera, of which there are seven in Portugal, were detected, possibly because they tend to have quieter calls. However, the apparent absence of *Myotis daubentonii*, Daubenton's Bat, is surprising, especially as it is associated with feeding over water and is common in Portugal. It is possible that this is because of the inability of the surveyor to differentiate its call from those of the many Pipistrelles feeding simultaneously over the marsh, due to inexperience.

Another common species not detected was *Plecotus austriacus,* the Grey Long-eared Bat, although this is perhaps not surprising considering it has a very weak call, audible at distances of less than 5 m.

Most notable species
Several species identified as present in the study area are of particular note because their numbers in Portugal or Europe as a whole are small, declining, and perhaps in danger of extinction:
- all Horseshoe Bat species, *Rhinolophus* sp., are declining and endangered;
- Schreiber's Bat, *Miniopterus schreibersii*, is vulnerable and declining;

- of the identified group *Nyctalus* sp., Leisler's bat is rare and vulnerable, and the Noctule and Greater Noctule are rare and not well known;
- the European Free-tailed Bat, *Tadarida teniotis*, is also rare in Portugal.

It is also notable, that although it has not yet been officially confirmed as being present in Portugal, the Common Pipistrelle, *Pipistrellus pipistrellus*, was relatively abundant in the study area.

Success and limitations of method

The heterodyne detector is a relatively inefficient tool for multi-species surveys: the whole frequency range cannot be monitored at once, therefore the tuning dial must continually be turned, and also the detector is much less sensitive at the high and low ends of the frequency range. The former was successfully overcome in this study by undertaking each transect a number of times, each time monitoring a different portion of the whole frequency range.

The likelihood of detection is also dependent on the species: some are only detected at distances of less than 3 m, some at over 100 m. Detection rates can even vary within species according to whether they are flying in an open or cluttered environment: detection is less likely in clutter due to adaptations in call characteristics employed. Comparisons between the abundance of different species are therefore not reliable without applying weighting factors. The standardisation of the duration of transects, rather than of their lengths, also means that comparisons of species abundance are not reliable.

Species identification using the heterodyne method is difficult, and as it is done by ear, relies on the experience and abilities of the surveyor. Daubenton's Bat may not have been detected because of the inexperience of the surveyor to differentiate its call from those of the many Pipistrelles feeding simultaneously over the marsh.

There are major limits to identification, as calls of different species are always, or temporarily, indistinguishable. These can be overcome to a large extent using more advanced bat detectors, such as time expansion and frequency division equipment, in combination with computer analysis.

Tracking bats at dusk and dawn in order to find roosts is most successful with those species that emerge early, have loud echolocation calls, and come from large roosts. During this study tracking was found to be limited to the three Pipistrelle species, which broadly fulfil these criteria. Although the primary goal to find roosts was not accomplished, it is now known that these species do not roost in the study area, and their commuting routes to and from where they actually roost have been found. It is now likely that further tracking work would successfully locate roosting sites and key feeding areas.

Despite the drawbacks and difficulties of the methods employed, this study has provided valuable new knowledge of the bat species on Quinta da Rocha.

Recommendations for further studies

Those rare and endangered species found to be present in the study area could be the subject of a single species study, to gain further data on abundance and habitat use. The presence of the Common Pipistrelle, *Pipistrellus pipistrellus*, should be confirmed in conjunction with the Instituto para a Conservação da Natureza (ICN). The apparent absence of Daubenton's Bat, *Myotis daubentonii*, from the western marsh might be investigated. In order to locate possible roosting sites near Figueira and key feeding sites, tracking at dusk and dawn should be continued.

Acknowledgements

Gratefully acknowledged is the assistance of the volunteers who stayed up late and got up early to observe bats, the guidance on methodology given by Renata Medeiros, and the input of Will Simonson during the writing up and editing of this report.

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Table 1 Bat species recorded in the survey.

Species	**Identification**	**Portuguese Red Data Book Status and apparent trend***	**First and last dates of recording**	**Frequency of recording,** (no. of *ad hoc* sessions)	**Habitat **** (no. of passes on transect)
Rhinolophus ferrumequinum Greater Horseshoe Bat	Characteristic CF call (warble sound) of horseshoe bats, at frequency less than 100kHz.	E (declining)	10.9.02	1	P
Pipistrellus pipistrellus Common Pipistrelle	Levelled FM call ('wet smack' sound) at frequencies between 43-48kHz.	*Yet to be officially confirmed as present*	5.5.02 – 19.8.02	18	C, T(2), F, E, A
Pipistrellus pygmaeus Soprano Pipistrelle	Levelled FM call between 53-56kHz (was at 54kHz) and seen to be Pipistrelle sized.	NT (?) *[refers to 55kHz phonic group of* 'P.pipistrellus' *before it was split into two species]*	15.8.02	1	C
Pipistrellus kuhlii Kuhl's Pipistrelle	Levelled FM call at frequencies between 35-42kHz; distinguished from *P. nathusii* by their single, rather than doubled or tripled, social calls.	NT	5.5.02 – 5.11.02	23	C, T(8), F(1), S(1), P(1), E (7), A
Miniopterus schreibersii Schreiber's Bat	Levelled FM call between 53-56kHz (was at 55kHz) with rapid pulse rate (14-18 per second), fast flight and seen to be noticeably larger than Pipistrelles.	V (declining)	24.9.02	1	T

Table 1 (cont.)

Species	**Identification**	**Portuguese Red Data Book Status and apparent trend***	**First and last dates of recording**	**Frequency of recording,** (no. of *ad hoc* sessions)	**Habitat **** (no. of passes on transect)
Tadarida teniotis European Free-tailed Bat	Call heard by ear alone as a high-pitched 'tseek'; slow and regular call rate, speeding up occasionally. Has smooth sound rather than the rolling 'tzrree' of other species' social calls.	R (?)	3.9.02 – 21.10.02	1	C, T(1), S(2)
Rhinolophus sp. Greater Horseshoe, Lesser Horseshoe, Mediterranean Horseshoe or Mehely's Horseshoe	Characteristic CF call (warble sound) of horseshoe bats.	E (declining)	4.5.02	1	T
Pipistrellus pipistrellus / Pipistrellus pygmaeus Common Pipistrelle, Soprano Pipistrelle	Levelled FM call at frequencies between 49-52kHz and seen to be Pipistrelle sized.	Common Pipistrelle: *Yet to be officially confirmed as present.* Soprano Pipistrelle: NT(?)	1.7.02-5.11.02	6	C, T, F, A
Pipistrellus pipistrellus / Pipistrellus pygmaeus / Miniopterus schreibersii Common Pipistrelle, Soprano Pipistrelle, Schreiber's Bat	Levelled FM call at frequencies between 49-52kHz (size not seen).	Common Pipistrelle: *Yet to be officially confirmed as present.* Soprano Pipistrelle: NT(?) Schreiber's Bat: V (declining)	6.5.02-24.9.02	4	C, T(3), F(1), S(4), E(31)

Table 1 (cont.)

Species	**Identification**	**Portuguese Red Data Book Status and apparent trend***	**First and last dates of recording**	**Frequency of recording,** (no. of *ad hoc* sessions)	**Habitat **** (no. of passes on transect)
Pipistrellus pygmaeus / Miniopterus schreibersii Soprano Pipistrelle, Schreiber's Bat	Levelled FM call at frequencies between 53-56kHz (size not seen).	Soprano Pipistrelle: NT(?) Schreiber's Bat: V (declining)	10.5.02 -24.9.02	5	C, T(5), F(2), P(1), E
Nyctalus sp. Leisler's, Noctule or Greater Noctule	Call resembling 'chips' and 'chops' (alternating FM & CF) detected at around 40kHz (probably a harmonic).	Leisler's: V (?) Noctule: I (?) Greater Noctule: I (?)	27.8.02	1	C
Eptesicus serotinus/Nyctalus sp Serotine, Leisler's, Noctule or Greater Noctule	Mostly slow and irregular calls between 20-35kHz, levelled FM only (as *E.serotinus* in all situations and *Nyctalus sp.* in cluttered environments).	Serotine: NT Leisler's: V (?) Noctule: I (?) Greater Noctule: I (?)	9.9.02- 24.9.02	2	T, S(1)
Eptesicus serotinus/Nyctalus sp./ *Hypsugo (Pipistrellus) savii* Serotine, Leisler's, Noctule, Greater Noctule or Savi's Pipistrelle	Levelled FM call, irregular rate and rhythm, at 40 kHz (probably a harmonic). Similar to certain calls on reference CDs, but does not exactly match any.	Serotine: NT Leisler's: V (?) Noctule: I (?) Greater Noctule: I (?) Savi's Pipistrelle: IK (?)	24.9.02	1	F

* E – Endangered, V – Vulnerable, R – Rare, NT – Not Threatened, I – Indeterminate, IK – Insufficiently Known

** C – Cruzinha, T – Track, F – Field, S – Scrubland/abandoned vineyard, P – Pine woodland, E – Estuary, A – Abicada

TWO NEW HIGHLIGHTS DURING AUGUST IN THE A ROCHA AREA: PURPLE SWAMP-HEN *PORPHYRIO PORPHYRIO* AND EAGLE OWL *BUBO BUBO*

Willem Scheres

Introduction

During August 2002 two new bird species were discovered in the A Rocha study area: Purple Swamp-hen *Porphyrio porphyrio* and Eagle Owl *Bubo bubo*. Both are uncommon residents in Portugal (Moore *et al*., 1997). This article describes and comments on the presence of both newcomers and the habitats in which they were found. It is conjectured that the area may become a permanent site for the Purple Swamp-hen, with one marsh in particular providing suitable marsh habitat.

Purple Swamp-hen Porphyrio porphyrio

During an evening visit on 27 August to a marsh close to the EN125 an adult Purple Swamp-hen was seen while it was coming out of a small patch of Lesser Reedmace *Typha angustifolia*. This reedmace-bed is along a dead river meander north-east of the main channel of the Odiáxere River. Other vegetation along this part of the meander consists mainly of Sea Club-rush *Scirpus maritimus,* Sea Rush *Juncus maritimus* and the grass *Paspalum dilatatum*. To the north and east the vegetation mainly consists of tall reedmace.

The Purple Gallinule was twice as big as the Moorhen *Gallinula chloropus* that was observed in the same water body. It has a dark purple-blue body, head and neck with a heavy bright red bill and a large bright red shield on the forehead above the bill. The legs were barely visible because of the depth of the water. The under-tail coverts were completely white. The bird was flicking with its tail like a Moorhen. Later on it flew with hanging long legs, plunged into the reedmace-bed and disappeared. The Purple Swamp-hen was seen again during the next two days by two members of the A Rocha team. On all three days observed it was in exactly the same part of the marsh.

The habitat where this bird was found is typical of the kind of environment that Purple Swamp-hens prefer. According to Cramp & Simmons (1980) the bird specialises in lowland wetlands of the Mediterranean zone where fresh or brackish, narrow or sheltered open waters are more or less densely fringed or overgrown by dead or living vegetation consisting of reedmace, reed *Phragmitis* sp., sedge or other sturdy and/or emergent vegetation. Its food habits are omnivorous; the plant food that is preferred is the pith of reedmace and *Scirpus* stems. Both plants are abundant along the open water of the site in question.

In the southern Algarve the Purple Swamp-hen is present in at four sites: the Ludo marshes and Quinta do Lago (both in the Ria Formosa National Park), Vilamoura and the Lagoa dos Salgados near Armação de Pêra (all personal observations). In three of the four locations the habitat consists of a body of open water surrounded by reedmace beds within a golf course. Records in Portugal outside of the Algarve are exceptional (Moore *et al*., 1997). Formerly the Purple Swamp-hen used to nest as far north as Coimbra (Hudson & Cramp, 1975). Because of severe burns during mid-summer of 2002 in the Quinta do Lago/Ludo area, it is possible that several marsh inhabitants have left the partly destroyed marshes, including the individual Purple Swamp-hen found in the Alvor Estuary.

Within the Alvor Estuary, the marsh where the bird was seen is the only area with significant areas of Lesser Reedmace and Sea Club-rush along a body of open water; generally the reedmace is not widespread in this study area (Simonson, pers com.). The habitat has much in common with the breeding habitats in the the central Algarve littoral, but because of its rarity in the western Algarve it is important that it is preserved. It has the potential of harbouring rare breeding wetland birds such as the swamp-hen itself and Little Bittern *Ixobrychus minutus* and is also important for wintering marsh species like Penduline Tit *Remiz pendulinus*. On 25 October 2001 a flock of five Penduline Tits was seen landing in the tall reedmace-bed near to the swamp-hen site (Felgueiras *et al*., 2002).

***Eagle Owl* Bubo bubo**

In August a large owl was flushed at 7.30 a.m. during a walk of a neighbour of Cruzinha, Mr C. Key. For a short while the owl was perched on a branch of a pine tree. It was very large with a thick head with long ear-tufts and with bright orange-red eyes. The bird was apparently roosting in the pines of Quinta da Rocha, and seemed to have the characteristics of an Eagle Owl *Bubo bubo*.

During a search for feathers of Azure-winged Magpies *Cyanopica cyanus* in their roosting area (the same pine wood) on 26 August, the author flushed an Eagle Owl. It flew up to a tall Maritime Pine *Pinus pinaster* in a relatively open part of the wood. The bird had a large barrel-shaped body with a thick rounded head with long erected ear-tufts and bright orange-red eyes. After perching on a branch for a short period, the bird flew east towards scrubland close to the eastern marsh. The owl had a wing-span comparable with a Grey Heron *Ardea cinerea*. Its upper-wings were dark brown and the ends of the wings rounded. Because of the long ear-tufts the individual could not be a first year juvenile. Eagle Owls often roost in daytime in conifers combining concealment with a view of potential intruders (Cramp & Simmons, 1985). The Quinta da Rocha pines, especially Stone Pines *Pinus pinea*, give a thick cover.

In the southern part of Quinta da Rocha three small piles of Cattle Egret *Bubulcus ibis* feathers were found. Another was encountered on the slope to the eastern marsh close to the abandoned almond grove near Cruzinha. In each case some feathers were fixed together by small pieces of skin. It is possible that the Eagle Owl has preyed on Cattle Egrets. An enormous range of bird species up to the size of a full grown Grey Heron is recorded as prey (Cramp & Simmons, 1985).

In all populations individuals wander outside their normal range to some extent. Ringing recoveries show movement of between 11 and 250 km (Cramp & Simmons, 1985). Grzimek *et al.* (1969) also mentions that in their first two years Eagle Owls may cover long distances to find new territories. The map of breeding sites in Portugal shows a scattered pattern with confirmed nesting spread over the whole country (Rufino, 1989). Some of these sites are in the Alentejo and the Algarve. According to Moore *et al*. (1997) the Eagle Owl is a rare resident in Portugal which occurs mainly in remote inland areas in the east of the country, for example Barrancos. Dispersing Eagle Owls would be able to reach the A Rocha study area from inland sites in southern or eastern Portugal. Quinta da Rocha is a relatively quiet and undisturbed area between the built-up urbanisations of Portimão and Lagos, and also contains a good availability of potential prey, and its attraction to Eagle Owls is not difficult to understand.

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A PARTLY MELANISTIC CATTLE EGRET *BUBULCUS IBIS*

Willem Scheres

Cattle Egrets *Bubulcus ibis* are the most numerous species of the Ardeidae within the A Rocha study area. They are continuously present and occur sometimes in large numbers, such as 750 in mid November 2000 and 200 in October 1990 (Felgueiras *et al*., 2002). On 25 August 2002 a partly melanistic Cattle Egret flew west of the Cruzinha garden. Its head and breast were blackish while the wings and the rest of the body were white. The shape of the body and the wings was the same as a following normal one which provided comparison. A few days later, on 29 August, the same bird landed in a tree in a wooded area to the south-east of the headland not far from the slope to the eastern marsh. The bird perched on top of the tree and was clearly visible. The head and neck were completely black with a contrasting yellow bill; the breast was a dark grey. The rest of the body was white except a few dark feathers on the mantle. Later this partly melanistic Cattle Egret was seen several times by other observers.

In Cramp S. *et al*. (1977), melanistic forms of several egret species are mentioned. Melanistic Little Egrets *Egretta garzetta*, which are rare, have a grey to dark slate plumage with or without white chin and throat. Partly dark coloured ones are also described from Africa. The Western Reef Egret *Egretta gularis* is polymorphic, with dark and white morphs and intermediates commonly existing. But there is no description of melanistic or partly melanistic Cattle Egrets; only the fact that immature birds and non-breeding adults sometimes have a grimy grey cast to plumage is mentioned. Also Jonsson (1993) mentions dark morphs of the Little Egret and several forms of the Western Reef Egret, but no such variations within Cattle Egret. These facts suggest that melanistic features in Cattle Egrets must be rare.

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RINGING REPORT FOR 2002

Renata Medeiros

Weekly ringing using the established net sites around the Cruzinha grounds continued through 2002. More frequent sessions were held during the autumn migration period, and also the Storm Petrel campaign (see R. Thomas, this report). The total of 1293 captures during 2002 included 929 birds ringed of 44 species (Table 1). Table 2 lists species and totals of birds ringed in previous years but not 2002. There is one addition to the ringing list this year, a Bullfinch *Pyrrhula pyrrhula* in October, bringing the centre's total to 172 species. Marcial Felgueiras continued as director of operations, with Renata accompanying him as trainee. Also assisting the ringing at various points were Filipa Bragança, Derek Whitton, Heather Coats, Keith Ellis, Dave Kelly, Chris Boyes and Rebecca Owen.

Table 1 Birds ringed by A Rocha during 2002 and in all years together.

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	2002	Grand Total
Cory's Shearwater						3							3	5
European Storm-petrel						188	37						225	2786
Kestrel				1									1	6
Collared Dove								2					2	5
Kingfisher							2	1	1				4	177
Hoopoe	1		1	3	4		5	1	2	1	1		19	384
Crested Lark							1						1	76
Swallow				1									1	1503
White Wagtail												1	1	53
Wren							1						1	8
Robin	7	2	1							6	1		17	2251
Nightingale				1		1	2	1	1				6	531
Redstart				1	1								2	285
Stonechat										1			1	257
Song Trush			1							1		1	3	511
Blackbird			1	3	20	17	17	6	4	1	4		73	1109
Garden Warbler				8					12	4			24	3446
Blackcap	19	8	2	2		1	1			26	18	2	79	8272
Sardinian Warbler	5	2	2		6	7	6	3	1	2			34	1140
Whitethroat				1					1	3			5	409
Subalpine Warbler									1				1	222
Sedge Warbler									1				1	245
Zitting Cisticola						1							1	347
Cetti's Warbler										1			1	115
Reed Warbler				1	4	1			12	7	1		26	2062
Melodious Warbler				1		1	4	4	2	1			13	720
Willow Warbler									12	6			18	2128
Bonelli's Warbler									4				4	70
Chiffchaff	7	2	1	1				1	7	14	18	1	52	7753
Firecrest										2			2	59
Spotted Flycatcher									2	1			3	163
Pied Flycatcher				4				1	19	3			27	1137
Great Tit	1			3	3	2	3	1	1				14	469
Blue Tit		2					1	2		1	1		7	70

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	2002	Grand Total
Penduline Tit											1		1	164
Woodchat Shrike						2	1						3	301
Azure-winged Magpie	2								1				3	41
Waxbill	1	5		2		1		3	2	1		1	16	1202
Chaffinch	3	1		1	7	10				2	1	1	26	839
Goldfinch		3	4	15	16	22	14	1	1	1	2		79	1678
Greenfinch	2		7	5	12	27	6	4	3		3		69	2179
Siskin	1		1										2	52
Serin	4	1	2	17	16	6	7	1		3			57	1273
Bullfinch*										1			1	1
Totals	**53**	**26**	**23**	**71**	**89**	**290**	**108**	**32**	**90**	**89**	**51**	**7**	**929**	**46504**

Table 2 Species ringed in 1986-2001 but not in 2002.

Aquatic Warbler	2
Avocet	3
Barn Owl	2
Bar-tailed Godwit	19
Bee-eater	95
Black Redstart	129
Black-eared Wheatear	4
Black-headed Gull	19
Black-shouldered Kite	4
Black-tailed Godwit	1
Black-winged Stilt	15
Bluethroat	167
Brambling	1
Buff-breasted Sandpiper	1
Cattle Egret	16
Chestnut Mannikin	1
Cirl Bunting	1
Common Rosefinch	1
Common Sandpiper	103
Common Tern	2
Corn Bunting	177
Crag Martin	7
Crossbill	36
Cuckoo	2
Curlew	4
Curlew Sandpiper	74
Dartford Warbler	11
Dunlin	2435
Dunnock	6
Dusky Warbler	2
Goldcrest	4
Golden Oriole	29
Golden Plover	1
Grasshopper Warbler	133
Great Grey Shrike	16
Great Reed Warbler	61
Great Spotted Cuckoo	1
Green Sandpiper	10
Greenshank	17
Grey Plover	76
Grey Wagtail	40
Hawfinch	44
House Martin	68
Icterine Warbler	2
Jack Snipe	13
Jay	1
Kentish Plover	435
Knot	132
Lapwing	1
Lesser Black-backed Gull	16
Linnet	64
Little Bittern	2
Little Egret	1
Little Grebe	2
Little Owl	79
Little Ringed Plover	12
Little Stint	37
Little Tern	21
Long-eared Owl	3
Long-tailed Tit	7
Madeiran Storm Petrel	2
Marsh Harrier	1
Marsh Warbler	16
Meadow Pipit	216
Montagu's Harrier	1
Moorhen	12
Nightjar	1
Olive-backed Pipit	1
Orphean Warbler	7
Ortolan Bunting	35
Osprey	4
Oystercatcher	1
Paddyfield Warbler	1
Pallid Swift	68
Pectoral Sandpiper	1
Quail	6
Red-cheeked Cordon-bleu	1

Red-breasted Flycatcher	2
Red-legged Partridge	1
Red-necked Nightjar	22
Red-rumped Swallow	1
Redshank	306
Redwing	2
Reed Bunting	37
Ringed Plover	379
Rock Sparrow	1
Rock Thrush	1
Ruff	15
Rufous Bushchat	4
Rustic Bunting	1
Sand Martin	55
Sanderling	3
Sandwich Tern	4
Scaly-breasted Munia	17
Scops Owl	11
Semipalmated Sandpiper	1
Short-toed Eagle	7
Short-toed Lark	58
Short-toed Treecreeper	8
Skylark	24
Snipe	78
Spanish Sparrow	57
Sparrowhawk	1
Spectacled Warbler	5
Spotless Starling	13
Spotted Crake	1
Stone-curlew	8
Swift	109
Swinhoe's Storm Petrel	1
Tawny Pipit	8
Teal	1
Thekla Lark	2
Tree Pipit	31
Tree Sparrow	184
Turnstone	33
Turtle Dove	15
Water Pipit	17
Water Rail	3
Wheatear	49
Whimbrel	35
Whinchat	55
Wood Sandpiper	3
Wood Warbler	1
Woodlark	1
Wryneck	16
Yellow Wagtail	173
Yellow-browed Warbler	8
Yellow-legged Gull	23
Grand Total	**6933**

RINGING CONTROLS AND RECOVERIES REPORTED DURING 2002

Renata Medeiros

The following list refers to birds which were reported from sites other than the original ringing location. This includes two groups of birds: those ringed during the course of Observatory operations in the Algarve and subsequently reported elsewhere; and those which had been ringed elsewhere and were subsequently controlled at Quinta da Rocha or reported to the Observatory. The majority of controls refer to ringed birds which were retrapped during ringing operations. The rest include those whose rings or colour marks were read in the field and ringed birds that were found dead. The recovery circumstances are given.

The following codes are used:

Condition at recovery
X found dead
XF found freshly dead or dying
R caught and released by a ringer
VV rings or colour marks read in the field

Age when ringed
1 nestling
2 fully grown, year of hatching unknown
3 ringed during calendar year of hatching
4 hatched before calendar year of ringing, but exact year of hatching unknown
5 hatched during calendar year prior to ringing
6 hatched before year prior to ringing, but exact year unknown
etc.

Abbreviations used for foreign ringing schemes

BLB	Brussels, Belgium
BRL	British Museum, London, UK
DKC	Copenhagen, Denmark
FRP	Paris, France
NOS	Stavanger, Norway

White Stork *Ciconia ciconia*

CEMPA	1	27.05.1997	Cavaleiro, Beja, **Portugal**	37° 35' N 08° 49' W
MR1518	VV	01.04.1999	Portimão, Faro, Portugal	37° 10' N 08° 31' W
CEMPA	1	27.05.1997	Baía dos Tiros, Faro, **Portugal**	37° 25' N 08° 48' W
MR1521	VV	10.04.1999	Portimão, Faro, Portugal	37° 10' N 08° 31' W

Greater Flamingo *Phoenicopterus ruber*

FRP	1	18.07.2001	Étang de Fangassier,	43° 25' N 04° 38' E
X1836			Bouches-du-Rhône, **France**	
	VV	07.03.2002	Ria de Alvor, Faro, Portugal	37° 08' N 08° 35' W

European Storm-petrel *Hydrobates pelagicus*

N387	6	16.06.1998	Ponta de Almádena, Faro, Portugal	37° 04' N 08° 47' W
	R	25.06.2001	Calf of Man, Isle of Man, **England**	54° 03' N 04° 49' W
N468	6	22.06.1998	Ponta de Almadena, Faro, Portugal	37° 04' N 08° 47' W
	R	27.06.2001	Fladda, Strathclyde Region, **Scotland**	56° 30' N 06° 24' W
N776	6	15.06.1999	Ponta de Almadena, Faro, Portugal	37° 04' N 08 47' W
	R	14.07.2000	Vatsetter, Yell, Shetland, **Scotland**	60° 35' N 01 02' W
N1523	6	21.06.2000	Ponta de Almadena, Faro, Portugal	37° 04' N 08° 47' W
	R	20.07.2001	Eilean nan Ron, Highland Region, **Scotland**	58° 33' N 04° 26' W
N1567	6	18.06.2001	Ponta de Almadena, Faro, Portugal	37° 04' N 08° 47' W
	R	18.06.2001	Eilean nan Ron, Highland Region, **Scotland**	58° 33' N 04° 26' W
N1578	6	19.06.2001	Mexilhoeira Grande, Faro, Portugal	37° 09' N 08° 37' W
	R	31.07.2002	Krakenes Lighthouse, Sogn og Fjordane, **Norway**	62° 02' N 05° 00' E
N1605	6	20.06.2001	Ponta de Almadena, Faro, Portugal	37° 04' N 08° 47' W
	R	17.07.2001	Ulsta, Yell, Shetland, **Scotland**	60° 29' N 01° 10' W
N1798	6	02.07.2002	Ponta de Almadena, Faro, Portugal	37° 04' N 08° 47' W
	R	11.08.2002	Salthovdi, Sandoy, **Denmark**	61° 49' N 06° 52' W
NOS E409685	6	01.08.1999	Krakenes Fyr, Sogn og Fjordane, **Norway**	62° 02' N 05° 00' E
	R	08.06.2002	Ponta de Almadena, Faro, Portugal	37° 04' N 08° 47' W
DKC 9939440	4	18.08.2001	Norda Bordin, **Faeroe Islands**	61° 59' N 06° 38' W
	R	03.07.2002	Ponta de Almadena, Algarve, Portugal	37° 04' N 08° 47' W
NOS 9988999	6	04.08.2001	Skogsoy, Hordaland & Bergen, **Norway**	60° 33' N 04° 48' E
	R	03.07.2002	Ponta de Almadena, Algarve, Portugal	37° 04' N 08° 47' W

Dunlin *Calidris alpina*

D8050	6	11.05.1990	Ria de Alvor, Faro, Portugal	37° 08' N 08° 35' W
	R	22.08.1990	Bouin, Vendée, **France**	46° 58' N 01° 59' W

Pied Wagtail *Motacilla alba alba*

BLB 42V42517	3	01.10.2000	Oud Turnhout, Antwerpen (Anvers), **Belgium**	51° 19' N 04° 59' E
	X	15.02.2002	Budens, Faro, Portugal	37° 05' N 08° 49' W

Robin *Erithacus rubecula*

DKC	3	27.08.2000	Christiansø, Bornholm, **Denmark**	55° 19' N 15° 12' E
9L24380	XF	03.12.2001	Budens, Faro, Portugal	37° 05' N 08° 49' W

Spotted Flycatcher *Muscicapa striata*

BRL	1	08.07.1997	Suffolk, **England**	?
K806450	X	17.09.2000	Boliqueime, Faro, Portugal	37° 07' N 08° 10' W

Chaffinch *Fringilla coelebs*

A186201	3	30.07.2001	Lagoa de Santo André, Setúbal, **Portugal**	38° 05' N 08° 47' W
	R	28.02.2002	Mexilhoeira Grande, Faro, Portugal	37° 09' N 08° 37' W

STORM-PETREL RINGING IN 2002

Rob Thomas

A Rocha's Storm-petrel ringing project is in its thirteenth year. This long-term monitoring project now provides a unique and valuable window into the mysterious lives of these tiny ocean-going seabirds.

Despite weighing an average of only 27 g (about the weight of a sparrow), European Storm-petrels *Hydrobates pelagicus* spend almost all of their lives far out at sea, coming ashore only to breed on remote Atlantic islands. Most European Storm-petrels are ringed near their breeding colonies in north-west Europe. A Rocha's dataset is unique in that these storm-petrels are caught hundreds of miles away from their colonies, while they are migrating northwards in early summer, past the coast of southern Portugal. Our monitoring project therefore provides an unusual opportunity to examine the biology of a highly pelagic seabird outside the breeding season and away from the breeding colonies, and has already provided a valuable contribution to our understanding of the biology of this species. Papers drawing on the A Rocha data include Harris *et al*. (1993), Fowler & Hounsome (1998), Bolton & Thomas (2001) and Wernham *et al*. (2003).

At the end of the breeding season, European Storm-petrels set off on a very long-distance migration, from their breeding grounds in the North Atlantic, to the seas off Namibia and South Africa, some even rounding the Cape to reach the Indian Ocean. Adults make this return journey each year, and since they can live for at least 30 years, the total distances covered are astonishing. In contrast, fledglings leave their nests and migrate to the South Atlantic, and most remain there for two to three years. For example, only 3-4% of European Storm-petrels caught in Portugal are under one year old (Bolton & Thomas, 2001). On their first few return trips to the North Atlantic, the young birds do not breed, but wander widely, visiting different colonies and checking out potential nest burrows and mates for future years. It is mainly these 'wandering pre-breeders' that we catch using tape lures at night on the Portuguese coast (Harris *et al*., 1993; Fowler & Hounsome, 1998). The storm-petrels begin to breed when they are 3-5 years old, whereupon they become less attracted to our tape-lures.

A substantial number (approximately 8%) of the storm-petrels that we catch in Portugal are already bearing a ring, or are subsequently recaptured in north-west Europe. These recaptures are helping to build up a picture of storm-petrel movements around the North Atlantic. One striking feature of these movements is that the northward migration can be surprisingly rapid, with individuals covering up to 200 km per day over many days. Patterns of movements between Portugal and different locations to the north indicate that the wanderings of pre-breeders may not be simply random as was previously believed.

Rob Thomas

Much research activity is currently directed towards understanding how the natural world is likely to be affected by climate change. But this is a difficult task, as both climate and ecosystems are very complex. One of the great benefits of long-term datasets such as A Rocha's bird-ringing database (of which the storm-petrel dataset is just a fraction) is that they can be used to investigate how birds have been affected by environmental changes in the past. These studies can in turn give us insights into how future changes (eg climate warming) may affect individual birds and entire populations.

For example, the storm-petrels tape-lured as they migrate rapidly northwards past southern Portugal vary greatly in body mass between years. Rather than varying erratically between years, these body mass changes have followed a remarkably smooth oscillation over the past 13 years. The degree of variation is equivalent to about 12% of the average total body weight, and thus represents a very big variation in the level of stored energy reserves (mainly fat) carried by these migrating birds. The puzzle is why should body reserves vary so much between years? It turns out that the level of body reserves carried in each year is strongly associated with the temperature of the ocean off southern Portugal. However, the link between ocean and migration behaviour is not direct, as the association is strongest with sea temperatures in the months *before* storm-petrels are actually passing Portugal! In other words, something seems to be happening in the sea that affects how storm-petrels behave a few months later. An obvious possibility is that sea temperatures earlier in the year influence the petrels' food supply, and current research is focussing on how the abundance of marine life in early summer may be affected by differences in climate and sea conditions between years.

In 2002, 229 storm-petrels were caught, bringing the grand total to 2910. This year, their average weight was the lightest since the project began in 1990. Sea temperatures were correspondingly high. The main personnel involved this year were Marcial Felgueiras, Dave Kelly, Isabel Gough and myself, and we enjoyed the company of many other staff and visitors on different nights.

We continued to collect data on the high rate of physical handicaps in these seabirds. Usually, disabled birds are rarely encountered in the wild, presumably because disabled birds are less likely to survive. But storm-petrels are unusual in that the incidence of one type of disability, leg-loss, is relatively common. Up to 7% of surviving individuals in the population may have lost all or part of a leg, and our study is investigating the causes and consequences of this physical handicap.

Despite some confident predictions, no Swinhoe's Storm-petrels *Oceanodrama monorhis* or Madeiran Storm-petrels *Oceonodrama castro* were ringed this year. However, three Cory's Shearwaters *Calonectris diomedea* were mist-netted – the first caught and ringed by A Rocha since 1995. Another major storm-petrel field season is planned for June 2003 – so watch this space!

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TAXONOMIC DIFFERENTIATION AND DISTRIBUTION STATUS OF CAMPHOR THYME *THYMUS CAMPHORATUS* IN THE WESTERN ALGARVE

Will Simonson

Introduction

The genus *Thymus* (thymes) is represented by 66 species in Europe (Tutin *et al*., 1972), 11 species of which are recorded for Portugal (Franco, 1984). Of these, four species are endemic to the Iberian peninsula, and four species endemic to Portugal. Amongst these endemics, *Thymus capitellatus, T. camphoratus, T. carnosus* and *T. zygis* are closely related as members of Section Thymus of the genus.

Table 1 Thymus species in Portugal.

Species	Distribution	Algarve distribution
T. capitatus Hoffmanns. & Link	Med region	Barrocal
T. mastichina L.	Portugal & Spain	Barrocal & Barlavento
T. tomentosus Willd	Portugal & Spain	Sotavento
T. caespititius Brot.	Portugal, Spain & Açores	-
T. cephalotus L.	Portugal	Barrocal & Sotavento
T. villosus L.	Portugal & Spain	-
T. capitellatus Hoffmanns. & Link	Portugal	
T. camphoratus Hoffmanns. & Link	Portugal	West coast
T. carnosus L.	Portugal	Barlavento & Sotavento
T. zygis L.	Portugal & Spain	-
T. pulegioides L.	Europe	-

Six thyme species are known in the Algarve region. Within A Rocha's programme of botanical surveys, *Thymus cephalotus* was discovered at three sandstone heathland sites – Algoz, Tunes and Porches (Simonson, 1993), and *Thymus camphoratus* at Quinta da Rocha (Simonson, 1992) and three Barrocal sites – Zavial, Barão de São João and Bensafrim (Jackson & Simonson, 1993). Both thymes are priority Annex 2 species under the European Community Habitats Directive, and the Alvor Estuary, including Quinta da Rocha, is a proposed Natura 2000 protected area on the basis of *T. camphoratus* and other priorities.

Identification of *Thymus camphoratus* at Quinta da Rocha

The Camphor Thyme *Thymus camphoratus* is described as a much-branched, dwarf rounded shrub to 40 cm, with narrow ovate (egg-shaped) leaves and terminal, globular flower heads of pink or violet flowers, provided with wide, reddish bracts (Afonso & McMurtie, 1991; Polunin & Smythies, 1988). Species of Section Thymus are characterised by leaves with a prominent mid-vein, revolute (downward turned) margins and tomentose (densely short-hairy) lower surfaces (Tutin *et al*., 1972). The calyx is more or less campanulate (bell-shaped). *Thymus camphoratus* is distinguished from the closely related *T. carnosus* by the hairiness of the former's upper leaf surfaces, and from *T. capitellatus* by the diameter of the inflorescence, length of the calyces, and the fact that the upper calyx teeth of the Camphor Thyme are usually ciliate (with hairs projecting from the margins) (Tutin *et al*., 1972; Franco, 1984). These and other distinguishing features identified by Coutinho (1939) are summarised in Appendix 1.

The same features were observed on 23 February 2003 for *Thymus* populations at three Barrocal locations for *T. camphoratus* given by Santo (1989): Boca do Rio (on scarp slope overlooking the

Ribeira de Vale Barão), Praia de Zavial (on the clifftop to the east of the beach) and Cabo de São Vicente. In addition, the Quinta da Rocha populations were studied on 19 February and 10 May 2002. The measurements are summarised in the final column of the table in Appendix 1.

Study of the three western Barrocal populations suggested that ciliation of the upper calyx teeth was not a reliable character for identifying the species, at least towards the east of the species' range, with specimens of the Boca do Rio population showing short ciliation if any. The Quinta da Rocha plants also did not show this character consistently. The leaf shape of the Barrocal populations was also variable, and at Praia de Zavial the leaves of plants in exposed conditions were strongly revolute and therefore narrow, and those in the shade of large bushes were much less flat, and therefore broader.

Comparison of thyme plants from Quinta da Rocha with specimens of *T. camphoratus*, *T capitellatus* and *T. carnosus* at the herbarium of the University of Lisbon botanic gardens (LISU) on 26 February 2002, confirmed their identification as *Thymus camphoratus*. It was most clearly distinguished from *T. carnosus* by leaf characters, with the latter species having ovate (rather than ovate-lanceolate) leaves which were definitely ciliate at the base, and fleshy in character. They were also obviously glandular-spotted, a trait that was less distinct, if present at all, in the leaves of the other two species. *Thymus capitellatus* was notable for its compound rather than terminal inflorescences. The leaves also seemed less lanceolate, and more tomentose on the upper surface, than those of the *T. camphoratus* specimens in the collection, although the consistency of these differences needs further investigation. Some *T. capitellatus* specimens showed reddish bracts, a feature more identified with *T. camphoratus*.

Status of the Quinta da Rocha population

Study of the sources of the LISU herbarium specimens was made in the hope that it would shed further light on known distributions of the three species. The results are shown in Table 2 and Figure 1, but are inconclusive, especially given the average age of the collections.

Table 2 Thymus specimens of LISU.

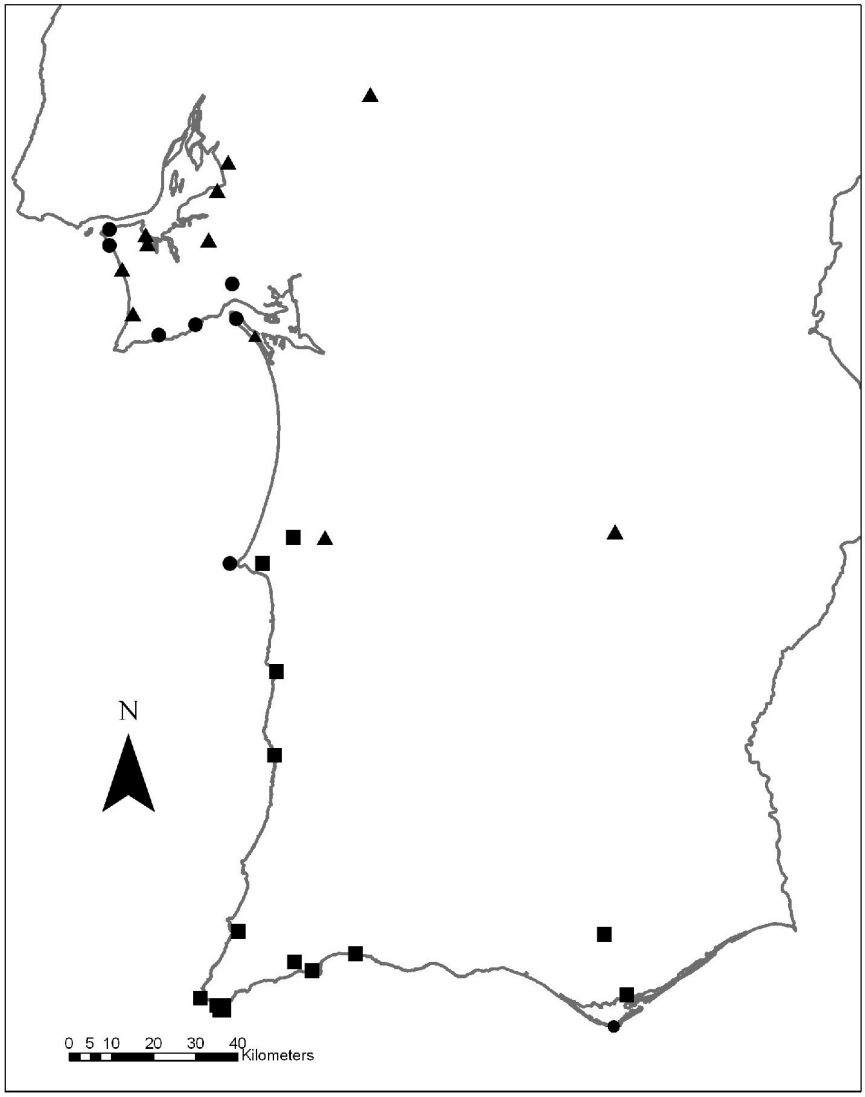
Species	Location	No of specimens	Date range
Thymus carnosus	Lisboa, Trafaria	1	1878
	Praia da Costa da Caparica	1	1882
	Serra da Arrabida	10	1852-1901
	Sesimbra	1	1972
	Tróia Peninsula	3	1840-1913
	Palmela	1	1880
	Sines	3	1936-1979
	Cabo de Santa Maria (Faro)	2	1883
Thymus carnosus X *mastichina R*ouy	Serra da Arrábida	1	1840
Thymus capitellatus	Beja	1	?
	Charneca da Caparica	1	?
	Troia peninsula	1	?
	Between Azoia and Lagoa de Albufeira	1	?
	Alfeite	1	?
	Vendiza-Seixal	1	1991
	Coruche	1	?
	Santiago de Cacém	3	?
	Pancas	1	?
	Alcochete	1	?
	Moita	1	?
	Lagoa da Sancha (Sines)		?
Thymus camphoratus	Santiago do Cacém	1	1978
	Sines – Ribeiro dos Alfoinhos	1	1926
	Vila Nova de Milfontes	1	1848

	Zambujeira (Odemira)	1	1917
	Carrapateira	1	1886
	Cape St Vincent	3	1906-1931
	Sagres	2	1887-89
	Espiche	1	1881
	Lagos, Valle da Luz	1	1881
	Portimão	2	1847
	Olhão	1	1883
	S. Brás de Alportel	1	1953

The specimens of *Thymus carnosus* were almost all from the peninsula of Setúbal, and the Alentejo coast. The one exception was a specimen from near Faro. Franco (1984) records a distribution that includes the Barlavento and Sotavento regions of the Algarve.

Thymus capitellatus is an essentially western Portuguese species, and does not extend to the Algarve according to Franco (1984). The specimens from LISU accord with such a distribution.

Figure 1 Distribution of *Thymus carnosus* (●), *T. capitellatus* (▲) and *T. camphoratus* (■), from LISU herbarium specimens.



Most specimens of Camphor Thyme had been collected from the Alentejo coast and western Algarve coast, extending round to Lagos. Of particular interest were two specimens taken from Portimão, as

well as one from Olhão and one from São Bras de Alportel. The species is not reported to occur in the Barlavento or Sotavento regions of the Algarve represented by these three localities (Franco, 1984). The Portimão specimens may refer to the hybrid *T. camphoratus* x *mastichina* P. Cout, described as 'very rare' and apparently restricted to the Portimão area, by Coutinho (1939).

With the eastern-most population found documented by the author being at Praia da Dona Ana, near Lagos (Mabberley & Placito, 1993), the question arises: exactly how far east does the current distribution of *Thymus camphoratus* extend?

The historical localities of Olhão and S. Brás de Alportel were not visited, but instead a search made of coastal clifftop scrubland areas between the Alvor Estuary and Carvoeiro, including Portimão, in May and June of 2002. Promising habitat was present near Prainha on an otherwise developed stretch of coast between Alvor and Praia da Rocha, but no thymes were found here. Similar habitat between Ponta do Altar and Carvoeiro did however hold significant populations of *Thymus capitatus*, apparently occupying a similar niche as a dwarf shrub in the scrubland matrix. No Camphor Thyme was recorded.

Conclusions

Camphor Thyme *Thymus camphoratus* has been positively identified at Quinta da Rocha, being distinguished from closely related species. Whilst not rare along the south west coast of the Algarve, its significance lies in being a Portuguese endemic species which is offered protection as an Annex 2 species of the European Habitats Directive. The population at the Alvor Estuary may also represent the eastern limit of its current distribution: excepting historical (19th century) records, the current study did not turn up any populations further east along the coast. Further research on the distribution, including the study of the sources of specimens held in other herbaria, is recommended, as well as investigation of the hybrid species recorded for Portimão.

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Appendix 1 Characteristics of *Thymus carnosus*, *capitellatus* and *camphoratus* (as described by Tutin *et al*. (1972) and Franco (1984)), and Algarve populations

	Thymus carnosus	***T. capitellatus***	***T. camphoratus***	**Quinta da Rocha population**	**Boca do Rio, Zavial and Cape St Vincent populations**
Leaf indumentum	Glabrous above, tomentose underneath, ciliate at base, markedly glandular-spotted	Tomentose on upper and lower surfaces	Tomentose on upper and lower surfaces	Upper surface less densely tomentose than lower surface	Upper surface less densely tomentose than lower surface
Leaf size and shape	5-7x1-2 mm, petiolate, ovate-lanceolate or ovate (LISU), fleshy	3-5x1-1.5, petiolate, narrowly ovate	3-5x1-1.5, petiolate, narrowly ovate	3-5(-7)x1-2.5(-3) mm, petiolate (1 mm) ovate-lanceolate	3-5(-7)x1.5-3-5(-5), petiolate (1-2 mm), ovate-lanceolate
Inflorescence	Elongate to >1 cm (LISU)	Compound of pedunculate cymes 6-8 mm	Terminal, 10-18 mm	Terminal, 10-20 mm (average of 12 measurements = 15.5)	Not measured
Calyx length	3-4 mm	3-4 mm	4-6 mm	4.5-5 mm	4-5 mm
Upper calyx teeth	As long as wide, not ciliate, middle tooth slightly larger	As long as wide, not ciliate, sub-equal	Triangular-subulate, usually ciliate, middle tooth obviously larger	Triangular-subulate, longer than wide, variably ciliate, middle tooth large than outer	More or less obviously ciliate
Bracts	Ovate, green	Sparsely tomentose, usually green, some (LISU) reddish	Tomentose, usually reddish	Densely tomentose, inner tinged with red	Not observed

THE ABUNDANCE STATUS OF CAMPHOR THYME *THYMUS CAMPHORATUS* ON QUINTA DA ROCHA

Richard Gunton

Introduction

The study by Simonson (2003) (previous article) showed that at Quinta da Rocha the Camphor Thyme *Thymus camphoratus* may be at or near the eastern limit of its range. Given the isolated nature of this particular population, its future survival cannot be taken for granted, and will depend on healthy population dynamics. A survey was therefore undertaken in order to:

1. determine the size of the population currently present on Quinta da Rocha;
2. map the distribution of the species within this study area; and
3. provide baseline data to which to relate the results of future studies and thus assess the dynamics of the population.

Methods

The survey was carried out between 2 and 25 July 2002. The plants had finished flowering but still bore seed heads and were easily recognisable on the ground.

Using a 1:2000 scale map of the Quinta da Rocha headland area, initial reconnaissance work was done to plot the location and extent of separate colonies of *Thymus camphoratus*, and to adjust the map where it did not agree with features found on the ground.

The local population of each colony was then assessed in turn, according to two parameters: number of individual plants and the area of ground covered by this species. The colonies were divided into 'zones' for ease of counting. In smaller and less densely-populated zones it was possible to count every plant and estimate its cover, whereas in larger and more densely-populated zones a sampling and extrapolation procedure was used.

Figure 1 is intended to give an idea of what was recognised as a 'single plant' when counts were made. Estimates are likely to be on the low side, as it would have been very laborious to attempt to work out whether close-knit clumps comprised several individual plants or not, and for the large zones where the sampling method was used, effort had to be partitioned between accuracy and using large enough sample sizes.

Cover was estimated by eye in units of 10 cm x10 cm, using an object 10 cm long as a guide.

The extrapolation technique used for estimating the sub-populations of larger areas was as follows. Boundaries to a zone, or to portions of a zone with fairly even *T. camphoratus* cover, were decided on, so that all plants were contained within these boundaries. Quadrats of 1 m^2 were then placed over the vegetation, at positions obtained by following a 'random walk' back and forth between boundaries, until at least 10 quadrats had been assessed. Quadrats were assessed by counting number of plants and estimating percentage ground cover within the quadrat. The total population size and cover of a zone could then be estimated by multiplying the mean number and percentage cover per quadrat by the area of the zone, which was derived from the map.

In a few zones a combination of the sampling and census techniques was used: after part of the zone had been censused, the proportion of the total area of the zone that remained was estimated and this figure was used to extrapolate from the census figures to an estimate for the whole area of the zone.

Figure 1 Indication of how individual plants were counted.

It was also important to have some estimate of accuracy, in terms of repeatability. Time prohibited a thorough check, but in part of one zone the census was carried out by two observers independently and in two other zones the census of number of plants was wholly or partially repeated (by the same observer) 11 days after the first count.

Results

The total population size was estimated as almost 13,000 plants, and the cover area as 110 m^2. The population fell very naturally into five discrete colonies, which were mapped (for confidentiality reasons, this is not included in this published report). The estimated sub-population totals for the five colonies are shown in Table 1, with a further breakdown of data given in Table 2.

Table 1 Estimated population sizes of *Thymus camphoratus* by colony, and total population size.

Colony	No. of plants	Cover (m^2)
1	8364	74.90
2	514	2.73
3	1257	12.83
4	1649	10.45
5	952	8.44
Total	**12736**	**109.35**

Table 2 Population data by sub-zones.

Zone	No. of plants	Plants not flowered		Cover (m^2)
		No.	%	
1.1	7474			48.48
1.2	390			5.72
1.3	500			20.70
1.4	?			?
2.1	54	4	7	0.50
2.2	109	11	10	0.31
2.3	250	71	28	0.88
2.4	62			0.87
2.5	39	5	13	0.17
3.1	851			7.98
3.2	188			3.35
3.3	218	33	15	1.50
4.1	78			0.72
4.2	1091			7.29
4.3	342			1.46
4.4	21			0.26
4.5	117	4	3	0.72
5.1	453			4.17
5.2	322	24	7	2.73

5.3	36			0.60
5.4	141	15	11	0.94
Total	**12736**			**109.35**

Assessment of accuracy
The assessment of the accuracy of the method can be summarised as follows:

1) Repeated census of part of zone 3.2 by two observers:
   Observer 1: 55 plants/ 0.61 m^2 cover
   Observer 2: 53 plants/ 0.68 m^2 cover
   differences: 4% / 11% (good)

2) Repeat count of part of zone 2.4:
   6 July: 62 plants
   25 July: 105 plants
   difference: +52% (poor)

- Repeat count of part of zone 2.1:
  6 July: 54 plants
  25 July: 47 plants
  difference: -14% (fair)

Will Simonson

Discussion

Evaluation
Large potential for subjectivity in determining population sizes was evident throughout the survey, but especially when numbers of plants were being assessed. This was because of difficulty in deciding whether closely-growing stems belonged to the same individual or to neighbours, and sometimes because impenetrable vegetation around the plants prevented close-enough inspection. The figures for cover are therefore a more reliable and consistent guide than those for number of plants.

The sampling and extrapolation technique was always used in zones with large local populations and it provided figures that contribute nearly 80% of the total population estimate. Accuracy could therefore be improved considerably by revisiting these zones and using more quadrats and subdividing zones into more areas of more constant population density.

Despite the care taken over consistency within this survey, there could be various sources of error if the results were compared with those from an independent survey of another site. Some factors to consider are listed below:

- care taken to separate individual plants; definition of 'individual plants'
- assessment and definition of cover
- habitat characteristics (size and clustering of plants; accessibility/visibility of plants)
- misidentification and overlooking (linked to phenology, weather conditions, observer's experience)
- sampling with extrapolation (location of quadrats, inhomogeneity of distribution, estimation of areas)

Any repeat survey of the Quinta da Rocha population in the near future by a different researcher would be enormously useful in giving an idea of the level of accuracy that can be attributed to the results.

Ecology

Regardless of these difficulties, it appears that the population of *Thymus camphoratus* on the Quinta da Rocha headland is thriving. Plants were observed at a range of sizes from small, single-stemmed, presumably young individuals that appeared not to have flowered to clumps of up to 500 cm^2 with prolific flower heads; there were plants surrounded by bare ground and plants growing amid low shrubby vegetation such as *Cistus* species, and even a few under the shady margins of Mastic Tree *Pistachia lentiscus*.

The reasons for the patchy distribution are not clear, and the existence of discrete colonies into which the population could be divided is intriguing. Given that there did not appear to be a shortage of other suitable sites, this distribution pattern may indicate limitation of recruitment by seed supply. It could be that the species is obligately colonial and cannot establish new colonies except in special conditions. This might be related to its strongly aromatic nature or to the small size of the individual infloresences with regard to attracting pollinators. Plants do appear to be capable of reproducing or at least spreading vegetatively by rhizomes, as one or two were unearthed during inspection, so seed dispersal may be unimportant in most conditions.

So far as a correlation with habitat type could be recognised, the plants appear to flourish in areas exposed to the south and where surrounding vegetation does not shade them out. Alongside worn paths there were frequently higher population densities than nearby. However, the species was by no means restricted to the completely exposed and eroded sites where some colonies occurred.

Perhaps biotic associations and interactions must be invoked to explain the patchiness of the distribution. A species that sometimes seemed to replace *T. camphoratus* beyond the boundaries of colonies was the Aromatic Inula *Dittrichia viscosa* ssp. *revoluta*. If the distribution of Camphor Thyme cannot be explained either by limitation of seed dispersal or by physical habitat characteristics, interactions with other species may be responsible. Colonies of the thyme and other species (such as the inula) could be resistant to invasion by each other and self-perpetuating. Alternatively, there could be 'non-equilibrium' coexistence of species, with slow competitive exclusion going on. This does not entail eventual extinction of any species, because fluctuating conditions over time could favour different competing species in turn, or colonies of a species could always be susceptible to invasion by other species (Chesson & Case, 1986; Schmida & Ellner, 1984). Most likely, a combination of these factors is involved.

Future work

In order to establish a monitoring programme for this population of *Thymus camphoratus*, some permanent plots for future surveys of a more focused nature than this one should be established. Zones particularly suitable for this might include the following:

2.4: a small, well-defined, easily-accessible path-edge habitat
3.3 (or part thereof): a relatively small colony in taller, dense vegetation
4.5: a small cluster of plants on fairly open ground with apparently little competition from other species
5.2: a site where plants are distributed along a gradient from exposed outcrop to shaded margins of shrubby vegetation

To allow quantitative assessment of the dynamics of colonies, the best approach might be to tag all the plants in a limited area so that they can be recognised on future visits. Growth and disappearance of plants and appearance of new ones between them could then be noted over a number of years.

Zone 1.1 might also be suitable for a simple survey by photographing the colony when the plants are in flower, from the same point in successive years. Being on a slope, this site allows a good view of the plants, so that the area covered by them could be estimated from one season to the next.

Further study of the ecology of *T. camphoratus* is also necessary in order to be able to develop a management regime for its protection at this and other sites. In particular, the habitat requirements and regeneration mechanisms of the species need characterising, for the communities in which it occurs. Reproductive biology could be investigated by testing seed germination, and if plants can be grown in pots or trial plots, their competitive relations and the conditions required for viable seed production can then be investigated.

Reviewing what is known about the ecology of more familiar *Thymus* species could also throw light on the ecology of Camphor Thyme.

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VEGETATION DYNAMICS ON THE ALVOR SAND DUNES

Richard Gunton

Introduction

In the early 1990s, sediment dredged from the Alvor estuary was deposited on the Alvor and Meia Praia sand dune spits, obliterating large areas of natural vegetation. Further disturbance to the dunes was caused by the creation of access roads along the spits for the heavy vehicles being used in the construction of breakwaters at the mouth of the estuary. Subsequent operations have removed much of the dredged sediment from the site. This has left a mosaic of habitat types on the Alvor Dunes. On the seaward side of the track that runs along the spit, natural, undulating, mature dunes remain, since sediment was only deposited on the landward (north) side. At the time of the survey a flat-topped pile of deposited sediment remained towards the eastern end. Flanking it were areas from which sediment had been removed at various times and to different depths, and further west there were natural dunes again. At the far western end of the spit is an area where not only dredged sediment but also some of the original substrate has been removed, creating an artificially low profile to this section. This area is only very sparsely vegetated, but the rest of the dune area is well covered in vegetation.

The Alvor Dunes provides a useful opportunity to study the dynamics and direction of succession in a stressful habitat, since the areas left bare by sediment-dumping or excavation have been gradually colonised by vegetation. A greater understanding of the vegetation dynamics is also of relevance to future sand dune restoration measures and the management of breeding habitat for water birds such as Kentish Plovers and Little Terns. A study by Hall (1996) found marked differences in vegetation composition between the sand pile (dredged sediments, rich in shell fragments) and natural dune areas. Nearly ten years on from the original dredging operation, it is difficult to tell at first sight whether some areas are pristine or secondary. The purpose of this present study was to determine the current status of the vegetation and to assess the long-term damage to plant communities that has been caused. Ongoing monitoring of the site should provide a clearer picture of what is going on.

For this study I sampled the vegetation of plots located in three different representative habitats: sand pile, excavated sand pile (ie areas where the original dunes had been buried and then uncovered) and natural, mature dunes.

Methods

The plots studied are shown in Figure 1, with the exact location described in Appendix 1. The methods were based on those of Hall (1996). Quadrats of 1 m^2 were placed at random positions across the plots being studied. This was carried out by using random XY coordinates and counting paces across the plot. A compass sometimes helped to ensure that pacing was done in the correct direction. Where the location turned out to be on a path or track, such that the quadrat would have contained extensive bare ground, another location was substituted for it.

For each quadrat, all of the species found within were recorded to allow estimation of the frequency of occurrence of different species across each plot. Species represented by any part of a plant that occurred within the quadrats were recorded as present, subject to their being recognisable (hence where only the woody remains of a plant were present, they were ignored). Where a species could not be identified, a sample was taken away for identification off-site. In addition, the maximum height of the vegetation within each quadrat was measured (the highest piece of vegetation above the quadrat regardless of whether the plant it belonged to was rooted within the quadrat). The level of ground cover was also assessed on a 4-point scale, from ‘completely covered’ (no bare ground visible), through ‘almost covered’ (small patches of bare ground) and ‘mostly covered’ (obvious patches of

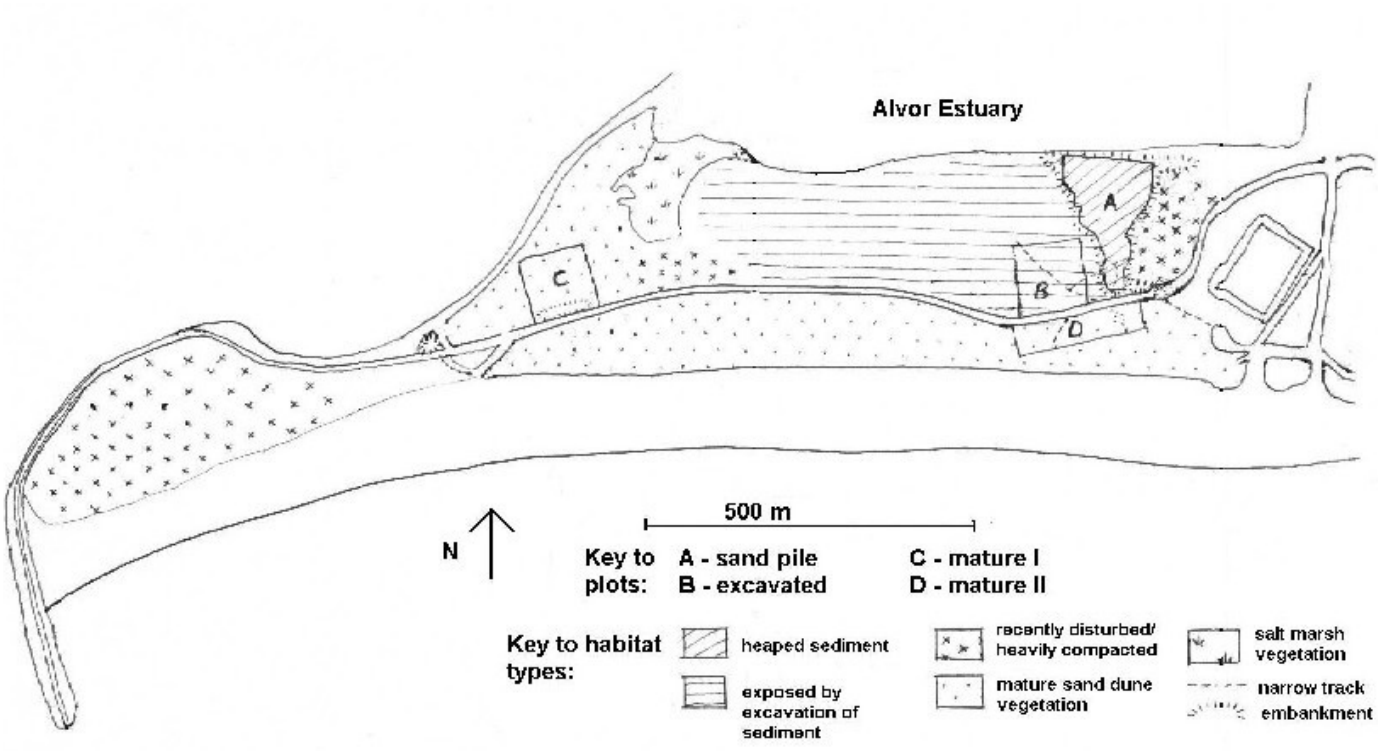
bare ground but none >15cm diameter) to 'patchy' (with patch/es of bare ground >15cm diameter). This work was carried out between 11 and 18 July 2002.

There was a single sand pile left on the Alvor Dunes, about 15 m high, which was mapped to establish its shape, dimensions and the approximate boundaries of different vegetation types on it. The whole sand pile was taken as one study plot and, when its total area was found to be about 10,000 m^2, it was decided to use equivalent areas for each of the other study plots. This was to facilitate comparisons between plots. The other habitat types were more extensive and allowed regular rectangular plots to be demarcated for study within them. There did not appear to be any significant edge effects on the vegetation of the sand pile. The location of the four study plots is shown in Figure 1.

Hall (1996) used 100 quadrats within each habitat type she studied. This procedure was applied to the sand pile, but for the other habitats some deviation was thought justifiable. 50 quadrats were used in each of two plots in the mature dunes habitat ('mature I' and 'mature II'); thus 100 quadrats were allocated to the mature dune habitat in total while at the same time there was replication. This was to facilitate inference of any real differences between generic 'sand pile' and 'mature' habitats. In the area where heaped sand had previously been excavated, only 50 quadrats altogether were used, owing both to lack of time and to a suspicion that this might be sufficient to make useful inferences.

Of the mature plots, one was at a similar distance from the sea as the sand pile but further west (mature I); the other (mature II) was close to the sand pile but nearer the sea (Figure 1). Neither plot included the embryo or shifting dunes found towards the high water level, since this zonation did not impinge on the sand pile or excavated areas, with which comparison was being made.

Figure 1 The Alvor Dunes, showing location of study plots.



Analysis

A table was constructed to show presence/absence of each species in each quadrat. The quadrats were grouped according to the plots they came from and the frequency of each species in each plot could then be calculated and expressed as a percentage. Mean values for maximum vegetation height in quadrats and median cover-score values were also calculated for each plot. Diversity values (to give an idea of diversity among quadrats in each plot) were calculated using Simpson's diversity index. This is calculated as follows:

$$I_S = \sum_{i=1}^{s} [n_i(n_i-1)] / N(N-1)$$

where n_i = frequency (%) of the *i*th species, and N = sum of frequencies (%) for all *s* species

and can take values ≥ 1.

To facilitate comparison between plots using the data for all species simultaneously, a multivariate analysis was required. Bray & Curtis ordination was applied, first to species frequency data for the four plots and then to frequency data for sub-plots. Sub-plots were defined by arbitrarily dividing each plot into contiguous areas of similar size, taking account of any habitat zonation observed on the ground as well as any clustering of quadrats. To allow these conditions to be better met, each sub-plot could contain between 9 and 11 quadrats. The sand pile plot (which covered twice the area of each of the other plots) was divided into 10 sub-plots and each of the others into 5, giving 25 sub-plots in total. Using sub-plots allowed use of the ordination procedure to give an idea of the differences between plots with respect to the variability of habitat within each plot.

Results

There were some obvious differences between plots in terms of physiognomy of the vegetation. The mature plots contrasted with the sand pile in having much more bare ground in between plants. Plants on the sand pile were typically shorter than on any of the other plots and here there were also distinct zones where different species predominated (e.g. *Medicago spp.* / *Dittrychia viscosa* / *Lotus creticus*). (These zones were taken into account when dividing the plot into sub-plots.) The other plots had more homogeneous vegetation at a large scale.

Table 1 shows frequencies of the most common species across the four plots, together with some basic statistics that summarise the diversity and physiognomy of the vegetation. Figure 2 shows the Bray & Curtis ordination graph for the 25 sub-plots.

Discussion

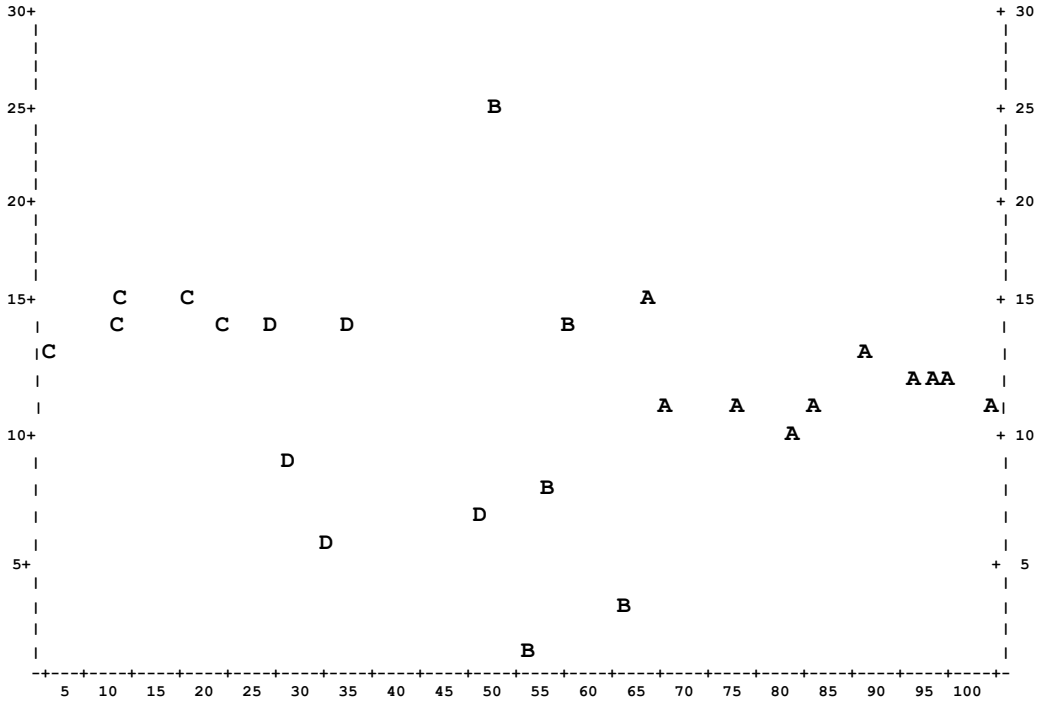
There are distinct differences between all four plots. The ordination graph suggests that there is more diversity among the separate plots than within any one of them, since the points representing sub-plots can be grouped by plot into non-overlapping regions on the graph. This could be an artefact of the way that plots were divided into sub-plots, since this division was superimposed *a posteriori* on a random distribution of quadrats. With hindsight, a better sampling strategy could have been to divide each plot into sub-plots of equal area before deciding where to place quadrats (in effect stratified sampling). However, this would have been a deviation from the methods of Hall (1995). As it was, the plots were divided into sub-plots in a way that attempted to observe natural gradients on the ground and spatial autocorrelation of quadrats. It therefore seems reasonable to conclude that the four plots were as distinct from each other as is implied by the clustering of sub-plots on the ordination graph.

Table 1 Frequency of occurrence of the 28 most common species, across all four sites.

	% occurrence of species			
Species	**sand pile**	**excavated**	**mature I**	**mature II**
Vulpia alopecurus	61	86	92	98
Silene obtusifolia	9	56	76	88
Ononis natrix	5	64	76	60
Malcomia littoralis	51	28	34	68
Hedypnois arenaria	42	60	10	60
Polycarpon alsinifolium	36	18	16	68
Plantago lagopus	42	56	4	22
Lotus creticus	93	6	4	14
Erodium cicutarium	9	44	2	46
Reichardia gladitana	26	38	12	24
Crucianella maritima	0	2	30	64
Paronychia argentea	22	2	56	12
Anagallis arvensis	11	54	2	16
Cyperus capitatus	0	4	32	44
Plantago coronopus	32	42	2	4
Silene nicaeensis	38	12	16	12
Crepis vesicaria	25	2	30	12
Pycnocomon rutifolium	0	0	56	10
Medicago spp	50	0	2	12
Puccinellia maritima	8	46	2	2
Piptatherum miliaceum	24	20	0	2
Ammophila arenaria	0	2	30	12
Avena barbata	0	32	0	8
Bellarida trixago	15	20	0	4
Artemisia campestre	2	2	8	22
Dittrichia viscosa	28	6	0	0
Urospermum picroides	3	24	0	2
Trifolium campestre	3	18	2	0
Total number of species found	**37**	**41**	**29**	**29**
Diversity (I_S)	**15.6**	**19.9**	**11.7**	**14.6**
Mean vegetation height (cm)	**38**	**53**	**92**	**42**
Cover (median)	**3**	**1**	**2**	**2**

The fact that two of the plots (mature I and mature II) represent undisturbed habitat and the other two represent disturbed habitats provides another way of assessing whether there are real differences between different habitat types on the Alvor Dunes. The proximity of the sub-plots representing the mature plots on the ordination graph, with the sub-plots from the disturbed plots (sand pile and excavated) on the other side of the graph, suggests that disturbance does have an effect that stands out from random variation between different areas of the dunes. The fact that the two mature plots were well separated from each other spatially, and were chosen to represent differing proximity both to the sea and to the two excavated plots, reinforces the conclusion that generic ‘mature’ dune habitat differs significantly from ‘disturbed’ habitats.

Figure 2 Bray & Curtis ordination graph of all 25 sub-plots. Letters A - D indicate membership of main plots: A = sand pile, B = excavated, C = mature I, D = mature II.



Besides the ordination graph, the statistics for species number, diversity, mean vegetation height and median level of cover provide additional information on the relationships between plots. The mature plots show similar values for most of these statistics; their diversity index and species number are both lower than those of either of the disturbed plots. Median cover is the same for both mature plots, but, intriguingly, it is higher for the sand pile and lower for the excavated plot. Some of these differences might be due to differing levels of stress for plant growth. The sand pile is presumably the most fertile (and least stressed) plot, since the substrate here had come from the bed of the estuary. The mature plots should have very low fertility, because nutrient input has always been low and there is high potential for nutrient loss through leaching and loss of biomass – hence they will constitute a stressful habitat. The excavated plot might be expected to have moderately high fertility, since leachates from the dredged material that was removed would have permeated into the layers of substrate that were left. However, the substrate may have been highly compacted by mechanical operations and this could make it a stressful habitat for plant growth, perhaps explaining its low level of ground cover. Differences could also be due to the length of time that has elapsed since significant disturbance last occurred.

The fact that higher species numbers and diversity were found on the two disturbed plots, which were (presumably) more fertile, is interesting. This probably reflects how low the overall fertility of sand-dune habitats is, since species need to be somewhat specialised in order to survive on nutrient-poor sand. It is also to be explained by reference to the actual species found on the two disturbed plots. These are notably biased towards weedy (ruderal) species, especially by some of the species that occurred at low frequencies. Some species typical of the sand-dune habitat (eg *Ammophila arenaria*, *Cyperus capitatus*) were absent or rare in the disturbed plots.

Mean vegetation height is the criterion on which the two mature plots differ most markedly. Whilst the sand pile had the lowest vegetation of all, the mature plot nearer the sea (mature II) had lower vegetation than the excavated plot, while the mature plot further west (mature I) had much taller vegetation. Mature II had higher diversity (due to more equitable distribution of the same number of species) than mature I.

In conclusion, it seems that the disturbance caused by dredging and dumping operations in the Alvor estuary has marked effects on the flora of the sand dunes, increasing the number of species that can be found some ten years later but probably causing weedy species to replace those typical of the sand dune habitat. Further surveys along the lines of this one will be needed to monitor the course of succession as time goes on. It might be possible to use further analysis of the dataset from this investigation in order to optimise the sampling technique for future surveys.

Acknowledgements

I thank Will Simonson for supervision of this project and especially for his invaluable help in identifying numerous specimens of plants that I had brought back from the dunes. Andrew Brookes also helped with the fieldwork.

References

Hall, J., 1996, The vegetation of the Alvor Dunes: an on-going monitoring scheme. *A Rocha Observatory Report for the Year 1995*, A Rocha Trust, pp.44-50.

Kent, M. & Coker, P., 1992, *Vegetation Description and Analysis: A practical approach*. Wiley & Sons, Chichester, UK.

Appendix: Location of the study plots

Sand pile: the remaining, distinctive flat-topped pile at the eastern end of the dune bar, close to the car-parking area for access to the beach. Excavation of the sand from the eastern end appears to be continuing, so the pile may decrease in area.

Excavated: immediately beyond (west of) the sand pile. The southern edge of the 100 x 100 m area chosen abuts the track. Its north-east corner is close to the edge of the sand pile.

Mature I: two-thirds of the way along the dune bar (towards the west end). The southern edge of this 100 x 100 m area abuts the track. Its south-west corner is at a piece of black pipe about 1 m in diameter and 3 m long, which lies in the undergrowth within a couple of metres of the track and about 800 m along it (measured from a sand blockade across the track, roughly parallel with the eastern edge of the sand pile).

Mature II: opposite excavated area on other side of track. A strip of 50 x 200 m, its long, northern edge abutting a relatively straight section of the track.

WEATHER REPORT FOR 2002

Ben Carpenter

A weather monitoring station was established at Cruzinha this year by Chris Boyes, and the weather was recorded between 1 September and 31 December. The observations were made daily at 0900hrs Universal Time Co-ordinated (UTC) and comprised temperature, maximum and minimum temperature of the previous 24 hours, relative humidity, rainfall over the previous 24 hours, cloud cover, wind strength and direction, visibility, occurrence of mist, fog or haze and other general weather observations. The temperature, rainfall and humidity data presented here are compared with data from the nearest official weather station at Praia da Rocha. This station is approximately 8 kilometres away and has published mean data from weather records between 1941 and 1970 (Faria *et al.,*1981).

Air Temperature

Figure 1 shows daily maximum and minimum temperatures from September to December. The highest temperature recorded in this period was 29.0ºC on the 12 September, and the minimum was 2.0ºC recorded on the 6 and 7 December. The mean maximum and minimum temperatures for each month are given in Table 1 and compared with mean temperatures collected from Praia da Rocha 1941-1970. It can be seen that the mean maximum temperatures at Cruzinha for 2002 were generally higher than average according to the Praia da Rocha data. For mean minimum temperatures the values are very similar.

There appear to be three distinguishable parts to the maximum temperature chart. Over the first 13 days of September the temperatures average around 26.5 ºC. From 14 September to 10 November, they are around the 25ºC mark. (The one exception to this is on 10 October where both maximum and minimum temperatures drop substantially.) In the third period, 11 November to the end of 2002, the maximum temperatures hover around 17ºC.

Figure 1 Maximum and minimum temperatures September – December 2002.

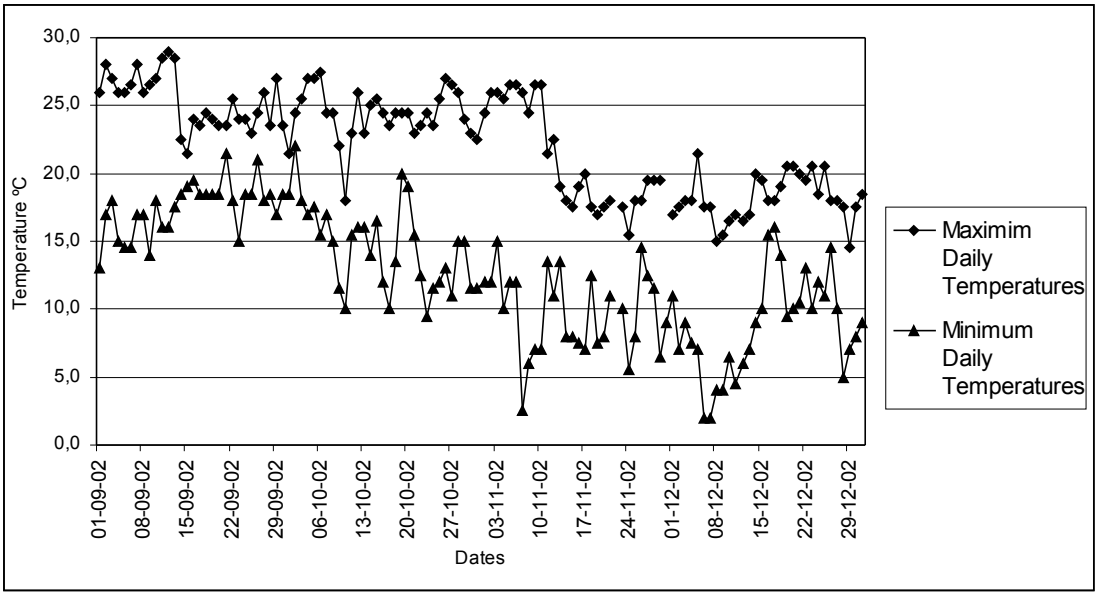


Table 1 Mean monthly maximum and minimum temperatures at Cruzinha in 2002 compared with 1941-1970 data from Praia da Rocha.

Month	Mean temperature ºC			
	Maximum		Minimum	
	Cruzinha	P. da Rocha	Cruzinha	P. da Rocha
September	25.5	25.5	17.4	17.2
October	24.5	22.1	14.6	14.8
November	21.2	18.6	9.7	11.5
December	18.2	16.2	8.8	8.6

Relative humidity

Relative humidity was recorded at 0900 hrs UTC using a hydrometer. This instrument measures the amount of water vapour in the air compared with the amount of water vapour that the air could hold. Table 2 provides monthly values in comparison with the long-term Praia da Rocha records. At both sites the relative humidity increases by 13% over the four months. At Cruzinha the relative humidity was at least 5% higher than the average at Praia da Rocha apart from in November.

Table 2 Mean monthly relative humidities at Cruzinha compared with 1941-1970 data from Praia da Rocha.

Month	Relative Humidity %	
	Cruzinha	P. da Rocha
September	77.8	72
October	87.7	78
November	86.0	85
December	91.1	85

Rainfall

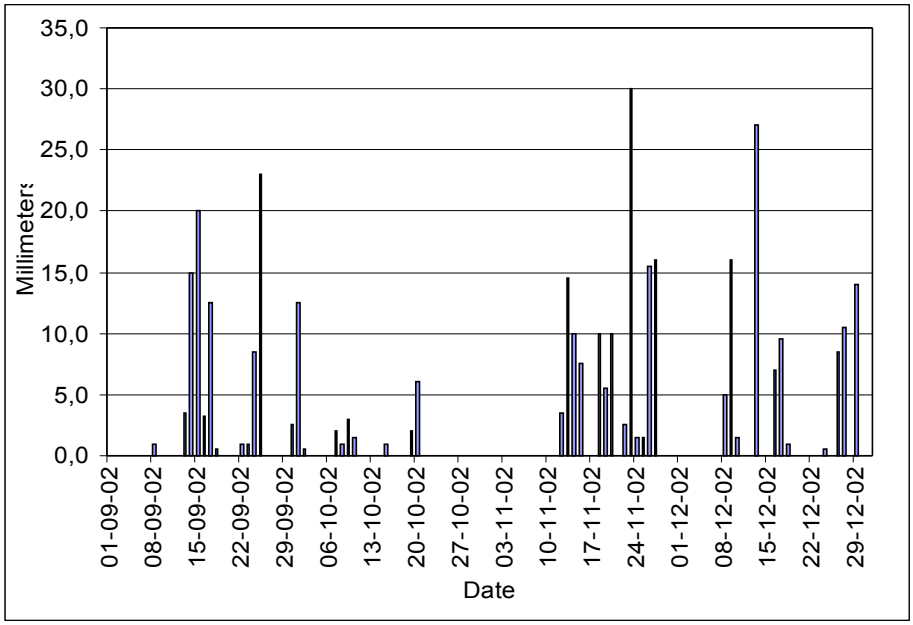
Measurements from our rain gauge are shown in Figure 2. The total rainfall recorded between September and December was 375 mm. This would seem to be a wetter than the average autumn/winter by comparison with the long-term data from Praia da Rocha: 211.4 mm is the mean total rainfall over this period at the latter station. Higher monthly rainfalls were recorded at Cruzinha for all months except October (Table 3).

There was some rainfall on approximately half of the days of each month at Cruzinha. The rainiest day was 23 November, with 30 mm recorded.

Table 3 Mean monthly rainfall at Cruzinha compared with 1941-1970 data from Praia da Rocha.

Month	Rainfall (mm)	
	Cruzinha	P. da Rocha
September	117.8	17.2
October	29.5	47.8
November	128.0	72.2
December	100.5	74.2

Figure 2 Rainfall September – December 2002.



Wind

Over the four month period there were not any exceptional wind strengths at 0900 hrs UTC. The wind was relatively light with most of the wind strength occurring between 0-4 on the Beaufort Scale and increasing to 6 on approximately three mornings. Of the days that the wind direction was recorded the prevalent direction appeared to be easterly (16% of the mornings), and north-westerly and north-north-westerly (both 10% of the mornings).

Occurrence of mist, fog and haze

Mist occurred on 17 mornings over the four months, on three mornings there was fog and on eight mornings it was hazy.

Reference

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