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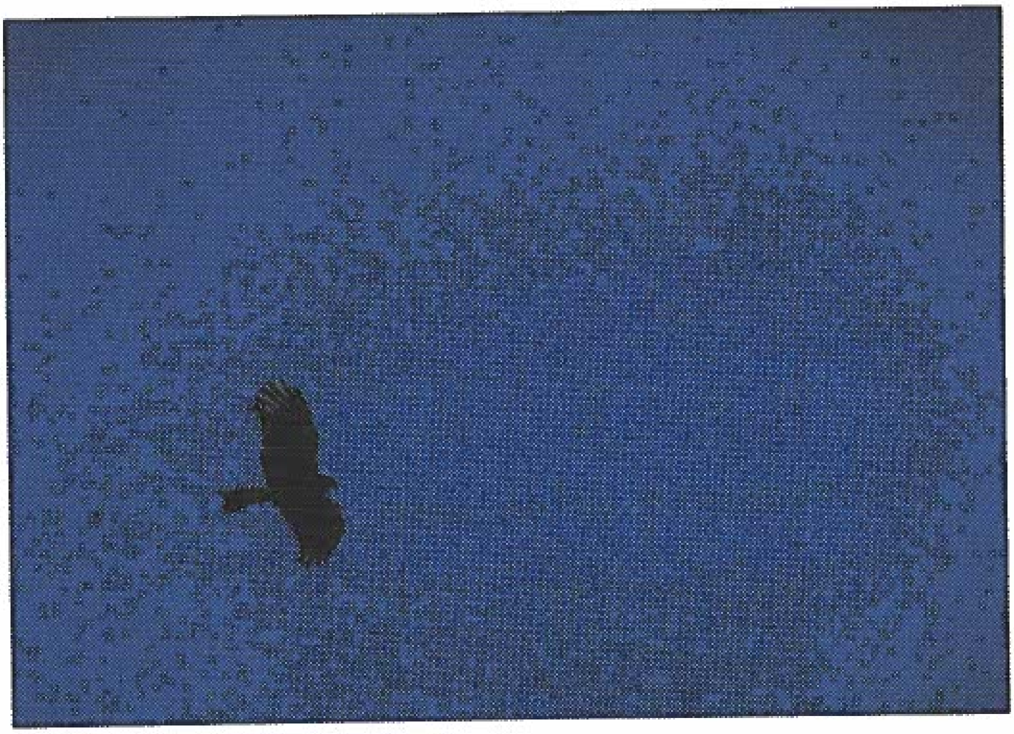
Gobi Sparrow Research Project

Field Report 2000



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SUMMARY

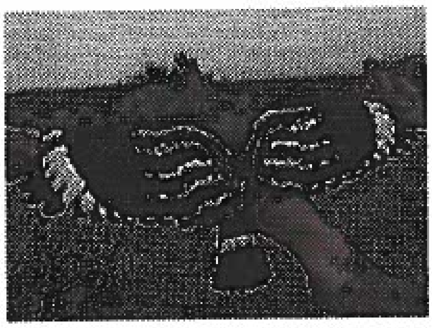
1. Between April and July 2000, we aimed to investigate the effect of food abundance on avian sex ratios in a wild population of saxaul sparrows, *Passer ammodendri*. A desert species was chosen because selection for adaptive sex allocation might be especially strong in populations breeding in extreme environments with limited food resources and/or time available to breed. The saxaul sparrow was chosen as the particular study subject because it nests in holes and hence data could be collected from pairs breeding in nestboxes that we provided. Data on insect abundances and parental feeding rates would also be collected. Incidental data on the flora and fauna of this little studied region would also be recorded.

2. In May 2000, 200 nestboxes were erected at 6 field sites in the southern Gobi desert, Mongolia. Despite previous publications claiming sparrows laid eggs in June, we caught fledglings in June. Hence when we erected nestboxes sparrows had already commenced breeding and it was not possible to collect breeding data. The 2000 field season was used to collect descriptive data of the flora and fauna of the region. The project has received future financial support for 2 years from the Leverhulme Trust and we intend to collect breeding data of sparrows in 2001/2002.

3. We collected voucher specimens of plants and insects in the southern Gobi desert for descriptive purposes, and took blood samples and morphological measurements of any birds we trapped in mist-netting efforts. These are available for any scientists interested in obtaining them for analysis, and will be advertised on the project internet site.

4. In 2001 and 2002 the original aims of the project will be pursued. We also aim in these 2 years to quantify plant and insect species abundance at each of the study sites. A more comprehensive work plan for 2001 is being prepared. Original sponsors will continue to receive updates on project progress, unless they request otherwise. We hope to encourage more scientific interest in the wildlife of this area.

5. We enjoyed good working relations with academics at the Mongolian National University. Two biology undergraduates from the university joined the project and were taught data collection and field techniques. It is envisaged that two more students join the field work in 2001/2002, and can use their experience and data collected to complete a dissertation for their degree studies. We also plan to find funding for a Mongolian student to visit a European laboratory in 2002. We hope to continue to collaborate with the National Parks authorities.



ACKNOWLEDGEMENTS

We would like to offer a huge thanks to those providing financial support for this project, and to our collaborators, officials and friends in Mongolia. We were happy to carry out this project together with the Mongolian National University and with kind permission from the Environmental Protection Agency at the Ministry of Nature and Environment (MNE). In Ulan Baatar, sincere thanks to Prof Samiya, Dean of Biology at the Mongolian National University for his cooperation, and staff at the Environmental Protection Agency. We have enjoyed a happy collaboration with the University and in particular with Nassa and Tsetseg, the two Mongolian Students accompanying the project. Thank you to the MNE and park authorities for allowing us permission to work in a strictly protected area, where we were privileged to experience the wonderful Mongolian countryside. Thanks also to Prof. Sodnomdarjaa at the Central Veterinary Laboratory, and for Yura, with help with paperwork for blood samples.

The project was funded by a number of bodies. We are sincerely grateful to the following organisations, institutions and trusts not only their financial contribution, but for their belief in the realisation of a project in an extremely remote location: The Winston Churchill Memorial Trust, The Association for the Study of Animal Behaviour, The Dan Lipscombe Memorial Trust, The University of Edinburgh Davis Fund, The Percy Sladen Memorial Fund and the British Ornithologists Union. I hope you will be assured that your contribution has been used wisely. Although the scientific material gathered was not exactly that originally proposed, we collected other data and specimens, and your contribution allowed the set-up of a project that has now received continued funding for 2 years. Hence, we are able to pursue the original aims of the project armed with a greater knowledge of the area.

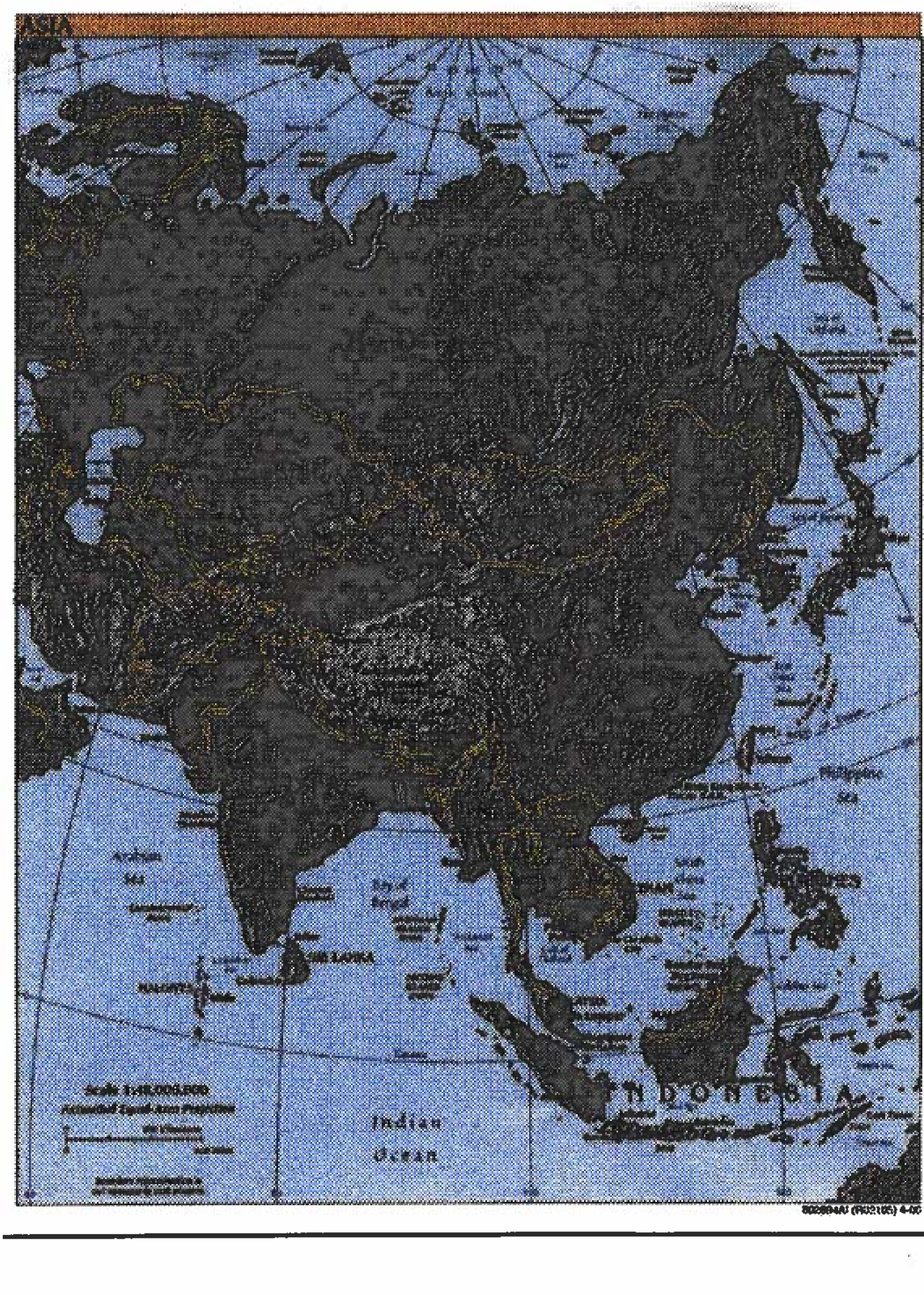
Thanks also very much to Sokkia, for providing GPS sets for 3 years, Inmarsat for providing a satellite phone handset and setup, and to Vango and Terra Nova for reduced price camping equipment. We thank Applied PC Training for all stationary and printing tasks, and J. Riss for medical supplies. All sponsors will be acknowledged on the following web site: http://www.gobiology.org (currently under construction) with links to organisation homepages where possible.

Thanks also in UB to Andy Goodwin at the British Embassy, Dominic O'Niell at Raleigh International, Sabine Schmidt at the GTZ, Alfred Reich, Dr. Mike, Andrew Laurie, Kirk Olsen, Come Dorflinger and Dr.Bold and Dr. Boldbaatar at the Mongolian Ornithological Foundation.. Most huge thanks of all to Gombobaatar Sundev, who lead us patiently through the maze of paperwork and corridors, and who tirelessly translated documents and instructions for us. Without his efforts we would no doubt still be waiting for a permit. In Dalanzadgad we are grateful for the cooperation of the staff at the National Parks Office, and to Enkhetuya and family for translating and hosting us. We are also extremely grateful to local families for introducing us to the ways of the desert, and always being eager to lend a hand to help us out.

In UK, KO and CH thank the University of Edinburgh, especially Peter Jones, for official support. For the interest and encouragement of our friends and family, we are very grateful, thank you all. Special thanks must go to the Pretzlik family for putting us up on our administrative trips to London, and to the Wallaces for doing likewise around airports. Thank you particularly to Jo and Ivor Oddie for fixing a myriad of administrative problems and for always providing a base.

CONTENTS

Figure 1: Mongolia, sandwiched between 'world superpowers' China and Russia, occupies an ecologically significant transition zone in Central Asia.



CHAPTER 1 PROJECT BACKGROUND & OBJECTIVES

1.1 Project aims

The project was to be carried out in the Mongolian Gobi desert from April to July 2000 to investigate the biological components of a desert ecosystem. Laboratory work in Europe was anticipated to analyse samples collected. Field work in 2000 was intended as a pilot study to establish a base for continued scientific investigations in this area. One crucial aspect of the project was the involvement of Mongolian University students in data collection.

The project was set up to investigate the consequences of environmental variation on breeding decisions in birds, in particular the sex ratio of broods. A desert-living species was chosen as the study organism because it was believed that such a species would respond rapidly to changes in the breeding environment (rainfall, insect abundance) because of limited temporal opportunities to breed. The focal species of the study was the saxaul sparrow, *Passer ammodendri*, chosen following reports of its common nature in the southern Gobi and its hole-nesting breeding habits. Although erecting nest-boxes in the desert might create somewhat artificial breeding densities, it presented a system by which data collection could be facilitated, allowing adequate sample sizes to be obtained.

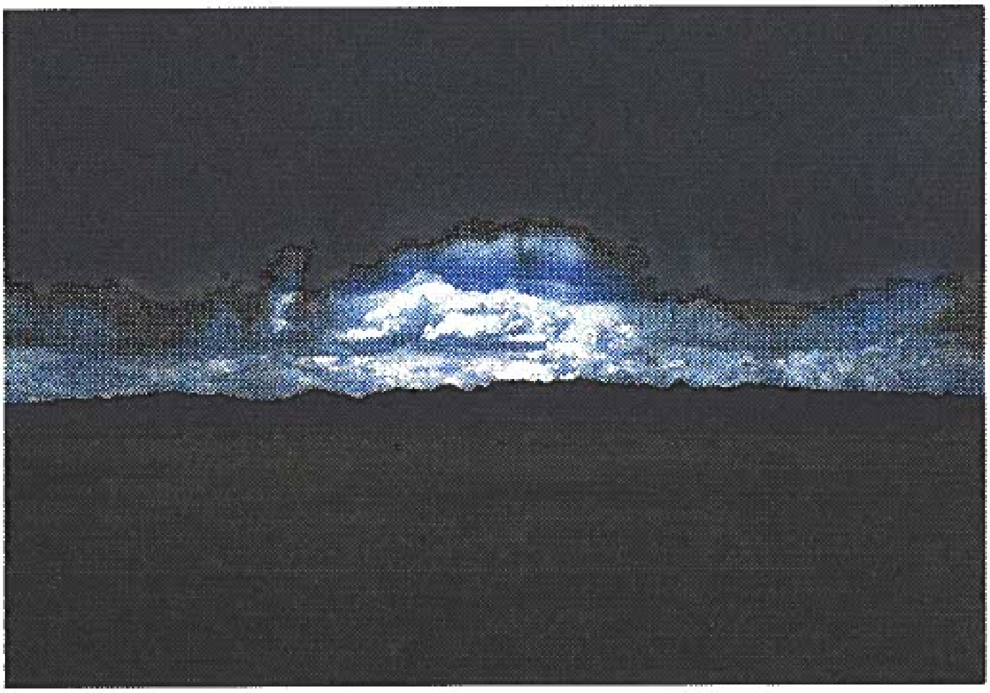


Figure 2: Rainfall approaches over the plains en route from Dalanzadgad to the field site. Near Gurvansaikhan National Park.

The original research plan involved erecting nestboxes in Gurvansaikhan National Park, Mongolia, to record data on nest-building behaviour, timing of breeding and clutch sizes. Birds would be caught at nestboxes for biometric measurement. Blood samples would be taken from nesltings to identify sex of offspring, in order to compare sex ratios of broods. Nestboxes would be erected at five different oases and whether sex ratio variation was associated with food conditions would be tested with using directional heterogeneity tests.

Specific Project Aims 2000

1. To set up nest-box areas in saxaul shrubs around 5 oases in the southern Gobi desert, Mongolia
2. To test whether sex ratio varies between these oases, and in relation to rainfall and insect abundances
3. To test whether parental feeding effort varied between pairs with different brood sex ratios

Figure 3: Male saxaul sparrow, *Passer ammodendri*

1.2 Mongolia and the Gobi desert

Mongolia is situated in Central Asia between Russia and China (see Figure 1). It covers 1.56 million km^2 (almost three times the size of France), yet with a population of only 2.3 million remains one of the least densely populated places on earth (1.5 people/km^2). Ecologically Mongolia's positioning is very important: the country contains a variety of ecological zones including Siberian taiga forests, extensive wetlands and lake systems, high Altai mountains, mountains forest steppes and vast grassland steppes. The southern 22% of the country is the high altitude Gobi desert. The Gobi was once a part of an inland sea basin that now extends into China. The low population density, remote location and traditional herding lifestyles still practised in Mongolia have contributed to the relative integrity of these ecosystems, at a time when most of the world has been subjected to unsustainable development. Hence, much of Mongolia represents pristine wilderness and habitats contain wild animals and plants that have disappeared in other parts of Asia.

Various systems of land distribution and utilisation have been employed in Mongolia. In 1206 Genghis Khan united Mongol tribes, establishing the Mongolian State and granting tenure of land to individuals. Land rights passed down through generations. In 1921 following the Russian invasion, land was nationalised and the country divided into administrative units, or 'sums' (Figure 5). Each sum contained an agricultural co-operative organisation that imposed regulations on land tenure and production. Herds were collected and redistributed, and arable production commenced. This restructuring apparently caused disruption to herders who became detached from their pastures.

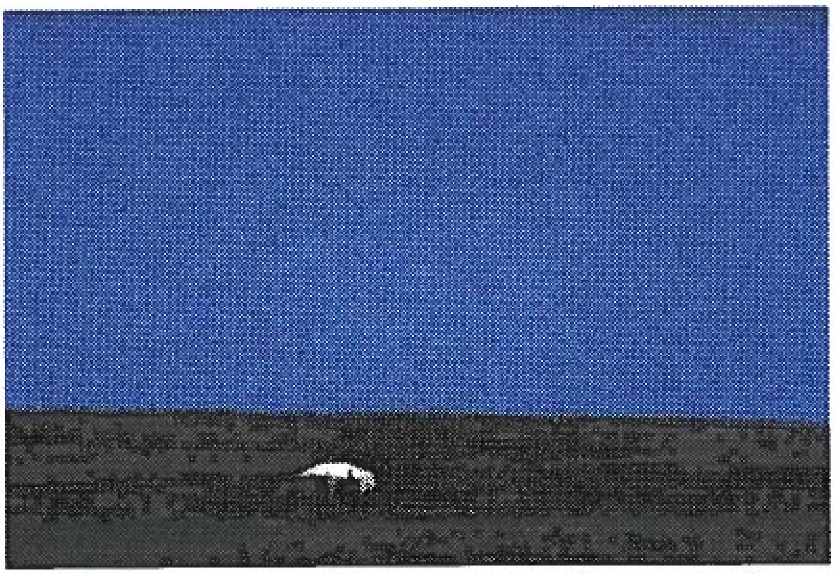


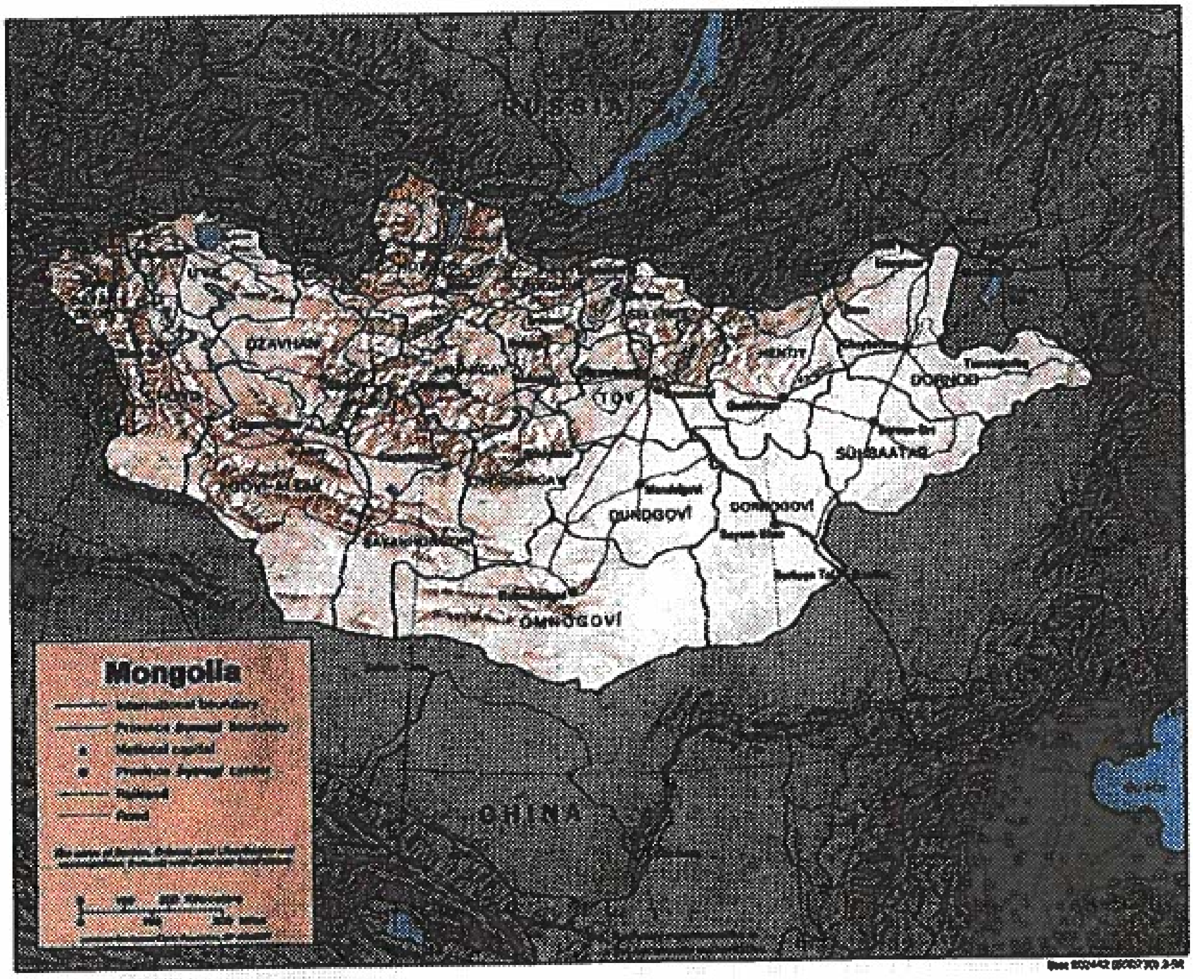
Figure 4: Typical Mongolian Scene. Southern Gobi desert in summer

Following the fall of the Soviet Union in 1990, rapid decentralisation occurred and the country embarked on an ill-prepared transition to a market economy. In the previous decade the Mongolian government have expressed a strong commitment to environmental conservation. Already they have set aside 12% of Mongolian land as protected areas, equivalent to 12.3 million hectares. However, the park system is still evolving and effective conservation is constrained by the inadequate staff numbers and training. As the country embraces a market economy, the huge socio-economic transition places increased pressures on the land, it's flora and fauna. Main threats include timber production, mining and land degradation coupled with falling ground water levels through increasing livestock numbers and overgrazing.

In the Gobi desert vegetation is sparse and herders graze livestock around springs and oases. Where there is no surface water, herders have maintained a truly nomadic lifestyle, moving livestock between waterholes approximately every 3 months (see box 1). Climate is extreme, with winter temperatures plummeting to -40°C, and reaching as high as 45°C in summer. Precipitation ranges from <50mm to 200mm per year, and windspeeds of spring dust storms have been recorded to reach 140km/hr.

Some areas of the Gobi are dominated by a woody shrub, the saxaul *Haloxylon ammodendron*. Saxaul 'forests' (although the bushes are typically less than 2m tall) are estimated to cover 4.5 million hectares of southern Mongolia. The shrubs are important in erosion prevention and water regulation, and provide a habitat for animals. However, saxuals are also used for firewood by local people, and with increasing gathering of firewood and price increases for alternative fuels such as coal, forest growth rates have fallen dramatically in 25 years. Action must be taken to find alternative fuel and reduce pressure on remaining forests. The Gobi Sparrow Research project aimed to investigate the breeding biology saxaul sparrows which had been reported to breed in hollows of saxaul bushes.

Figure 5: Relief map showing administrative boundries and province capitols. Each province is divided into sums.. The project was carried out in the largest province, Omnogovi, in the south of Mongolia.



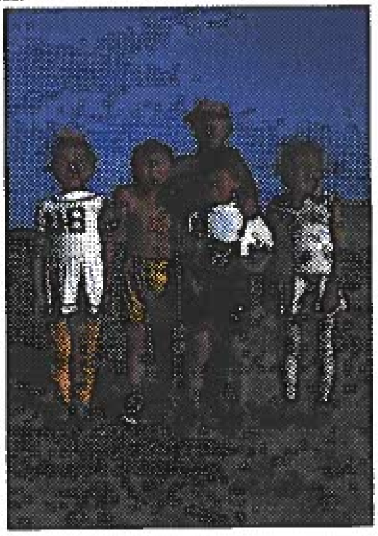
Box 1: Traditional herding life

Our base camp was situated approximately 14km from the Chinese border in an arid area ~200km south of Dalanzadgad (see fig. 3). A neighbouring family of herders situated 2km from our ger (traditional felt tent) move their livestock and ger approximately 4 times a year between water holes in this area.

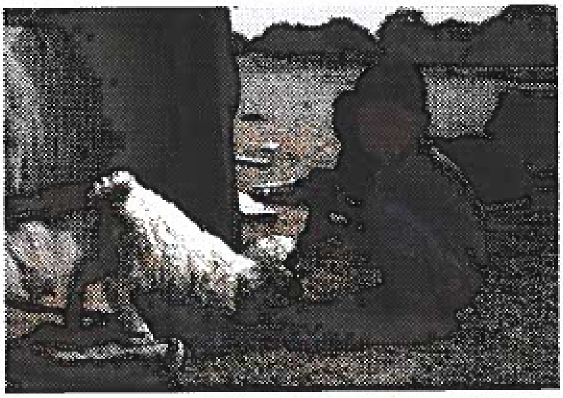
Figure 6: Bold and his camel still with winter coat

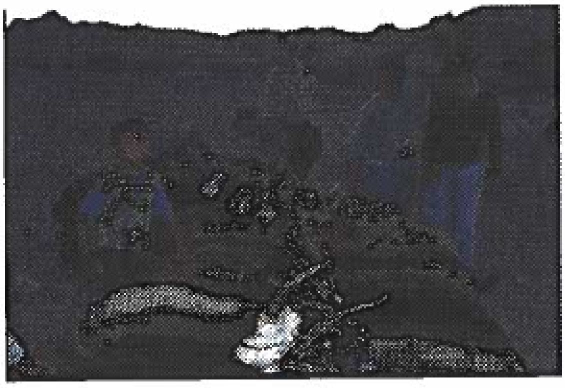
The family unit consists of a couple Bold, 45yrs and his wife Byampba, 40yrs, Bold's mother and their son Narambyer, 14yrs. Bold and Byampba's have five other children: the two oldest girls (18yrs and 20yrs) now live away from home and two younger sons (15 and 9yrs) and daughter (11yrs) attend boarding school in the sum capitol Nomgon. Narambyer attended senior school for three years, but following an operation on his throat is kept at home to herd the animals and will no longer be sent to school. Occasionally other children (nieces and nephews from Nomgon) stay for some weeks. When at home al children help with chores. Bold comes from a family of eight and his younger, unmarried, brother Gantugar often lives with them.

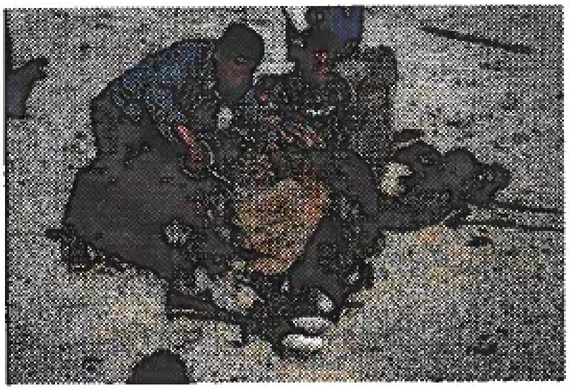
Figs. 7 & 8: Left: Bujei's first pencil. She lives at the nearest surface water, 45km from our camp. Right: Bolds three youngest on the left with their cousins.

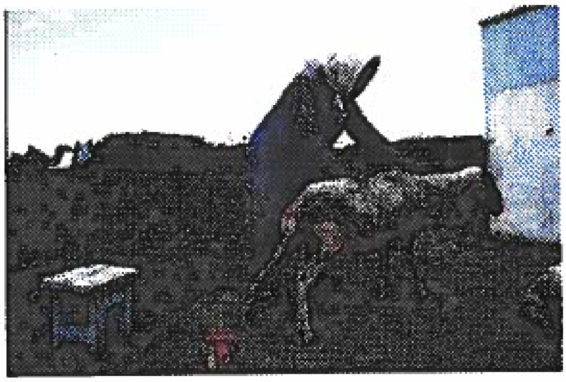


Figs 9 & 10: Ehkhbold uses a horn of milk to feed young lamb whose mother cannot produce milk (below), whilst Bollenchimeg rocks the urn of goat milk used to make the reknowned traditional drink 'airag' (left).









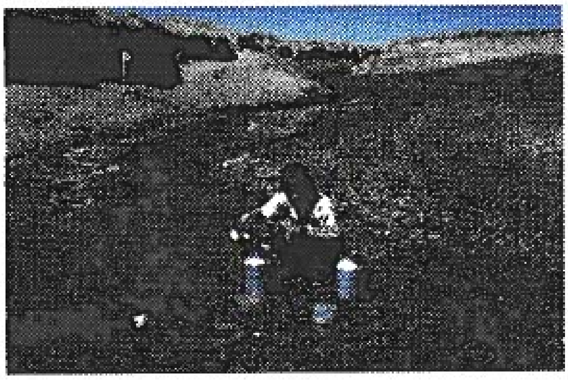


Figure 11-14: Goats are lined up for milking by the women and girls. Bold and Narambyer fleecing a camel – they will sell the wool in Dalanzadgad. Grandma sheers sheep in June at Jargal's ger. Collecting water at the spring at Jargals.

Bold's herd consists of the following livestock:

200 goats
16 cows
40-50 sheep
15 camels plus 3 young
20 horses
4 dogs

Figure 15: Bold's flock and camels

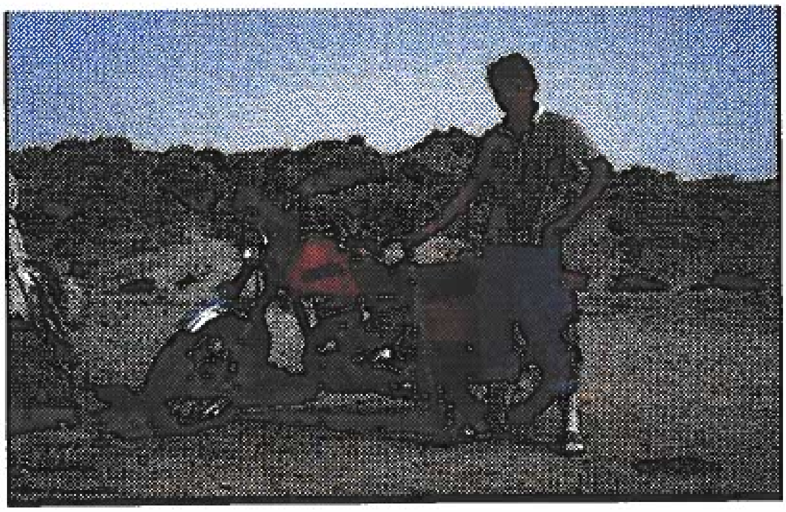


Figure 16: Gantugar proudly displays bike and rifle after returning from a hunting trip where he and a friend killed a wolf and her seven cubs. His friend took the furs to sell them in town. The previous week, Bold had lost 4 goats and two sheep to a wolf, which prompted the hunting excursion.

2.1 Project members

The project, based at Edinburgh University, initially involved collaboration with the Mongolian Academy of Sciences. Originally the project involved the following members:

Two scientific staff:

Name:	Kate Oddie (British)
Correspondence:	Institute of Cell, Animal and Population Biology, University of Edinburgh, West Main's Rd, Edinburgh, EH9 3JT, UK
Role:	Scientific Research Coordinator
Education:	PhD (Dec 1996 – Mar 2000) Edinburgh University: Sex ratio adjustment in birds: evidence from *Parus* species BSc. (Honours) Zoology, First Class, Bristol University
Experience:	Four years field experience with nest-box breeding passerines, including trapping/netting adults and taking blood samples from more than 5,000 birds (adults and chicks). Familiarity with molecular analyses involved, having sexed over 2,000 individuals already using this technique.

Name:	Bold Ayurzanyn (Mongolian)
Correspondence:	Mongolian Academy of Sciences, Institute of Biology, Ulan baatar 51, Mongolia
Role:	Collaborator from Mongolian Academy of Sciences
Education:	PhD. Mongolian State University (1957)
Experience:	From 1957-1961 lecturer at MSU. Has participated in expeditions in central and south west Mongolia, and conducted work in all parts of Mongolia. In 1961 established the Ornithological sector at the Institute of Biology, Mongolian Academy of Sciences and continues this work. Member of State Commission of Endangered Species. Has published 5 books and over 120 scientific works.

Two Mongolian students:

Names:	To be decided in April 2000 by Mongolian National University Staff
Correspondence:	National University of Mongolia, PO Box 46-337, 210646 Ulaan Baatar.
Roles:	Collection of insect specimens / Collection of avian field data – egg counts, blood sampling and trapping/netting of adult birds
Experience:	Students currently studying Biology at the Mongolian State University who will collect field data as undergraduate field project.

Project Organisation Officer:

Name:	Christophe Herrmann (French)
Role:	Logistics
Experience:	Planning and organisation of 1 year solo trip over Africa by motorbike, including desert crossings. Professional qualifications in carpentry and civil engineering. Basic mechanic skills.

2.2 Project timetable

The intended timetable had been for CH to arrive in Ulan Baatar (UB) late March to buy materials and cut wood to size for nestboxes. KO would arrive in Ulan Baatar in April, meet counterparts at the University and Academy of Sciences, and head south to the Gobi to establish nestbox areas by May 1st.

However, delays in UB caused modifications to the initial itinerary for several reasons. The collaboration with the Academy was changed to a cooperative agreement with the Mongolian National University, as the University would be allowing their students to join the project. Special permission was required from the Ministry of Nature and Environment to work at the selected field site as the work was to be carried out in a strictly protected area. It was necessary to have a blood test for AIDS before acquiring the necessary documentation to take to the police for a permit to leave the capitol.

Actual timetable:

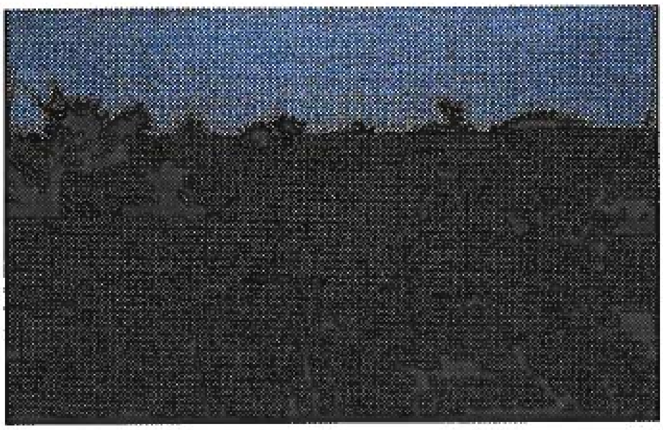
Date	*Event*
26/03/00	CH arrives in UB
15/04/00	KO arrives in UB
28/04/00	Leave UB for Dalanzadgad, town in Gobi desert
09/05/00	Field site located and base set up Commencement of nextbox piece assembly and erection
19/05/00	Nestbox erection completed
06/06/00	Students arrive
30/06/00	Students leave
07/07/00	Pack up field site and leave for UB
25/07/00	Leave UB

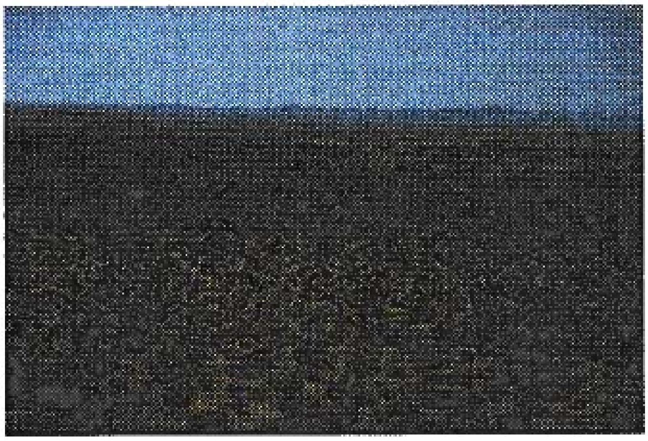
2.3 Field site description and Coordinates

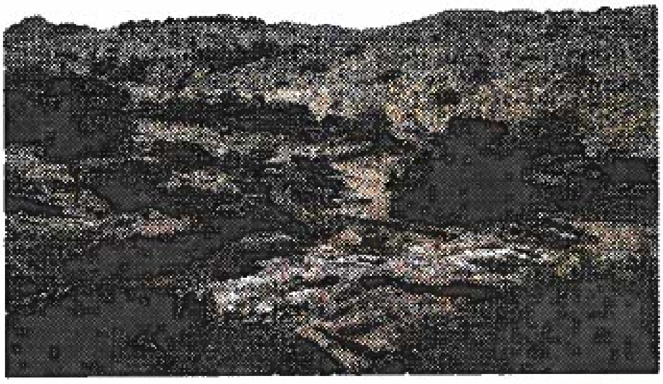
Researchers at the Mongolian National University recommended an area for the study where they had sighted saxaul sparrows in the previous year. This area, known as Borzygyn Gobi, is a mix of geographical types and landscapes. Most of the area is gravel desert with grassy hummocks on densely distributed, small (~1m^2) sand dunes. There are also sharp mountain ranges containing clearly delineated rock strata, most notably some type of quartz. Often the softer rocks have evidently been eroded leaving a line of more resistant rock types, which often resemble walls (see Figures 17-23). Further towards the chinese boarder the landscape changes completely to become an assortment of rounded boulders and sandstone. I have very little geological knowledge, but I imagine this would be a very interesting area for geological exploration.

Surface water is sparce. 180km south of Dalanzadgad are a chain of mountains, at the base of which are several springs. About 10 families live permanently by these springs which flood in summer (June-August). South of these mountains there is no surface water apparently before the chinese boarder. However, one or two nomadic families (i.e. Bold's family, see box 1) exist by obtaining water from a series of wells.

Figs. 17-20: Southern Gobi habitats.







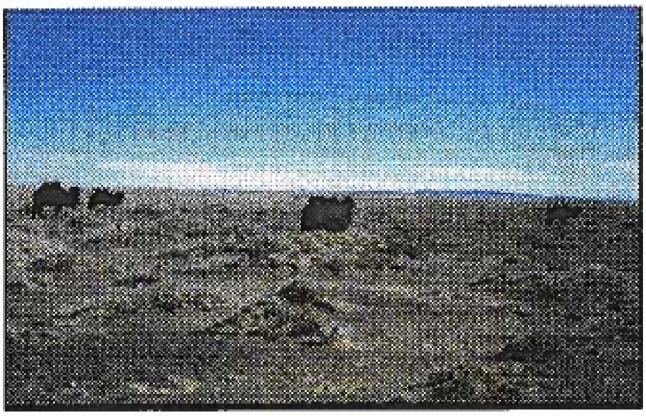
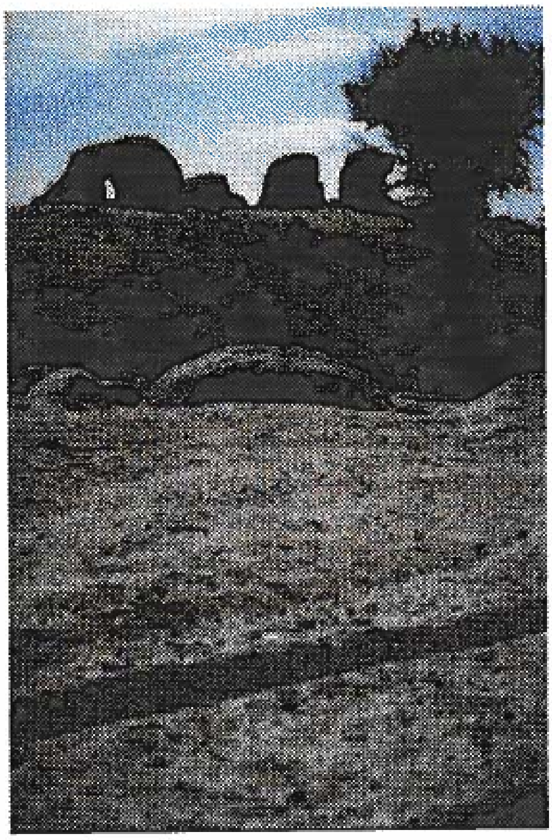


Fig21 (above): Dry river bed with large trees and bushes at each side.
Fig 22 (below left): Eroded sandstone rocks near the Chinese border.
Figure 23: Vegetation in the delta at base camp



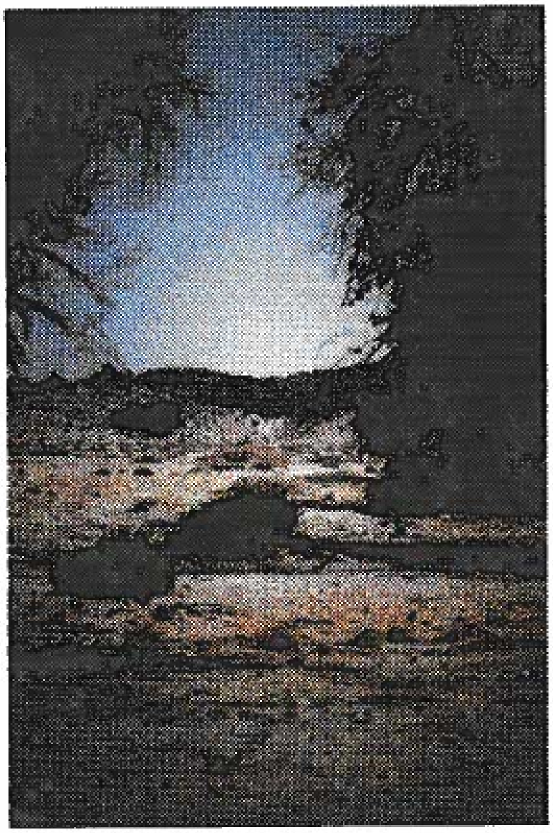
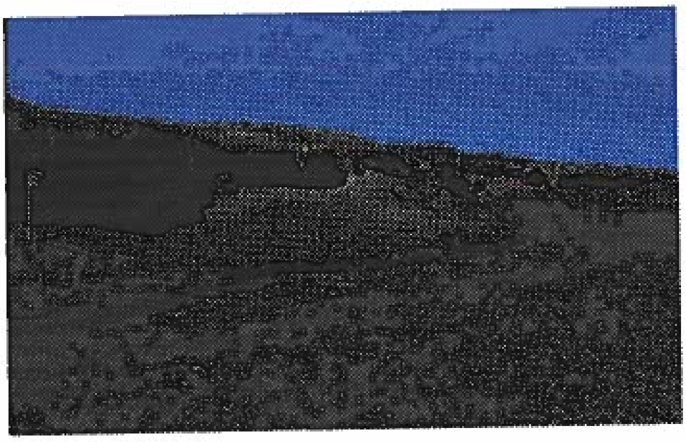


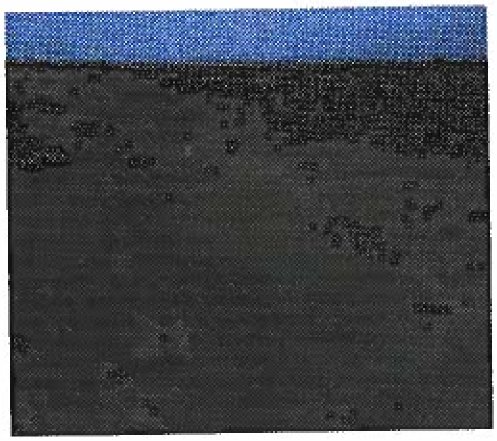
Fig 24: Ger set up and UAZ vehicle with 'delta' extending to right of photo

We chose to base our camp in a position 14km from the chinese boarder where we found a large group of ~70 poplar trees appropriate for mounting nest-boxes. Several permanently dry river beds support large trees on each bank, indicating the shallow depth of ground water. Following one of these dry river beds, we found it to flow into a 'dry river delta', where these 70 trees were growing.

Nestboxes were erected in several different habitat types for comparison of breeding data of birds nesting in each.

Area Name	**Area description (qualitative)**	**No. boxes**	**Reference**
Delta	Coarse grain sand, large poplars (girth 0.25-1.00m diameter), woody shrubs. No water.	56	N: 42°12'13.9" E: 105°20'43.2"
Bold's River	Coarse grain sand, woody shrubs and poplar trees on either side of dry river bed. No water.	39	N: 42°30'28.5" E: 105°11'58.7"
West River	Coarse grain sand, woody shrubs and poplar trees on either side of dry river bed. No water.	18	N: 42°26'14.2" E: 105°05'47.8"
Little Zag	Coarse grain sand, gravel pans in places, saxaul forest, i.e. saxaul 'monoculture', no other vegetation (nestboxes mounted on stakes). No water.	50	N: 42°30'00.5" E: 105°12'48.6"
Jargal's ger	Sand and mud, no trees and very few, very small shrubs, grass tussocks (nestboxes mounted on stakes or on walls of corral). Permanent water.	25	N: 42°29'02.4" E: 105°14'06.4"
Source	Rocky sunbstrate, small cliffs. Few woody bushes. Temporary water source which dries up in May.	12	N: 42°14'50.4" E: 105°11'38.8"
Total		***200***	





Figures 25 & 26: Permanent water source at Jargal's ger (45km from our base camp) in early May (above left) and in late June (above right). Nestboxes were set up on stakes on the banks (far left).
Figure 27: Nestboxes erected on small stakes in saxaul 'forest'

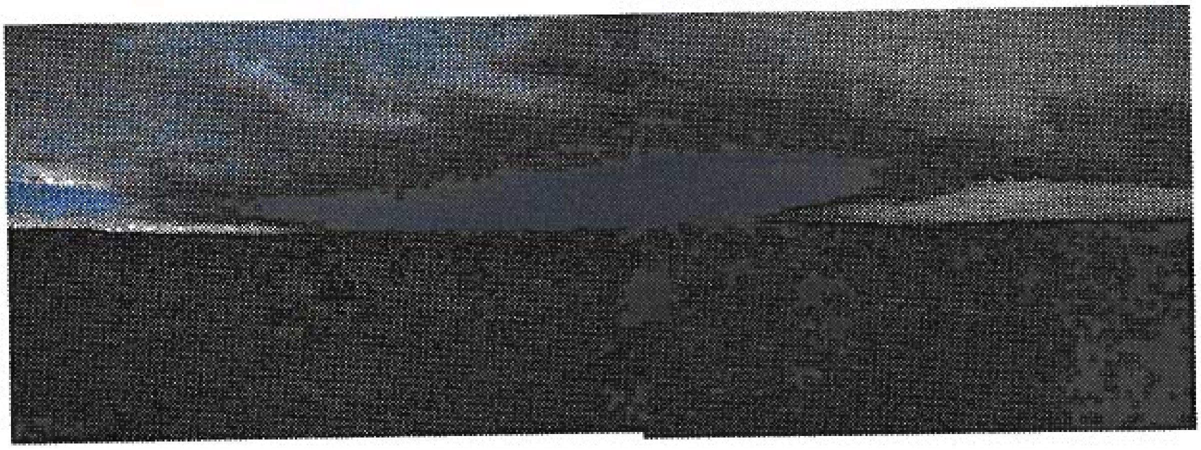
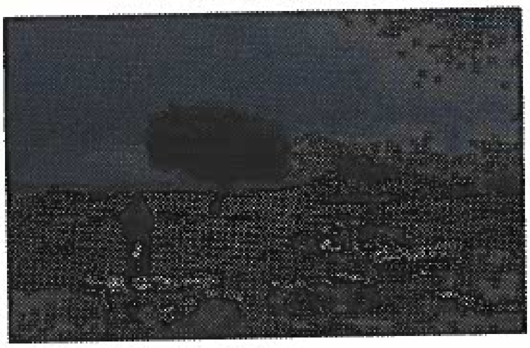


Figure 28 (left): Arranging wood pieces cut in Ulan Baatar for assembly into nestboxes. Figure 29: Nestboxes made and ready for mounting in study areas.



2.4 Daily routine

Having established a base camp and erected nextboxes, data collection began. Plants and insects were collected and pressed/preserved. Nestboxes were checked regularly, and birds were caught opportunistically using mist-nets. Blood samples were taken from any species caught to provide material for genetic analyses for other interested researchers.

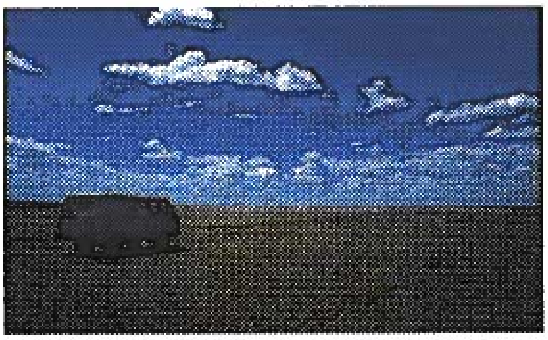
In June it was frequently too hot to work following lunch and this time was often spent in the ger sorting samples collected from the previous days efforts or those collected in the morning.

Typical working day:

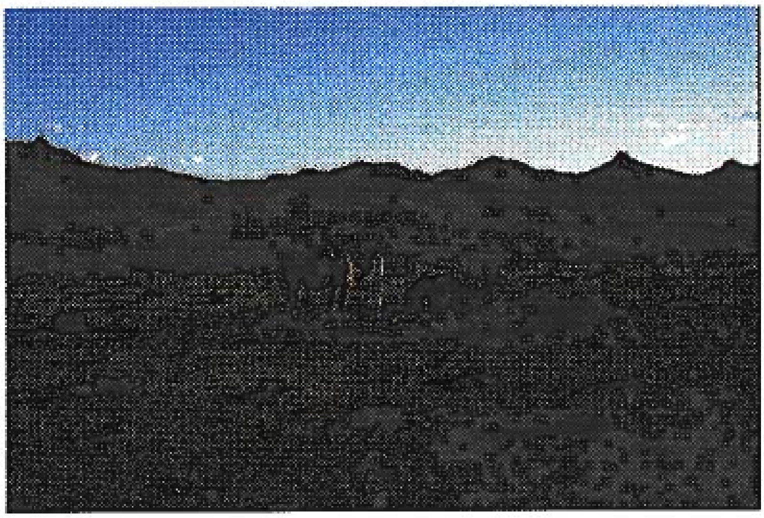
<table>
<tr><td>Time (hr of day)</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td><td>16</td><td>17</td><td>18</td><td>19</td><td>20</td><td>21</td><td>22</td><td>23</td></tr>
<tr><td>Activity</td><td colspan="19"></td></tr>
<tr><td>Insect collection</td><td colspan="2"></td><td>B</td><td colspan="5">Field work
Checking traps/
Collecting</td><td>L</td><td colspan="4">Field work
Plus preserving</td><td colspan="2"></td><td colspan="2">D</td><td colspan="2">Night collect (occ.)</td></tr>
<tr><td>Plant collection</td><td colspan="2"></td><td>B</td><td colspan="5">Field work
Collecting/ describing</td><td>L</td><td colspan="4">Field work
Collecting/ pressing</td><td colspan="2"></td><td colspan="2">D</td><td colspan="2"></td></tr>
<tr><td>Bird netting</td><td colspan="4">Field work
Mist-netting</td><td>B</td><td colspan="3">Field work
Mist-netting/
Box checks</td><td>L</td><td colspan="3"></td><td colspan="3">Field work
Mist-netting</td><td></td><td>D</td><td colspan="2"></td></tr>
</table>

Box 2: Project life in the desert

Throughout the period of stay in Mongolia we travelled using a Russian UAZ vehicle (figs) which was bought new in Ulan Bataar with 4-wheel drive. This standard model was chosen for ease of finding parts and mechanics familiar with the engine set-up. The engine construction is very simple and hence can be easily repaired with fairly basic mechanical knowledge. Furthermore, the engine location in between the two front seats allowed repairs to be carried out inside the vehicle during sandstorms. The vehicle proved extremely robust, negotiating steep hills, gravel, rocks, river crossings and sand dunes without problem. Unfortunately when temperatures soared near 40°C we encountered some problems with the thermostat. Hence, after only 5 minutes driving (especially in sand or in low gear) the engine water would boil. We used the vehicle little in the desert (to transport materials and set up nestboxes) and the rest of the fieldwork was carried out on camels, which we hired from a neighbouring nomad, Bold.

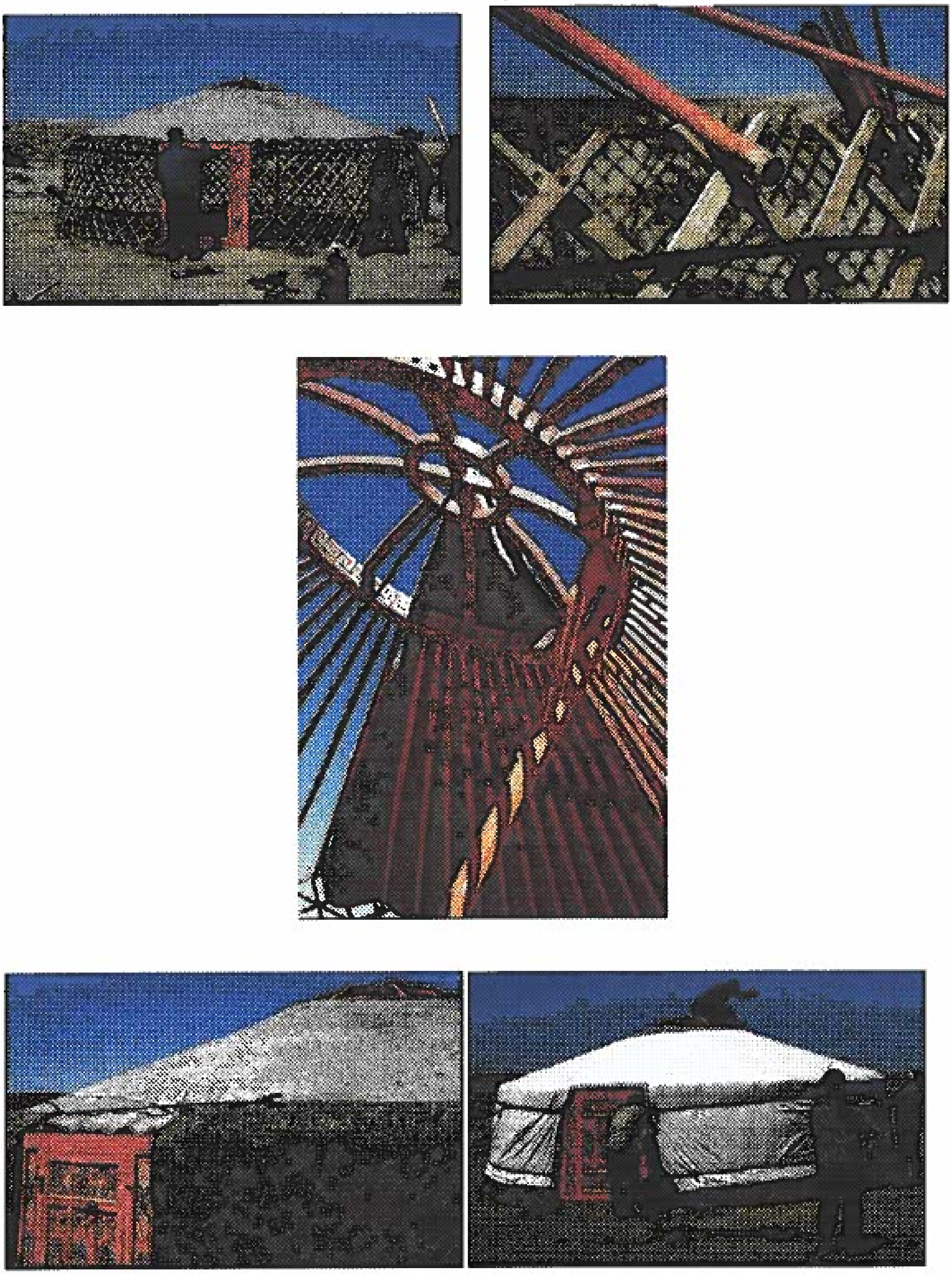


Figures 30/31: The UAZ crossing a dry lake bed 25km from base camp and crossing a river on the road to Ulan Baatar
Figure 32: Our camels, Jujigshar and Ottranboor, tethered behind base camp



Although I had reservations about using camels, they proved the most reliable means of transport, being remarkably quick, comfortable and easy to look after. Each camel required 50 litres of water per day and to be left out on the plains to eat freely, legs bound loosely to prevent them from straying too far.

We also purchased a ger in Ulan Baatar, to use as a base tent. Perfectly adapted for withstanding weather encountered in the Gobi, the ger served well and is brilliantly constructed from all natural materials (see photos 33 to 37).



Figures 33-37: Erecting the ger with the help of neighbours. First the walls, then the roof, then the felt and cotton covering. The ger is built around any furntiture, which cannot fit though the small door.

Food for nomads in this region consists of a diet of goat, rice and flour, with occasionally camel. The only vegetables which are available sporadically in Dalanzadgad were potatoes, onions and cabbage, with tomatoes and cucumbers appearing in June. We took supplies of tinned fruit bought in Ulan Baatar, as well as rice, flour and sugar, and meat was purchased from our neighbour Bold's family at $15 for a medium-sized goat. Goats were killed by Bold by breaking the aorta, and entrails prepared for eating by Bympba (see photos). This traditional method of slaughtering kills the animal in around 10 seconds without struggle and appears very humane and clean.

Figure 38 (below): Bold kills a goat with small ventral incision and breaks the aorta.
Figure 39 (right): Byampba cleans out all the offal and intestines, which are eaten in the first 1-2 days.

Figure 40 (left): The meat is cut into thin strips and left to dry next to our weather station monitor, suspended from the ger roof.
Figure 41 (right): Bold's children enjoy an ear each whilst the students and KO listen to Byampba.

CHAPTER 3 PROJECT ACTIVITY & RESULTS

3.1 Birds

3.1 (i) *Passer ammodendri* Timing of breeding

We set up nestboxes in mid May, approximately two weeks later than intended given previous reports of timing of breeding of saxaul sparrows. These reports indicated that female birds lay or incubate eggs in early June (Summers Smith 1998, Densley 1990). However, we found nests with hatched chicks already in mid-May and caught fledgling saxaul sparrows in mid-June. This indicates that in fact the breeding season begins much earlier than anticipated. I suggest the following timing of breeding for *Passer ammodendri* at our study sites:

APRIL		MAY			JUNE
	Nesting Laying	incubation	hatch	Nestlings	Fledging

Nestboxes therefore were erected too late to be occupied by nesting sparrows. However, we found 17 nests (5 in 'delta', 1 in 'Bold's river', 11 in 'Jargal's house') constructed in boxes in mid-June, at the same time as fledgling sparrows were being netted. This indicates that these were either very late nesting pairs, or that saxaul sparrows are double brooded, with some individuals producing 2 clutches per year.

Saxaul sparrows have been reported to associate particularly with saxaul 'forests', thickets of saxaul which occur in desert or semi-desert country. They are believed to eat the seeds of saxauls and associated insect fauna. However, we never sited any sparrows in areas of saxaul, and none of the 50 nestboxes erected in the saxaul thickets were occupied. Saxaul bushes in this region typically grow to a maximum of 2m, hence it may be that bushes are too small to support the holes which are the preferred nesting sites of sparrows.

Figure 42: Young saxaul sparrow, *Passer ammodendri*, fledgling

3.1 (ii) Nest construction

Nest boxes were also occupied by desert wheatears *Oenanthe deserti*, however nest construction differed between species. Both species used dry grass stems and leaves as nesting material. Sparrow's nests consisted of dry grass woven in a circular pattern, typically between 4 and 10cm deep and with a deep nest cup extending to the base of the nestbox. Eggs were laid directly on the nestbox floor rather than on the nest material. This may reflect the fact that it is unnecessary to insulate eggs from cold in this environment. Wheatears filled the entire nestbox with loosely packed straw and then constructed a tunnel which typically burrowed up to the roof of the nestbox before descending to the floor of the box, where eggs were laid. Pairs were observed feeding nestlings in natural cavities in large poplar trees, and in holes in corral walls built by nomads from packed goat faeces.

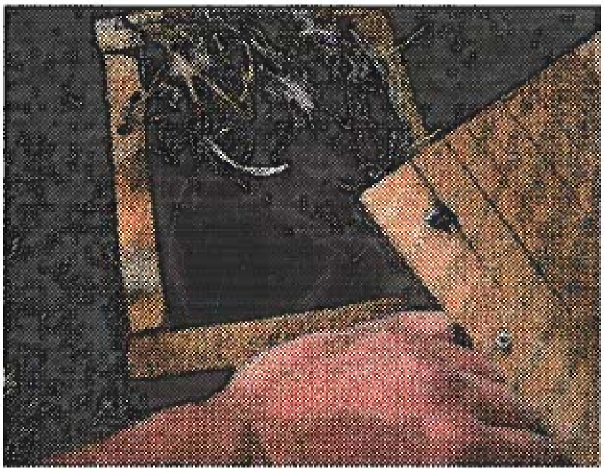


Figure 43: Nestbox occupied and one egg laid on the floor of the box

3.1 (iii) Blood sampling

Mist-netting at each site, we caught 8 species of birds (Appendix 1). Blood samples were taken from 14 species (Appendix 1). These will be advertised on the internet as available for any researchers wishing samples from these species for DNA analysis, e.g. for phylogenetic studies. For example, blood samples and photos of lark species have been sent to Dr. P. Alstrom at the Evolutionary Biology Centre, Sweden, as part of a worldwide study of relationships between lark species. In any publications arising from this work the Mongolian National University, Ministry of Nature and Environment and National Parks Bureau will be acknowledged.

Figures 44-46: Weighing a bird (left), taking morphological measurements (centre) and blood sampling (right). In this case the male saxaul sparrow is ringed 'pink right'.

3.1 (iv) Population differences of *P.ammodendri*

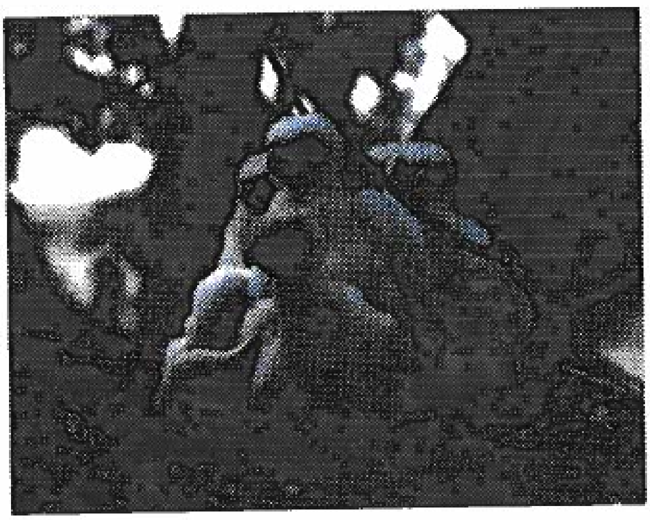
There has been one previous publication describing plumage and including photos of *P. ammodendri* (Densley 1990). He remarked on a white strip flanking each side of the black crown stripe on the male sparrow. These stripes are much less pronounced in the individuals we caught compared to those caught by Densley (see figure 47), approximately 350km away. He also described stripe patterns on the belly which were not evident amongst individuals we caught. Given this very evident plumage difference, it is possible that populations here are extremely isolated and that mixing is prevented due to an inability of individuals to migrate across desert areas with little surface water. Several races have been described over the whole of central Asia (see Summers-Smith 1988 for summary) but there is little information about the true distribution of these races.

Figure 47 (left): Male saxaul sparrow with white regions flanking crown stripe much less conspicuous than those photographed by Densley
Figure 48 (right): Female saxaul sparrow

Summers-Smith, J.D. (1988) The sparrows. *Calton.*

Densley, M. (1990) Saxaul Sparrow in Mongolia. Dutch Birding *12: 5-9.*

Figures 49-51 (above left to right): Isabelline shrike, *Lanius isabellinus*, ruddy shelduck, *Tadorna ferruginea*, and Henderson's ground jay, *Podoces hendersoni*. Figure 52-54: Nestlings of Henderson's ground jay (left), black kite, *Milvus migrans* (bottom left), and kestrel, *Falco tinnunculus* (bottom right).



3.3 Plants

We collected 62 species of plants from the study areas (see table 3.1). Plants materials were pressed and dried. Plants were not collected systematically to assess abundances, but rather as example specimens of the flora of the region. A quantitative evaluation of plant specimens is planned for 2001 (see chapter 5).

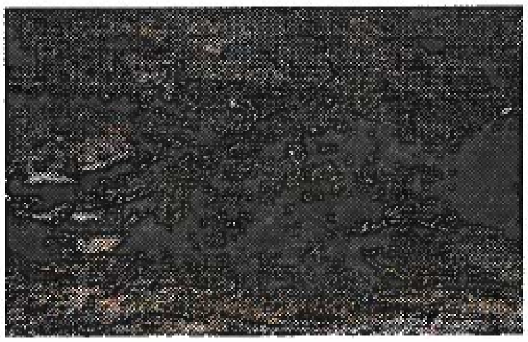
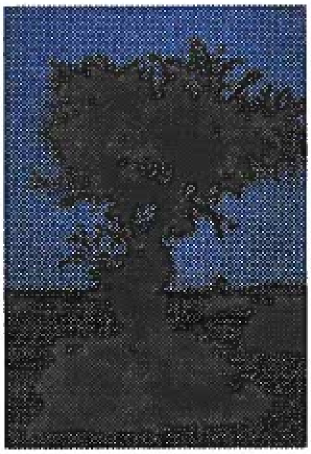


Figure 57-60: Plants, flowers, trees of the Gobi, including the saxaul bush *Haloxylon ammodendron* (below right) – this one is average in height



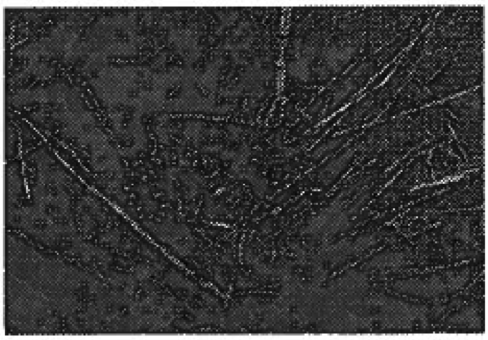
Plant category	Number of species collected
Trees	2
Woody shrubs/ bushes	14
Grasses	6
Flowering plants	18
Ground-covering plants	7
Other green plants	15
Total	*62*

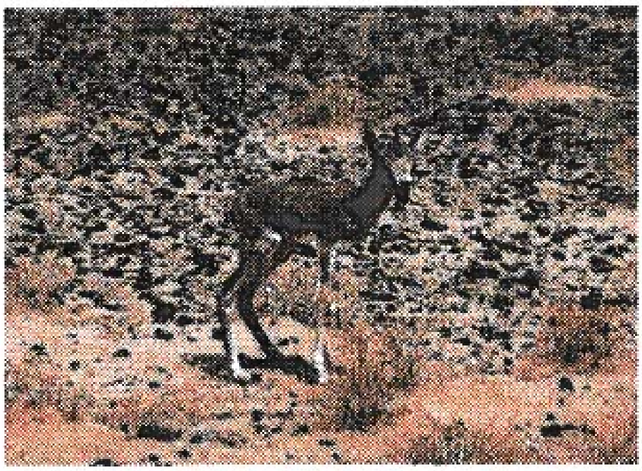
Table 3.1: Plant types collected from Southern Gobi in 2000

These dried specimens are currently in Ulan Baatar, requiring CITES permission to leave the country. Following the publication this year of 'The Guide to the Vascular Plants of Mongolia', we hope to be able to identify specimens to species level.

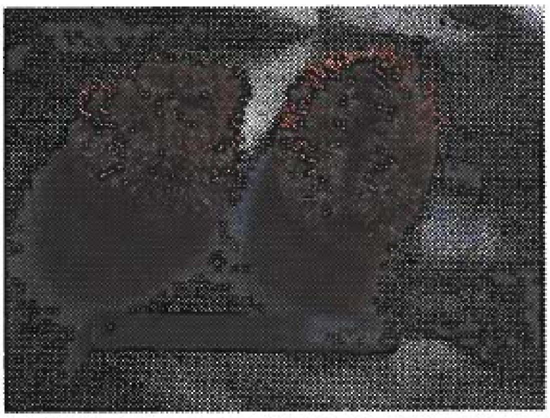
3.4 Other animals of the region

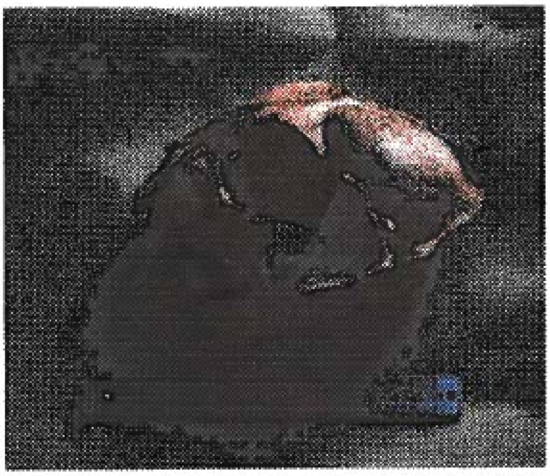
Records were kept of incidental sightings of other animals of spoor/remains spotted in the area. These included wild hare (top left), snakes (middle), sunwatcher lizard *Phrynosephalus helioscopus* (top right), wild ass or khulan *Equus hemionus hemionus* (centre), and goitered gazelle *Gazella subgutturosa* (bottom); (photos below 64-68).

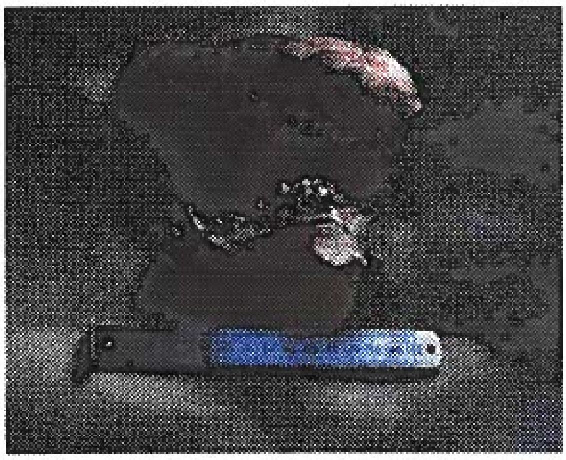




Figures 69-72: Remains of 2 daurain hedgehogs *Erinaceus dauricus* (top left), wild mountain sheep *Ovis ammon* (top right), snow leopard *Uncia uncia* (bottom left), and wolf *Canis lupus* (bottom right), all found within 20km of our base camp.

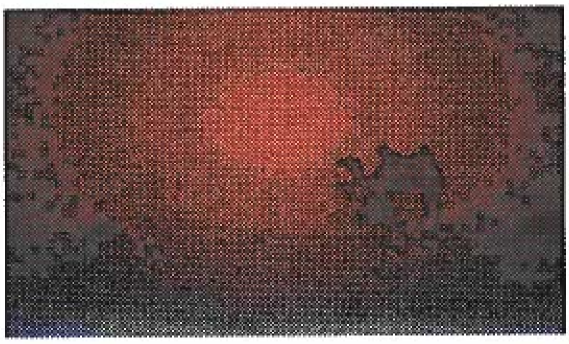


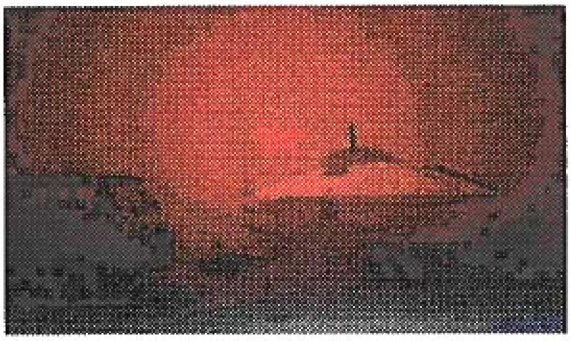




3.5 Climate

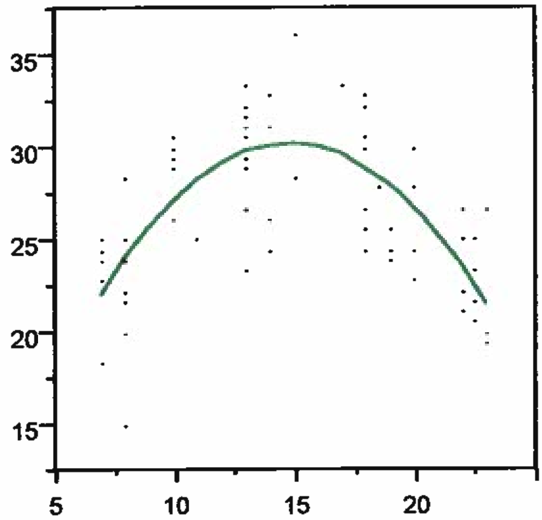
Throughout June we monitored temperatures, wind speed and wind direction with a portable 'weather station' (thermometer and anemometer). We also attempted to measure rainfall with a standard rain gauge, but this proved problematic as the gauge frequently filled with sand. Rainfall was frequent (approximately every 3-6 days), but the fact that very little (<1mm) fell during each event made volumes impossible to measure.





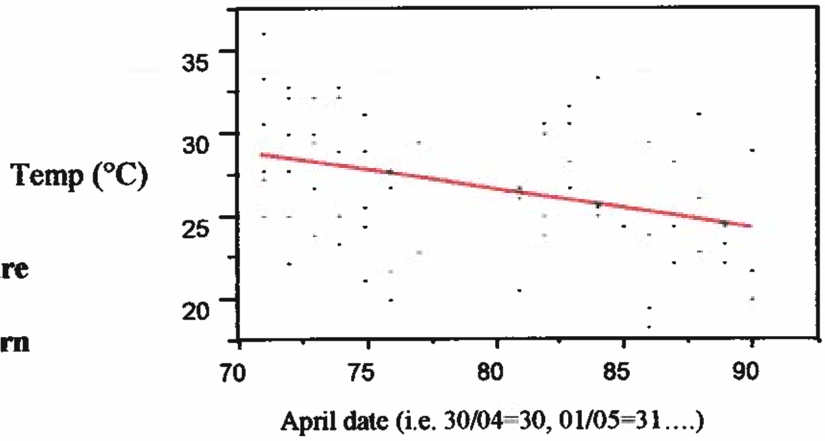
Figures 73 and 74: Our camels sit out the sandstorm for the day whilst we begin to pull everything inside and close the roof of the ger. Winds sometimes gusted up to 90km/hr and it was impossible to see more than 1m in these conditions.

Weather recordings were taken five times daily where possible, at 07:45 (±31 mins), 10:05 (±14 mins), 13:35 (±37 mins), 18:38 (±46 mins) and 22:29 (±23 mins). Temperatures ranged daily between 18 and 36°C, and generally there was 9°C variation within the day.



Graph 3.1: Daily variation in temperature at field site

Temperatures decreases throughout the month of June (Graph 3.2).

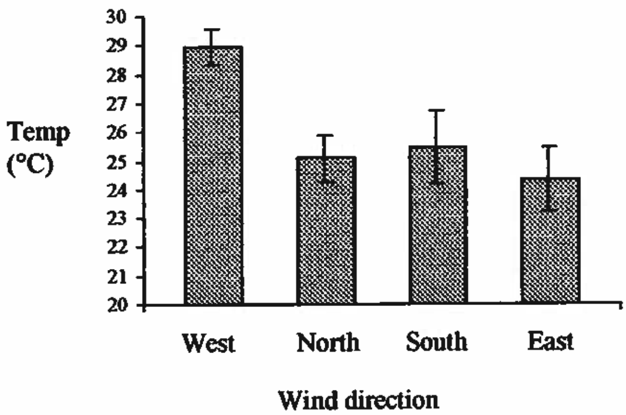


Graph 3.2: Temperature variation through the month of June, Southern Gobi 2000

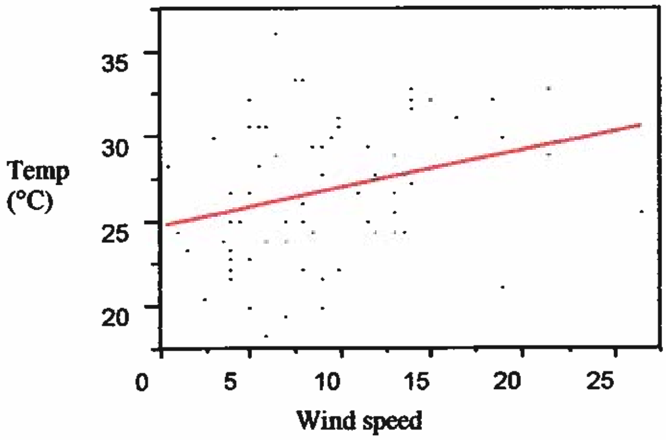
Temperatures were influenced by the speed and direction of the prevailing wind (table 3.2). Wind direction had a statistically significant effect on temperatures, with westerly winds being associated with particularly high temps (graph 3.3). There was a positive relationship between wind speed and air temperature (graph 3.4), suggesting that winds do not serve to cool the air but actually carry warm air to the region. It may be that westerly winds carry particularly hot air from the central Asian deserts to this area. There was no association between wind speed and wind direction ($F_{1,66}$=0.507, p=0.479).

Factor affecting temperature	Statistical *F* test (error d.f. = 63)	*p*
Date	0.744	0.391
Time of day	5.403	0.023
Wind speed	6.862	0.011
Wind direction	3.726	0.058

Table 3.2: Statistical examination of factors affecting temperatures at the Gobi field site. $p<0.05$ indicates a factor which affects temperature more than would be expected by chance, i.e. variation in temperature can be determined by time of day, wind speed and wind direction.



Graph 3.3: Effect of wind direction on ambient temperature



Graph 3.4: Effect of wind speed on ambient temperature

Box 3: Student involvement

We were accompanied by 2 students from the Mongolian Academy of Sciences in the field in June. Both students were taught general scientific methodology in collecting field data (e.g. random and repeated sampling) as well as specific collection methods for insects, plants and birds. They were shown how to capture, ring, and take morphological measurements of birds, capture methods for terrestrial and aerial insects, preservation of insect and plant materials, and recording methods for specimens collected.

Both students worked very diligently and enthusiastically. They were intelligent, used their own initiatives, demonstrated independent thought, and were always willing and able to give a hand. They were particularly interested in the natural history books that we brought with us. They both appeared to enjoy their time on the project, and we benefited greatly from exchange of views and opinions of cultural differences and approaches to science.

Tsetseg (22) was particularly helpful in identifying plant specimens, as she was familiar with Mongolian names of some plants from the region since her family is from Omnogovi province. She will finish University studies in June 2001 and hopes to return to Omnogovi as a biology teacher. Jobs as biologists in Mongolia are not easy to come by and she considers teaching her only option.

Figure 75: Tsetseg displays a hoopoe, *Upupa epops*, which we had just caught and banded

Nassa (23) comes from Hovsgol province in the north of Mongolia. This siberian part of Mongolia is a world apart from the Gobi and this was the first time Nassa herself had stayed in a ger. Being intelligent, ambitious, keen to travel and learn english well, I believe she has great potential for biological studies/work/environmental management in Mongolia. She has already expressed an interest in joining the project again in 2001. After she finishes her degree in June 2002 I hope to find funding for her to make a brief study visit to Europe to learn some molecular techniques and experience a European University system.

Figure 76: Nassa pins insects in the ger, watched by our inquisitive neighbours

One positive thought concerning the future of young Mongolians is their sincere wish to stay in their homeland. Many students we talked to wanted to travel abroad for a year or two to study and simply explore, but all expressed a strong feeling to return not simply to Mongolia, but to the province in which they were brought up. This national pride seems deep-rooted in all Mongolians, and could be very advantageous to the country if students have the opportunity to travel abroad to learn techniques, methodologies, management practices and languages, and then carry these back to Mongolia.

CHAPTER 4 PROJECT ASSESSMENT

The original aims of the project were to study the breeding habits of the saxaul sparrow, *Passer ammodendri*, and the importance of environmental predictability for sex allocation in birds (see chapter 1). Nestboxes were erected when breeding had already commenced, hence these original aims were not met. Time in the field was not however wasted, as voucher specimens of plants and insects were collected, blood samples of other bird species were taken, and nest-boxes are now in place for the study of breeding sparrow pairs in subsequent years (see chapter 6).

Although we were unable to collect breeding data this year, we are encouraged regarding the future feasibility of this project since we found sparrow pairs to nest readily in the boxes provided. (These must have been late- or second-nesters). Problems leading to missing the breeding season, and others, are outlined below.

4.1 Problems encountered

1. *Visa and work permits*

The visa type we were given in UK was a 'student' type, which meant that it was necessary for us to obtain a letter for the Minister of Education to get a permit to leave Ulan Baatar. However, our cooperation had been set up with the National University and permission to work in the parks obtained from the Environmental Protection Agency, Ministry of Nature and Environment (MNE). Given our student visa type, it was not possible for the MNE to support our application to obtain a permit to leave Ulan Baatar.

This paperwork took several days to fix, and we were also required to have an AIDS test before we would be allowed permission to go to the field. Hence, it was also necessary to spend time completing unexpected medical procedures.

2. *Previous literature incorrect*

Two previous publications on saxaul sparrow breeding behaviour stated females to be laying or brooding eggs in early June. This suggested that nestbuilding would commence in late April and through May, however for this population this does not appear to be the case. We estimate nestbuilding to begin mid-late April.

3. *Weather conditions*

Severe sandstorms lasting up to 2 days further delayed work erecting nestbox sites, especially in May.

4. *Sample export*

In order to remove voucher specimens from the country it is necessary to obtain permission from the CITES officials at the MNE. When we tried to do this upon return from the field, we were told it would not be possible as the persons responsible were on holiday for July and probably August. Hence, we left specimens in Ulan Bataar.

5. *General life*

Although we were prepared for working in difficult and remote conditions, field work was frustrating at first as the demands of everyday life took up quite some time (e.g. collecting wood/dung for cooking/boiling water, collecting water from the well, making bread, killing and preparing goats, keeping surfaces clean for specimens etc in sandstorms, continual sand everywhere…). The petrol stove we envisaged using blocked every 5 minutes due to dirty petrol and took 2hrs to boil 1 litre of water. Luckily our neighbour Bold supplied us with a traditional Mongolian stove and eased us into ways of life in the Gobi.

Figure 77: CH collects water from a well

4.2 Benefits to host country

1. *Descriptive ecology*. We hope to assist in collaborating with the National University of Mongolia to document plant, insect and bird species occurrence and abundance in the southern Gobi region of Mongolia. Plant and insect species that we collected are currently being held in Ulan Bataar. To our knowledge, there has been no previous scientific work in this area of the country. It will be particularly important to document flora and fauna presence now as Mongolia undergoes a period of rapid economic and social change since the collapse of the USSR in 1991. An uncertain financial environment may encourage exploration of remote areas of the country, such as the Gobi, for commercial purposes.

2. *Scientific training*
We trained 2 Mongolian students in field data collection techniques, and plan to continue this in subsequent years. These students received pay equal to that of the U.N. scale.

Figure 78: Bird handling techniques were taught, demonstrated here by Tsetseg

3. *Promotion and facilitation of biological study in Mongolia*
Through eventual publication of our results in scientific journals and advertising the project on the internet, we hope to stimulate interest in Mongolian fauna amongst specialist researchers. We hope this may encourage similar biological studies in Mongolia. Funds for scientific research must come from outside the country and Mongolian scientists are keen to collaborate with researchers from abroad. We are happy to facilitate further scientific research in Mongolia by giving advice to other western scientists wishing to work there, or providing them with a working base with us in the Gobi (see chapter also 6). We encourage strong links with the University and collaborative projects involving their staff and students, who have proved gratifying and stimulating to work with. Likewise, data collected should be provided to the National Parks Offices and conservation/development related projects encouraged.

4. *Mongolian National University Library*
Back-copies of several scientific journals of ecology and evolutionary biology have been sent to the National University, with the generous help of Raleigh International, in order to establish a current library for access by both students and staff. Currently the University receives no journal subscriptions and the few available texts are dated russian volumes. The University will receive subscriptions of the following journals:

a. Animal Behaviour
b. Behavioural Ecology
c. Journal of Animal Ecology
d. Ibis

as well as back-copies of BBC Wildlife and Trends in Ecology and Evolution.

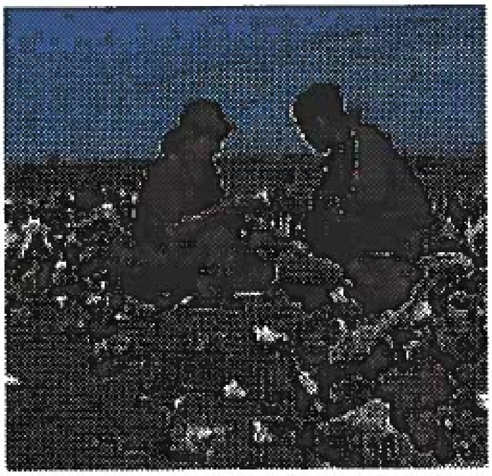


Figure 79: Bold shares some of his nomad's knowledge of the countryside

CHAPTER 5 FUTURE DIRECTIONS & SUSTAINABILITY

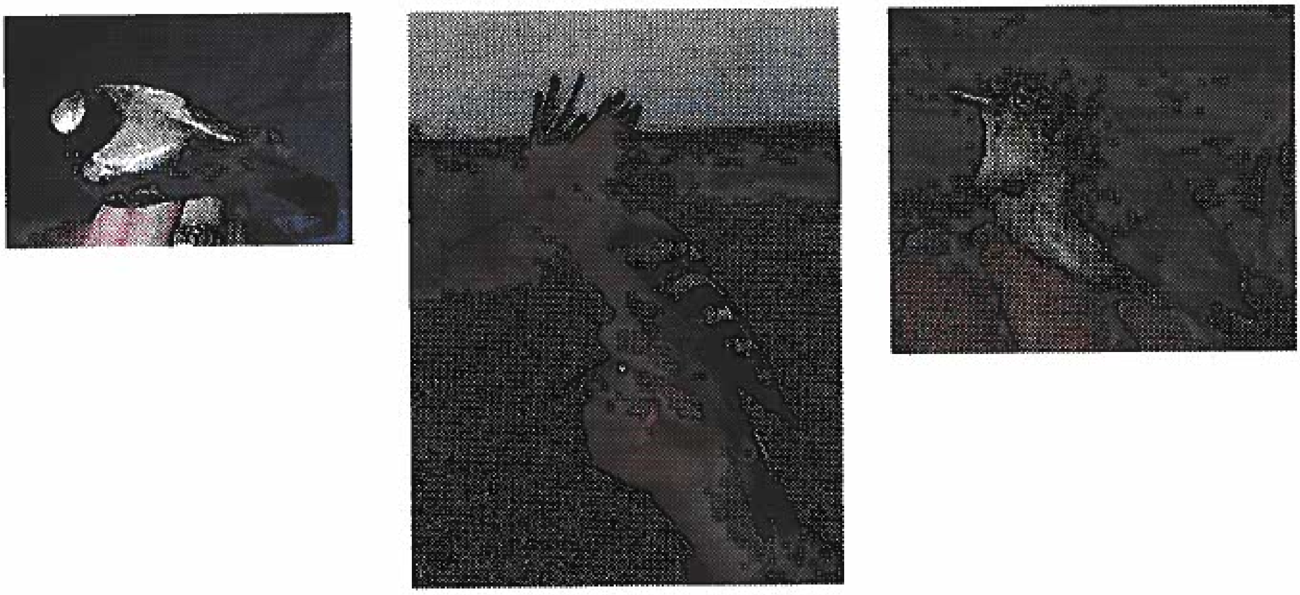
KO has received funding to continue the project for a further 2 years. Scientific study, in collaboration with the Mongolian National University, of the southern Gobi will continue in 2001 and 2002 with the following aims:

1. *Repetition of Original Aims*

With nestboxes now in place and sparrows known to nest in them, we hope to achieve the original aims of the project during 2001 and 2002. In 2001 KO will leave earlier for Ulan Baatar in mid-March, aiming to be in the Gobi for April 1st. This should give ample time to repair damaged nestboxes and begin data collection as nesting begins.

2. *Further work and scientific collaboration in the Gobi*

Opportunistic blood sampling of species will continue as in 2000. There has also been some interest expressed in small mammal sampling in this area, and we hope the project base will serve as a study site for collaborative work on small mammals of the area involving Dr. Batsaikhan (Mongolian National University), Dr. Lewis (Raleigh International) and Dr. Paradis (Montpellier University, France).



Figures 80-82: The desert wheatear *Oenanthe deserti* (left), hoopoe *Upupa epops* (centre), and desert warbler *Sylvia nana* (right), all found around base camp.

3. *Sample identification and export*
In 2000 our contacts with the Mongolian National University involved collaborations with ornithologists. In 2001 we hope to involve University botanists and entomologists in the identification of plant and insect specimens collected. The publication this year of 'The Vascular Plants of Monoglia' should aid significantly in this respect. We hope also to be able to obtain the necessary paperwork/CITES permission to export samples to the Royal Botanical Gardens, Edinburgh, and to the Natural History Museum, London.

Figure 83: Plant specimen taken back to the ger awaits description and pressing

4. *Collection of quantitative data*
In 2000 we collected descriptive data on plants and insects. In 2001/2002 we plan to assess plant and insect abundance at each of the nestbox field sites using standard ecological techniques. A detailed report of field aims and methodolgies for 2001 will follow.

Figure 84: Data collection: sampling kite nestlings

APPENDIX 1 BIRD SAMPLING

Blood samples

Blood samples were taken from *Passer ammodendri* (saxaul sparrows) and opportunistically from the following species:

Latin name	Mongolian name	English name	*Sample Details
Sylvia nana	Цөлийн зэржигэнэ	Desert warbler	1
Lanius isabellinus	Улбар суулт дунхай	Isabelline shrike	1
Anthus richardi	Хээрийн шийхнуухэй	Richard's pipit	2
Oenanthe deserti	Цөлийн чогчоохой	Desert wheatear	1
Upupa epops	Өвөөлж	Hoopoe	1
Galerida cristata	Согсоот болжмор	Crested lark	1
Calandrella brachydactyla	Бялзуумар	Short-toed lark	1
Milvus migrans	Сохор элээ	Black kite	3
Podeces hendersonii	Хулан жороо	Henderson's ground jay	3
Falco tinnunculus	Начин шонхор	Kestrel	3
Passer montanus	Хээрийн бор шувуу	Tree sparrow	1
Gypaetus barbatus	Ёл	Lammergeier	3
Hirundo rustica	Асрын хараацай	Barn swallow	3
		Unknown warbler spp	1
		Unknown flycatcher spp	1

*1: individual caught in net
*2: individual found dead
*3: individual bled as nestling

Mist netted birds

The following table lists birds caught in nets and gives details of times and locations of trapping, and whether they were ringed or not. Individuals were ringed with aluminium bands carrying unique numbers if the rings we carried were of the appropriate size for that species. Saxaul sparrows and desert wheatears were additionally ringed with coloured plastic bands that allow identification of individuals from a distance. Individuals of these species might therefore in future be identified entering and leaving nestboxes without needing to capture them in mist nets.

Date	Time	Area	Area descriptn	*GPS	Species	Sex	Tarsus (mm)	Wing (mm)	Weight (g)	Ring	Colour ring
02-Jun	615	Bold's river	behind ger	2	*Passer ammodendri*	F	19.7	78	26.5	grp1001	x,p
02-Jun	615	Bold's river	behind ger	2	*Passer ammodendri*	M	20.1	82.5	28	grp1002	x,lg
02-Jun	710	Bold's river	behind ger	2	*Sylvia nana*	F	18.45	59.5	8.75		
02-Jun	730	Bold's river	behind ger	2	*Passer ammodendri*	F	19.7	77	23.25	grp1003	x,r
02-Jun	745	Bold's river	behind ger	2	*Sylvia nana*	F	18.45	59	8.75		
03-Jun	1330	Bold's river	facing ger	2	*Passer ammodendri*	F	20.1	76.5	26	grp1004	x,x
09-Jun	700	Delta	delta centre	1	*Lanius isabellinus*		29.7	110	52.5	grp2001	
09-Jun	730	Delta	delta centre	1	*Passer ammodendri*	M	20.8	80	28	grp1005	x,x
09-Jun	1950	Delta	old corrall wall	1	*Oenanthe deserti*	M	27.35	102	19.75		
10-Jun	740	Bold's river	facing ger	2	*Lanius isabellinus*	Young m	24.4	95.5	31.75	grp2002	
10-Jun	1030	Bold's river	facing ger	2	*Lanius isabellinus*	Young f?	28	87	32.5	grp2003	
12-Jun	615	Delta	delta centre	1	*Passer ammodendri*	F	20.5	76.5	30.25	grp1006	x,x
12-Jun	700	Delta	delta centre	1	*Passer ammodendri*	M	19.5	76.5	26	grp1007	x,x
14-Jun	1930	Delta	delta centre	1	*Passer ammodendri*	Young	20.4	72	26	grp1008	x,b
14-Jun	1930	Delta	delta centre	1	*Passer ammodendri*	F	20.5	76	27.5	grp1009	x,dg
14-Jun	1930	Delta	delta centre	1	*Passer ammodendri*	M	19.4	80	28.5	grp1010	x,w
14-Jun	1930	Delta	delta centre	1	*Passer ammodendri*	M	20.5	78	27	grp1011	p,lg
15-Jun	610	Delta	delta centre	1	*Passer ammodendri*	Young	20.3	72	19.5	grp1012	p,r
15-Jun	610	Delta	delta centre	1	*Passer ammodendri*	Young	20.1	75	23.5	grp1013	p,b
15-Jun	610	Delta	delta centre	1	*Passer ammodendri*	Young	20.3	73	22.5	grp1014	p,dg
15-Jun	610	Delta	delta centre	1	*Lanius isabellinus*		25.7	97	29.75	grp2004	
15-Jun	845	Delta	delta centre	1	*Upupa epops*		23.4	154	73	grp2005	
15-Jun	900	Delta	delta centre	1	*Passer ammodendri*	F	20.5	76.5	26.75	grp1015	p,w
16-Jun	955	Jargals	cliffs	3	*Oenanthe deserti*	Young f?	26.4	89	21	grp1016	lg,p
16-Jun	955	Jargals	cliffs	3	*Oenanthe deserti*	F	25	91.5	18	grp1017	lg,r
17-Jun	615	Jargals	cliffs	3	*Oenanthe deserti*	F	26.4	100	18.25	grp1018	lg,b
17-Jun	615	Jargals	cliffs	3	*Oenanthe deserti*	F	26.7	97	23.5	grp1019	lg,dg
17-Jun	1220	Jargals	cliffs	3	*Oenanthe deserti*	M	25.45	101	19.25	grp1020	lg,w
17-Jun	1310	Jargals	cliffs	3	*Galerida cristata*	F	25.7	116			

17-Jun	1710	Jargals	cliffs	3	*Galerida cristata*	F	25.6	106	41		
17-Jun	2015	Jargals	cliffs	3	*Oenanthe deserti*	F	27.6	96.5	18.75	grp1021	r,p
17-Jun	2050	Jargals	cliffs	3	*Oenanthe deserti*	M	26	92.5	17.75	grp1022	r,lg
18-Jun	600	Jargals	corral	3	*Oenanthe deserti*	M	24.1	93.5	18	grp1023	r,b
18-Jun	800	Jargals	corral	3	*Calandrella brachydactyla*	m?	20.6	98.5	23	grp1024	
18-Jun	850	Jargals	corral	3	*Oenanthe deserti*	F	26.05	98	20	grp1025	r,dg
18-Jun	1010	Jargals	corral	3	*Sylvia nana*	F	18.4	59.5	10.5		
18-Jun	1120	Jargals	corral	3	*Oenanthe deserti*		26.55	97	20	grp1026	r,w
18-Jun	1720	Jargals	corral	3	*Oenanthe deserti*	M	26.5	96.5	18.75	grp1027	b,p
18-Jun	1720	Jargals	corral	3	*Oenanthe deserti*	F	25.8	90.5	21	grp1028	b,lg
18-Jun	2015	Jargals	corral	3	*Passer montanus*	F	17.75	71	28	grp1029	b,r
20-Jun	830	Delta	delta centre	1	*Passer ammodendri*	Young	19.7	78	27	grp1030	b,dg
23-Jun	1900	Delta	delta centre	1	*Passer ammodendri*	M	19.8	80	28.25	grp1031	b,w
25-Jun	515	Delta	delta centre	1	*Passer ammodendri*	F	19.2	74	24.5	grp1032	w,p
26-Jun	625	Delta	delta centre	1	*Passer ammodendri*	Young	20.2	79		grp1033	w,lg
26-Jun	625	Delta	delta centre	1	*Passer ammodendri*	M	19.15	81	25.5	grp1034	w,r
26-Jun	625	Delta	delta centre	1	*Passer ammodendri*	Young	19.7	80	23.25	grp1035	w,b
26-Jun	650	Delta	delta centre	1	*Passer ammodendri*	Young	20	76	28	grp1036	w,dg
29-Jun	600	Delta	Old well/reed	1	*Warbler spp.*	F	19.5	61.5	8.75		
29-Jun	600	Delta	Old well/reed	1	*Warbler spp.*	Young	18.36	60	8		
29-Jun	630	Delta	Old well/reed	1	*Flycatcher spp*	F	24.55	91	70	grp1037	
29-Jun	700	Delta	Old well/reed	1	*Flycatcher spp*	M?	26.1	103	18.75	grp1038	
29-Jun	715	Delta	Old well/reed	1	*Warbler spp*	M?	19.5	65	8.75		

* GPS coordinates:

1: N: 42°12'13.9''/E: 105°20'43.2''
2: N: 42°30'28.5''/E: 105°11'58.7''
3: N: 42°29'02.4''/E: 105°14'06.4''

Weather records taken at base camp, June 2000.

Date	Time (hours)	Wind speed (mph)	Wind direction (degrees)	Ambient external temperature (°C)	External temperature with windchill (°C)
09-Jun	10	14	247.5	27.2	25.0
09-Jun	13	10	292.5	30.6	29.4
09-Jun	15	6.5	270	36.1	35.6
09-Jun	17	7.5	270	33.3	32.8
09-Jun	20	12	247.5	27.8	25.6
09-Jun	22	4	110.5	25.0	25.0
10-Jun	7	4	247.5	22.2	22.2
10-Jun	10	3	247.5	30.0	30.0
10-Jun	13	5	270	32.2	32.2
10-Jun	18	14	247.5	32.8	32.2
10-Jun	20	9	247.5	27.8	26.1
10-Jun	22.5	8	270	25.0	23.3
11-Jun	7	6	270	23.9	22.8
11-Jun	10	11.5	292.5	29.4	27.8
11-Jun	13	18.5	292.5	32.2	31.7
11-Jun	18	15	270	32.2	31.7
11-Jun	20	19	247.5	30.0	28.9
11-Jun	23	5	360	26.7	26.1
12-Jun	7	8	225	25.0	22.8
12-Jun	10	21.5	247.5	28.9	27.2
12-Jun	14	21.5	247.5	32.8	32.2
12-Jun	18	14	247.5	32.2	32.2
12-Jun	22.5	4	247.5	23.3	22.8
13-Jun	7	12	292.5	24.4	21.1
13-Jun	10	13	337.5	28.9	27.2
13-Jun	13	16.5	337.5	31.1	30.6
13-Jun	19	26.5	67.5	25.6	21.7
13-Jun	22	19	22.5	21.1	16.1
14-Jun	8	9	22.5	20.0	15.0
14-Jun	10				
14-Jun	13	11	360	26.7	24.4
14-Jun	18.5	13.5	90	27.8	26.7
14-Jun	22.5	4	45	21.7	21.7
15-Jun	7	5	360	22.8	22.2
15-Jun	10				
15-Jun	13	8.5	360	29.4	28.9
15-Jun	18				
15-Jun	22				
19-Jun	7				
19-Jun	10				
19-Jun	14	8	337.5	26.1	25.0

19-Jun	18	13	315	26.7	25.6
19-Jun	22.5	2.5	337.5	20.6	20.6
20-Jun	8	3.5	90	23.9	23.9
20-Jun	10				
20-Jun	13	5.5	292.5	30.6	30.6
20-Jun	18	9.5	292.5	30.0	28.9
20-Jun	22	11.5	315	25.0	22.8
21-Jun	8	0.5	180	28.3	28.3
21-Jun	10	6	205.5	30.6	30.0
21-Jun	13	14	270	31.7	31.1
21-Jun	18	5	270	30.6	30.6
21-Jun	22	4	292.5	26.7	26.1
22-Jun	8	7	337.5	25.0	24.4
22-Jun	10				
22-Jun	13	8	270	33.3	33.3
22-Jun	18	13	110.5	25.6	22.8
22-Jun	22				
23-Jun	8	17.5	110.5	15.0	8.9
23-Jun	10				
23-Jun	14	13.5	225	24.4	22.2
23-Jun	18	13	157.5	24.4	22.8
23-Jun	22				
24-Jun	7	6	225	18.3	15.0
24-Jun	10				
24-Jun	13	9	225	29.4	28.3
24-Jun	19	7	315	23.9	23.3
24-Jun	23	7	360	19.4	17.8
25-Jun	7				
25-Jun	11	4.5	22.5	25.0	25.0
25-Jun	15	5.5	360	28.3	27.8
25-Jun	20	8.5	360	24.4	22.2
25-Jun	22	8	360	22.2	20.0
26-Jun	7				
26-Jun	10	8	360	26.1	25.6
26-Jun	14	10	337.5	31.1	31.1
26-Jun	20	4	110.5	22.8	22.8
26-Jun	22				
27-Jun	8	10	110.5	22.2	20.6
27-Jun	10				
27-Jun	13	1.5	180	23.3	23.3
27-Jun	19	1	315	24.4	24.4
27-Jun	22				
28-Jun	8	9	67.5	21.7	18.9
28-Jun	10				
28-Jun	13	6.5	90	28.9	28.3
28-Jun	18				
28-Jun	23	5	110.5	20.0	20.0