Observations on the cooling behaviour, and associated habitat, of four desert lark species (Alaudidae) in two areas of Kuwait

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INTRODUCTION

Birds that occupy hot arid environments are confronted with acute problems of energy and water balance due to extreme stress factors such as lack of surface water, intense solar radiation and high ambient air temperatures (Williams & Tieleman 2001). In response to such demands, birds thermoregulate by both physiological and behavioural means to prevent their body temperature reaching the upper lethal limit of 46–47°C (Maclean 1996). According to Williams & Tieleman (2005), an important physiological adaptation in desert lark spp is the lower rate at which they metabolize energy compared with mesic species of the same family. Behavioural responses to thermal stress and high solar radiation include avoidance strategies such as seeking shade. This may not always be quite straightforward in sparsely-vegetated desert environments. Burrows of the large herbivorous spiny-tailed lizard *Uromastyx aegyptius* are used as thermal refugia, during the hottest part of the day, by various desert lark spp in the Saudi Arabian desert (Williams *et al* 1999). These authors estimated that Hoopoe Larks *Alaemon alaudipes*, in this manner, could reduce their evaporative water-loss by as much as 81%. Shobrak (1998), also in the Saudi Arabian desert, noted male Hoopoe Larks at midday either under *Acacia* bushes avoiding direct sunlight or on top of them avoiding ground level heat. In addition, he observed birds prostrate themselves, facing into the wind, for a few seconds at a time on mats of the herb *Corchorus depressus* in summer during the heat of the day. He interpreted this behaviour to be thermoregulatory, considering the foliage to be cooler than the surrounding desert substrate. Cowan & Brown (2001) reported on similar behaviour of three desert lark spp (Dunn's Lark *Eremalauda dunni* (Plate 1), Bar-tailed Lark *Ammomanes cinctura* (Plate 2) and Temminck's Lark *Eremophila bilopha* (Plate 3) in Kuwait, but sitting on the desert gourd plant *Citrullus colocynthis*. This plant is morphologically similar to *Corchorus* (which does not occur in Kuwait) in that it too grows as dense mats adpressed to the ground. Furthermore, the birds apparently remain on the *Citrullus* mats for quite long periods during the hottest part of the day, rather than the fleeting visits mentioned by Shobrak (1998).

Plate 1. (left) Dunn's Lark *Eremalauda dunni*, 20 February 2007, SARS extension, Kuwait. © *Gary Brown*

Plate 2. (right) Bar-tailed Lark *Ammomanes cinctura*, 3 January 2008, Liyah, Kuwait. © *Gary Brown*

Plate 3. (left) Temminck's Lark *Eremophila bilopha*, standing on *Citrullus* mat, 31 August 2006, Liyah, Kuwait. © *Gary Brown*

Plate 4. (right) Black-crowned Sparrow-Lark *Eremopterix nigriceps*, male by pool, 26 April 2008, SARS extension, Kuwait. © *Gary Brown*

The present paper reports opportunistic observations, made 2005–2008 in two desert areas of Kuwait, of apparent cooling behaviour of Black-crowned Sparrow-Larks *Eremopterix nigriceps* (Plate 4), Dunn's Larks, Bar-tailed Larks and Temminck's Larks during the hottest part of the year (June to September), when diurnal ambient temperatures regularly exceed 40°C, and often reach 50°C.

METHODS

Observations were carried out in two study sites, described in more detail below: (1) the new 20 km² extension of the Sulaibiya Agricultural Research Station, SARS, of the Kuwait Institute for Scientific Research (KISR) at Kebd, central Kuwait, and (2) at a former gravel quarrying site in Liyah, north-central Kuwait ('Liyah'). The first site was visited at least once weekly from November 2004, the second at least once a month from this date. Birds displaying cooling behaviour in reaction to ambient temperature could be expected from late April to early October, when daytime temperatures of 40°C and above are recorded. Photographs of the birds showing apparent cooling behaviour were taken whenever possible.

A weather station is permanently installed in the SARS extension, providing data at 10-minute intervals on important climatic variables such as ambient temperature and rainfall. Temperature readings from the weather station corresponded very closely to those of the ambient-temperature gauge of the moving research vehicle, so that temperature for Liyah, where there is no weather data available, could be assessed. All air temperatures stated in this paper are shielded 'shade' temperatures.

ENVIRONMENT OF KUWAIT

Kuwait is a small (*c*18 000 km²) desert country located in the north-east of the Arabian peninsula. According to the Atlas of Desertification (Middleton & Thomas 1997), the climate of Kuwait can be classified as arid. Detailed information on the physical environment has been provided by Halwagy & Halwagy (1974a), and is summarised in the following. The landscape is flat to gently undulating, and rises almost imperceptibly from the coast to a maximum altitude of nearly 300 m in the southwest. The climate is characterised by hot, dry summers, when mean daily temperatures are about 35–37°C, and relatively mild winters. During the winter period, mean daily temperatures are about 14–16°C, with absolute temperatures dropping to nearly 0°C and occasionally just below during the coolest months (January & February). Rainfall occurs mainly during the winter and spring

months, November–April. Mean annual rainfall is *c*115 mm, with extreme values of 28 and 260 mm.

An overview of the vegetation has been provided by Halwagy & Halwagy (1974b). In brief, much of the desert environment should be occupied by open dwarf shrub communities or open grasslands (which include the sedge *Cyperus conglomeratus*). Desert annuals are a characteristic feature in years of high rainfall. The main growth period for plants coincides with the winter and spring period, and lasts for a maximum of *c*4–5 months.

In recent decades, the desert environment has been subject to severe degradation, mainly due to increased anthropogenic pressures, in particular massive overgrazing by domestic livestock (sheep, camels and goats), but also due to off-road driving, camping and the military activities associated with the liberation of Kuwait from the recent Iraqi occupation (Omar 2000, Brown 2003).

STUDY SITES

In 2004, KISR obtained a 20 km² tract of highly degraded desert directly abutting SARS (also 20 km²), *c*30 km southwest of Kuwait City. All livestock, camps and rubbish were removed from the new area in early 2004, and it was enclosed by a secure fence. At the time of enclosure, there was virtually no vegetation cover remaining, except for some heavily-grazed *Cyperus conglomeratus*. Since 2004, natural revegetation has taken place quite rapidly over the entire area, aided initially by several years of good rainfall. Two separate vegetation units are now discernible: one in which the perennial dwarf shrub *Moltkiopsis ciliata* as well as the perennial grasses *Centropodia forsskaolii* and *Stipagrostis plumosa* play an important role (*Moltkiopsis* community), mainly on shallow, gritty soils, and the other dominated by stands of the coarse sedge *Cyperus conglomeratus* (*Cyperus* community). The latter is characteristic of deeper, sandier substrates. A mosaic of these two main vegetation units occurs over large areas (Plate 5). Total perennial vegetation cover reaches 12% in the *Cyperus* community, but only about 2–3% in the *Moltkiopsis* community. Furthermore, because vegetation height in the *Moltkiopsis* community is much less (*c*10 cm, compared with up to 30 cm in the *Cyperus* community), the stands are much more open.

Plate 5. Typical sparse vegetation cover of the *Moltkiopsis* community, with the more dense vegetation of the *Cyperus* community in the background. The *Molkiopsis* community is an ideal habitat for both Dunn's Larks *Eremalauda dunni* and Black-crowned Sparrow-larks *Eremopterix nigriceps*. 11 March 2005, SARS extension, Kuwait. © *Gary Brown*

The vegetation of the original SARS area is markedly different in that it is mostly dominated by rather dense stands of the dwarf shrub *Rhanterium epapposum*, which grows to a height of 50–60 cm.

The former quarry site at Liyah, *c*60 km to the NW of Kuwait City, covers an area of *c*200 km² and, after cessation of quarrying activities, now presents itself as flat to gently undulating desert. As a broad generalisation, the site can be divided into two fairly equal-sized sections separated by a tarmac road. The northern section was heavily affected by excavation work and has recently been refilled and levelled. Natural vegetation regeneration is hardly proceeding in this section at all, except in the few depressions in which rainwater accumulates. Vegetation cover in most of the northern section is less than 0.5%. In the southern section, there has been impressive natural regeneration, locally at least, with

extensive stands dominated by the perennial grass *Stipagrostis plumosa*. On firmer, gritty substrates, the dwarf shrub *Moltkiopsis ciliata* is the dominant perennial, and it is usually accompanied by *Stipagrostis plumosa* in varying amounts. Vegetation cover varies according to location, but in general, it is between 0.5 and 5%. In the southern section, the relatively large number of animal burrows indicates that certain reptiles and mammals appear to be much more common there than in the north section.

Of particular interest are the several large but shallow depressions located in the northern section. During 2006, heavy rainfall was received on several days late in the spring (mid-April), leading to the creation of several temporary pools up to *c*0.25 km² in area that persisted for several weeks. On drying out, mass germination of the desert gourd *Citrullus colocynthis* was triggered, and a large number of large prostrate plants developed. Individual plants can easily exceed 2 m in diameter, and the mats can be so dense that the underlying substrate is not visible. The green of these and other plants in the depressions strongly contrasted with the otherwise virtually barren surroundings.

Depending on the availability of water, *Citrullus* is an annual or perennial. This cucurbit is remarkable in that it is one of the few species with the C_3 photosynthetic pathway to remain physiologically fully active during the hot summer months in Kuwait, and even flowers then. Furthermore, the leaves show none of the typical adaptations of desert plants, such as small size. Much the opposite, the leaves are among the largest (measuring up to 6 × 5 cm) of any wild species found in Kuwait. As mentioned by several authors (*eg* Lange 1959, Althawadi & Grace 1986), the plant transpires heavily to provide evaporative cooling of the leaves, with Lange (1959) reporting a reduction of up to 15.3°C compared with ambient air temperatures. Brown (2001) noted that it is highly dependent on a constant supply of subsurface water. Consequently, in years of unfavourable rainfall some plants will die off through lack of water.

RESULTS AND DISCUSSION

Black-crowned Sparrow-Lark

The Black-crowned Sparrow-Lark breeds in Kuwait and can be seen year-round especially in areas protected from overgrazing (Cowan & Pilcher 2003, Gregory 2005). Small numbers breed in Liyah (Brown pers obs), but a good site to see the species in Kuwait is the SARS extension.

Due to the substantial disturbance in the area that was to become the SARS extension, it is highly unlikely that the birds were breeding there before 2004, although it is possible that a few pairs may have been nesting in the original SARS area. According to E DeLima (pers comm), a single pair of birds began breeding in the newly protected SARS extension in an area of desert (*c*0.25 km²) that was irrigated in 2004. By 2006, several hundred pairs were breeding in the SARS extension, with by far the highest density in the irrigated site. This rapid colonisation of such a small area is quite remarkable, and reminiscent of the invasion and breeding of Dunn's Lark in the Arav'a valley, Israel, as described by Shirihai (1991). In the SARS extension, the species breeds in the *Moltkiopsis* community and open stands of the *Cyperus* community, but the former seems to be preferred. Most nests have been found at the base of *Cyperus* plants, which also occur as scattered individuals in the *Moltkiopsis* community.

Breeding numbers appear to have decreased somewhat during 2007 and 2008, possibly due to the distinctly low rainfall of the 2006/2007 and 2007/2008 seasons. However, a small pool was constructed in April 2007 immediately adjacent to the irrigated site that undoubtedly helped offset greater reductions in the breeding population, which was estimated to be in excess of 100 breeding pairs in early 2008. This pool is the most reliable place to see

Plate 6. Black-crowned Sparrow-Larks *Eremopterix nigriceps*, two females/juveniles by pool, 26 April 2008, SARS extension, Kuwait. © *Gary Brown*

Plate 7. Black-crowned Sparrow-Larks *Eremopterix nigriceps*, male, female and juveniles standing in the shade of the water supply tanks, 28 July 2008, SARS extension, Kuwait. © *Gary Brown*

Plate 8. Black-crowned Sparrow-Lark *Eremopterix nigriceps*, disturbed female that was sitting in the shade of a tyre, 17 July 2008, SARS extension, Kuwait. © *Gary Brown*

Plate 9. Black-crowned Sparrow-Lark *Eremopterix nigriceps*, male lying in the shade of a tyre, 17 July 2008, SARS extension, Kuwait. © *Gary Brown*

Plate 10. Juvenile Black-crowned Sparrow-Larks *Eremopterix nigriceps* apparently cooling on moist ground near the pool, 25 May 2007, SARS extension, Kuwait. © *Gary Brown*

Plate 11. Juvenile Black-crowned Sparrow-Lark *Eremopterix nigriceps* apparently cooling itself in a depression on moist ground near the pool, 24 May 2007, SARS extension, Kuwait. © *Gary Brown*

the birds during the summer months, when up to 80 adults and juveniles may be present at any one time (Plates 4, 6). Individual birds usually begin arriving by *c*08.00 h local time, when temperatures begin to rise above 35°C, and they remain in the vicinity throughout the day. Many of the birds rest in the shade of the immediately adjacent structure housing water supply tanks (Plate 7). Individual birds also seek refuge in the shade of car tyres which are used to mark out tracks in the area (Plates 8, 9). However, some birds, including

Plate 12. Adult male Black-crowned Sparrow-Lark *Eremopterix nigriceps* apparently cooling itself in shade on moist ground near the pool, 26 April 2008, SARS extension, Kuwait. © *Gary Brown*.

Plate 13. Adult male Black-crowned Sparrow-Lark *Eremopterix nigriceps* apparently cooling itself in a slight depression on moist ground near the pool (visible in background), 28 July 2008, SARS extension, Kuwait. © *Gary Brown*

adult males, females and juveniles, create small hollows in the damp/slightly moist ground immediately adjacent to the pool and will spend considerable periods of time there during the heat of the day, with their upper bodies fully exposed to the sun (Plates 10–13).

Dunn's Lark

Dunn's Lark was first recorded in Kuwait in 1987 and may be a regular breeder now. It has been observed at a number of sites including in the Sabah Al-Ahmed Natural Reserve (SAANR), but not in the south (Cowan & Pilcher 2003, Gregory 2005). As with Black-crowned Sparrow-Lark, perhaps the best place to see Dunn's Lark in Kuwait is in the SARS extension. Strangely, it appears to be absent from Liyah, which is quite near to SAANR, even though the southern section has a very similar vegetation structure to SAANR and the SARS extension.

It is highly unlikely that breeding occurred in the SARS extension before its protection. It has never been observed in the original SARS area, with its predominance of *Rhanterium epapposum*, probably because the area is too densely vegetated. In 2007, at least 20 pairs were estimated to be breeding in the SARS extension, possibly even more, although numbers were distinctly lower in the exceptionally dry spring of 2008. The species appears to prefer the low open vegetation of the *Moltkiopsis* community, as virtually all sightings have been reported from there. The species is frequently observed foraging on wide tracks in areas of that community. If disturbed, it will fly into *Cyperus* stands, but birds have not been seen feeding there. Its habitat preference appears to be for areas of low and very sparse vegetation. These are often highly degraded vegetation types or pioneer ones, the latter in the process of recovering from degradation.

The areas that Dunn's Lark inhabits offer few natural places where the birds can find effective shade. It is perhaps surprising that individuals in the SARS extension do not seem to take more advantage of those patches that do present themselves. Occasionally, birds are spotted in the shade of tyres that are scattered around the area, but even during the hot summer periods, most birds are still observed out in the open. Up until July 2008, there were fewer than 5 sightings of birds visiting the pool. However, on several occasions between 6 July 2008 and 3 September 2008, up to 2 birds could be observed at the pool in the early morning (08.15 h local time). One bird (Plate 14) sometimes remained for up to 30 minutes, allowing close approach in a vehicle (as close as 4 m). On one occasion (6 August 2008), the bird flew towards the vehicle and rested on moist ground in the partial shade of a log supporting the water inlet to the pool, just 2.5 m from the vehicle (Plate 15). When it was finally disturbed, it flew off into the shade of the water tanks, *c*20 m away. Again, the

Plate 14 (left). Dunn's Lark *Eremalauda dunni* by pool, 6 August 2008, SARS extension, Kuwait. © *Gary Brown*

Plate 15 (right). Dunn's Lark *Eremalauda dunni* apparently cooling itself in partial shade on moist ground near the pool, 28 July 2008, SARS extension, Kuwait. © *Gary Brown*

bird allowed close approach (*c*3 m) by vehicle, before flying off into open *Moltkiopsis* vegetation. On turning off the car engine, the bird gradually returned to the exact place from where it flew off, first walking then flying in short bursts. It was then observed and photographed for over an hour from a distance of *c*3–5 m. Shortly later, 3 other birds were seen in the open desert, less than 1 km away. During the period from 6 July to 21 August 2008, when I visited the pool weekly, what was almost certainly the same bird (identifiable by the distinctive pattern of small feather shafts surrounding the eye) would arrive at the water tanks by 08.15 h at the latest, at the same time as the first influx of Black-crowned Sparrow-Larks. Presumably, it was there every day resting in the shade. Temperatures at 08.15 h were rapidly rising above 35°C at this time of the year. If sufficiently cautious, the bird could be approached up to about 3–5 m, and if disturbed, it would soon return, as described above. On 21 August 2008, the bird arrived at 08.10 h, and was singing continuously from the shade for 30 minutes (before I left) in between bouts of preening and feeding. When I visited the pool on 3 September 2008, the temperature was still below 35°C at 10.00 h, and it was extremely humid. Two Dunn's Larks were drinking at the pool at *c*09.00 h, but there were no birds in the shade of the water tanks (except for a Eurasian Hoopoe *Upupa epops* and two Short-toed Larks *Calandrella brachydactyla*). The Dunn's Larks were quickly disturbed by the vehicle and flew off into open desert. At 10.00 h, one Dunn's Lark (possibly the same bird that was repeatedly seen by the water tanks over the previous weeks) was found resting in the shade of a tyre, about 250 m from the pool. It allowed close vehicular approach (*c*5 m), but eventually few off. On returning to the same spot 10 min later, the bird was back again.

Bar-tailed Lark

Bar-tailed Lark is a breeding resident in Kuwait away from the coastal conurbation. It is regularly seen in various sites in northern Kuwait, usually in protected areas or in remote, less disturbed locations such as in the far west (Cowan & Pilcher 2003, Gregory 2005). It is regularly observed in Liyah, where it presumably breeds, but it is absent from SARS. In SAANR, both Bar-tailed and Dunn's Larks breed in the same general area.

Plate 16. Bar-tailed Lark *Ammomanes cinctura* on *Citrullus* mat, allowing close vehicular approach. The bird appears slightly alarmed, 27 August 2006, Liyah, Kuwait. © *Gary Brown*

In Liyah it has been observed mainly in the southern section in open *Stipagrostis* stands, but small groups of 4 or 5 birds have also been seen on virtually barren substrate in the north. On two occasions (at least), birds have 'mysteriously' disappeared whilst observing them in the southern section of Liyah. In both cases, it was found that they had entered *Uromastyx aegyptius* lizard burrows, presumably to protect themselves from the sun. Williams *et al* (1999) reported that entering these burrows is less frequent in the smaller larks (including Bar-tailed Lark) compared with the larger Hoopoe Lark, in Saudi Arabia.

In August 2006, a single bird, apparently cooling itself on a mat of *Citrullus colocynthis*, was observed on several occasions in a depression in the northern section (also by E DeLima, pers comm). A number of Temminck's Larks were also present on adjacent plants (see below). The Bar-tailed Lark allowed close vehicular approach and it was standing, or rather crouching, with its wings slightly open towards the wind (Plate 16).

Temminck's Lark.

Temminck's Lark appears to breed regularly in the west of Kuwait, mainly in the vicinity of Wadi Batin (Cowan & Pilcher 2003). I photographed adults feeding their young there on 13 April 2006. It seems that after the breeding season, many birds disperse to other parts of Kuwait, as they have been seen in Liyah, SAANR (where, according to Gregory 2005, the species has bred) and in the SARS extension.

In August 2006 it was possible to guarantee observation of Temminck's Lark in the northern section of Liyah because of a remarkably high concentration of up to 40 birds. They occurred in three nearby depressions containing *Citrullus colocynthis*. Air temperatures were generally around or above 40°C. Birds would remain standing, crouching or even sitting on the *Citrullus* mats, with wings held away from their body, allowing close approach by the vehicle (Plate 17). Presumably, these birds had all previously been sitting on the mats, before vehicular approach. Up to 3 birds were often present on any one mat. If disturbed, the birds would either soon return to the same plant, or fly over to the next one close by. Conversely, it was rare to find a bird that was not associated with a *Citrullus* mat during the hottest part of the day. Occasionally, birds would be spotted in the shade of dwarf shrubs such as *Astragalus spinosus*. In both 2007 and 2008, no gourd mats developed in the depressions due to a paucity of rainfall earlier in the season, and as a consequence, presumably, neither Temminck's Lark nor Bar-tailed Lark was seen there during the summer period.

The apparent cooling behaviour of birds sitting on prostrate plants that transpire heavily, such as *Citrullus colocynthis*, is directly comparable to that of Black-crowned

Plate 17. Temminck's Larks *Eremophila bilopha* on *Citrullus* mat, allowing close vehicular approach, 31 August 2006, Liyah, Kuwait. © *Gary Brown*

Plate 18. Temminck's Lark *Eremophila bilopha* by pool, 1 August 2007, SARS extension, Kuwait. © *Gary Brown*

Sparrow-Larks sitting in shallow hollows in moist ground in the SARS extension. In both cases, the upper body of the birds remains fully exposed to the sun, which is in marked contrast to birds that enter lizard burrows. Detailed studies are required to assess the relative importance and efficacy of these strategies.

Single Temminck's Larks are occasionally seen in the SARS extension, usually after the breeding season, in August and September, although one bird was observed 8 April 2008. All sightings (*c*10, all involving single birds) were from the vicinity of the small pool, and on several occasions a bird was photographed drinking there (Plate 18). The species also takes advantage of the shade of car tyres used to mark out tracks there.

ACKNOWLEDGEMENTS

Dr Edgardo DeLima (formerly Kuwait, now Manila, Philippines), provided very useful information on occurrences of larks in Liyah. Dr Salem Al-Hajraf (KISR, Kuwait) ensured easy access to the Liyah area. Various other colleagues at KISR are thanked for their support. I am particularly grateful to Dr PJ Cowan (Nizwa, Oman) for encouragement to write this paper and valuable comments on a draft manuscript.

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