A population of Bosk's fringe-toed lizard *Acanthodactylus boskianus* (Daudin, 1802) in the Hajar Mountain foothills of the UAE

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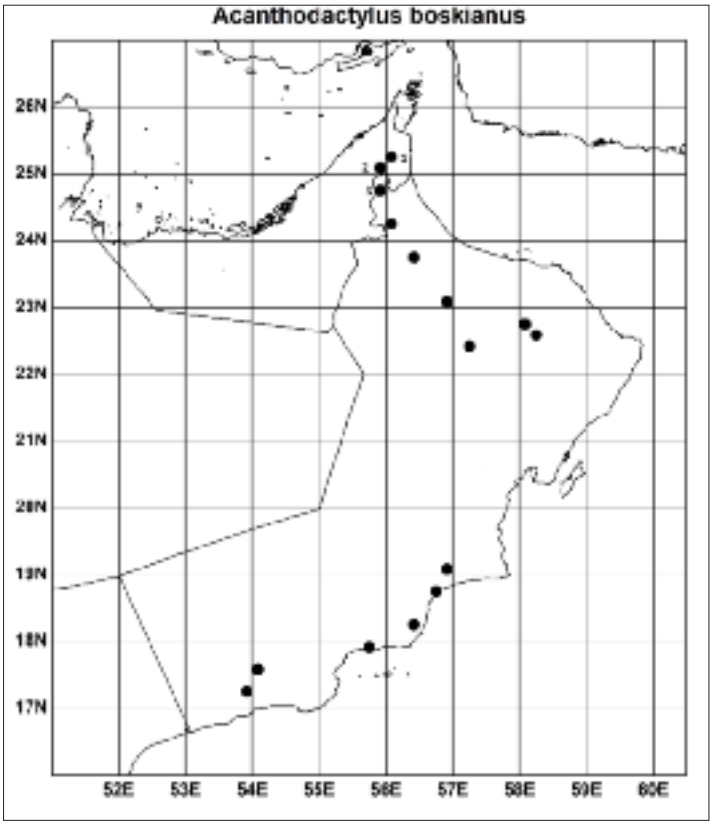

Fig. 1: Records of *Acanthodactylus boskianus* from the UAE and Oman (courtesy of A.S. Gardner). Point 1 represents the two sites discussed in this paper. Point 2 shows the approximate location of the first UAE reports of *A. boskianus* (Arnold 1984). Point 3 represents unpublished records from Peter L. Cunningham, described as being "in the area between Ash-Shu'ayb [Shuwayb or Shwaib] and [the] general Hatta direction" (Cunningham, *pers. comm.*). The map is not an authorityon international borders.

Abstract

A localised population of *Acanthodactylus boskianus* lizards (n 50 ± 10) has been identified along a wadi in the foothills of the Hajar Mountains of the United Arab Emirates (UAE). Photographs of adult male, adult female, juvenile and adolescent individuals are presented for reference. This constitutes only the second report of *A. boskianus* from within the UAE and expands the habitat for that species from what has been described on the basis of most earlier records from the UAE and neighbouring northern Oman.

The newly recognised *A. boskianus* population is associated with abandoned and eroded fields bordering a gentle wadi. Observation of foraging and foraging behaviour suggests that ants constitute the principal prey of this population, although termites were actively dug for and eaten and other, larger prey is probably taken opportunistically. The lizards are active primarily in the morning but some, particularly adolescents, also forage in late afternoon. Population evidence indicates that the reproductive season is extended but may be centered in fall and winter. Winter dormancy is possible but not confirmed.

Our successful effort to find *A. boskianus* at a second, similar location leads us to suggest that the species has heretofore probably been overlooked and under-recorded, being more common than was previously thought. Ironically, however, its foothills wadi habitat is today under severe threat throughout the UAE.

Introduction

Bosk's fringe-toed lizard *Acanthodactylus boskianus* (Daudin, 1802) is the most widespread species in the Saharo-Sindian lacertid genus *Acanthodactylus*, which includes about 30 species (Arnold 1980, Rastegar-Pouyani 1999). It is also the largest *Acanthodactylus* species throughout its range (Arnold, 1980, Sahara-Nature), which includes all of Saharan North Africa and the Middle East, i.e., Arabia, the Levant and Mesopotamia (including the Turkish border), as well as north-western Iran (Rastegar-Pouyani 1999). A recent account of the systematics of *A. boskianus* is given in Rastegar-Pouyani (1999).

A. boskianus is said to be present in all regions of the Sahara and to "frequent a range of stony and sandy environments such as the edges of routes, channels, wadi beds [and] palm groves" (Sahara-Nature). Jongbloed (2000) has mentioned that outside the UAE it is known from elevations up to 2000 metres. In Egypt, it is said to be common and found in a variety of habitats throughout the country (Khanoon 2009).

In the UAE, *A. boskianus* is one of six *Acanthodactylus* species, and one of the only two that have been recorded on other than sand substrates (Hornby 1996, Jongbloed 2000, Gardner 2005b, Gardner 2008, Gardner *in press*). *A. boskianus* has also been considered one of the rarest of the UAE's *Acanthodactylus* lizards. The only prior UAE records are those of Arnold (1984), believed to be from eastern Sharjah emirate, in the area between Dhaid and Madam (Gardner *pers. comm.*, Gardner *in press*), not far from the border with northernmost Oman (Fig. 1). The habitat was described as the interface between the gravel outwash plains along the west flank of the mountains and the active sand dunes still farther west (Arnold 1984).

It was therefore a considerable surprise when the authors encountered a small population of *A. boskianus* in early December 2012 in a lower tributary of Wadi Isfani, in the foothills south of Siji, on the west flank of the Hajar Mountains (Fig. 1). Our surprise was all the greater because extensive quarrying, road-building, power lines, private construction and weekend picnicking have severely disrupted the natural environment in that general area.

Nevertheless, within less than an hour we were able to observe and photograph an adult male, adult female and juvenile, each showing different and distinctive colour patterns (Rastegar-Pouyani 1999), in what was evidently a relatively concentrated local population. We also made some preliminary behavioural observations.

This population represented not only an extension of the known geographic range of *A. boskianus* within the UAE and Oman, but also an expansion of the range of habitats within which it is known to occur. We therefore made follow-up visits in mid and late December 2012, and again in early and mid-August 2013, to try to better

Fig. 2: An adult male *Acanthodactylus boskianus*, early December 2012. [BR]

Fig. 3: A young adult male *Acanthodactylus boskianus*, mid-August 2013, showing a relatively high proportion of vivid intermittent dark scales, retained from juvenile colouration. [BR]

Fig. 4: An adult female *Acanthodactylus boskianus*, early December 2012. [BR]

assess the size of the population and understand more about its ecology. This report describes and discusses our observations.

Identification

Comparison of our original photographs with literature sources (Rastegar-Pouyani 1999, Jongbloed 2000, Gardner 2008) permitted a tentative identification as *A. boskianus*, a species not previously encountered by either of the authors. That identification was confirmed by Gardner (*pers. comm.*) and Cunningham (*pers. comm.*). It is worth noting that images of *A. boskianus* available on the internet were inconclusive for purposes of identification, owing to the diversity of colour patterns found at other locations.

Description

The adult *A. boskianus* we observed were relatively large – larger (in our estimation) than *A. schmidti*, the UAE's most common *Acanthodactylus*, with which we are familiar. Relative size was one of the factors in favour of a tentative identification as *A. boskianus*. However, size remains a qualitative assessment. Because we wanted to be able to study the ecology of the population and wished to habituate the lizards to our presence, we did not attempt to capture and measure any specimens.

Jongbloed (2000) states maximum snout-vent length for *A. boskianus* as 95mm, versus a range of 60-100mm for snout-vent length in *A. schmidti*, but Arnold (1980) has pointed out that the sizes of both *A. boskianus* and *A. schmidti* vary with geography (and suggests that this is due to character displacement resulting from sympatry with other species). Like other *Acanthodactylus* lizards, *A. boskianus* has a very long tail, longer than the body length. Tail colour evidently varies with maturity and, in adults, with season.

Males. In adult males (Figs. 2 and 3), the ground colour is bronze, mottled with intermittent darker scales and marked with three faint pairs of pale, longitudinal stripes, residual from the juvenile colour pattern. A horizontal line of four irregular dark spots, separated by white, is present under the eye. Depending on light conditions, the overall bronze colour may appear slightly grayish or greenish. The belly is yellowish. Tail colour is dull blue-grey.

Females. Adult females (Fig. 4) have a medium to light brown ground colour with three distinct pairs of thin, pale, longitudinal stripes, retained from the juvenile colour pattern. The belly is pale. Tail colour in December was bluish-grey, similar to the male. Tail colour in August was dull pinkish-tan. In all cases the base of the tail was marked by subdued, darker transverse piping, fading out distally.

Juveniles. Juvenile *A. boskianus* (Fig. 5) were observed in both early December 2012 (n = 2) and mid-August 2013 (n = 1). They are distinguishable from adults not only by their much smaller size but also by their colouration, which features a boldly striped body with a pale, turquoise-blue tail. Length was measured indirectly at *ca*. 9cm, including the long tail. The trunk displays a pattern of contrasting

Fig. 5: A juvenile *Acanthodactylus boskianus*, early December 2012, showing the blue coloured tail. [BR]

Fig. 6: An adolescent *Acanthodactylus boskianus*, early August 2013. [GRF]

dark and pale longitudinal stripes from the base of the skull to the base of the tail. A dark central dorsal stripe (dark brown, appearing almost black) is flanked by three thin, pale cream-coloured stripes alternating with three slightly broader dark stripes. The belly is pale. A dagger of pale colour divides the central dorsal stripe from the base of the skull to the shoulder girdle. As in adults, the posterior surface of the legs is spotted white on very dark brown.

The pattern of a boldly striped trunk and a colourful tail is common to juveniles of a number of *Acanthodactylus* and other lizards, e.g., *A. opheodurus* (Arnold 1980). In this instance it created particular confusion initially, not only because *A. boskianus* was unexpected but because its juvenile colour pattern (black-and-white striped trunk and pale blue tail) closely resembles that of another juvenile lacertid found in the UAE, *Omanosaura cyanura*, a Hajar Mountain endemic (Feulner 2013). The latter would normally have been found only deeper in the mountains, in habitats characterised by narrower, bedrock wadis, but in the field we were forced to consider at the outset whether the juvenile form we encountered was conspecific with the undoubtedly 'new' male (*A. boskianus*) or whether it was an errant *O. cyanura*.

Adolescents. Adolescent *A. boskianus* (Fig. 6) were observed only in August 2013, when they constituted a majority of the individuals seen. They are intermediate in size between juveniles and adults. They continue to display the juvenile colour pattern of contrasting parallel longitudinal stripes, but the dark stripes are much less vivid and the tail is no longer turquoise blue but pale, slightly dull pink, as described for females. Closer inspection shows that the colour change to the trunk results because the dark stripes no longer consist of uniformly dark scales. Instead, in adolescents the dark stripes contain only intermittent dark scales, with lighter brown scales in between. A continuation of this process, i.e., reduction in the number of dark scales in favor of light brown ones, would result in what we have called the adult female colour pattern.

Several larger and less contrastingly striped adolescents displayed a diffuse but distinct reddish patch dorsally at the base of the tail, behind the hips (Fig. 7*)*. Its significance is unknown, but sexual signalling is an obvious possibility. The evidence for late summer egg laying (see "Reproductive cycle" below) makes the hypothesis of sexual signalling more plausible, but if it is correct, it would mean that at least some of the lizards that we have characterised as adolescents are in fact sexually mature, notwithstanding that they still retain some of the dark scales seen in juveniles.

Fig. 7: A late adolescent or young adult female *Acanthodactylus boskianus*, early August 2013, one of several individuals showing a diffuse red patch dorsally at the base of the tail. The significance of the red patch is unknown. [GRF]

Habitat

The *A. boskianus* population we have studied is associated with accumulations of silty soil along the low banks of a gentle wadi, representing former cultivated fields now eroding and exposing coarse gravel beneath. *A. boskianus* has been found along a 0.6 kilometre stretch of the wadi but the concentration of lizards is greatest where the silt is most continuous and dotted with small trees and shrubs, especially *Pulicaria glutinosa* (Family Asteraceae, a very common Hajar Mountain foothills shrub not browsed by quadrupeds). In a few places, the soil cover has been bulldozed in the past, for unknown reasons; we always found lizards near the resulting low, bulldozed piles of soil, perhaps because they created preferred substrate or more diverse small scale habitat.

No other reptiles were recorded among our *A. boskianus* population. Other UAE lizard species which might reasonably be expected at or near such a site include the diurnal lacertid *Mesalina adramitana* and the nocturnal gecko *Bunopus spatalurus* (*pers. obs.*, Gardner *in press*). A single semaphore gecko *Pristurus rupestris* was found at a second, smaller *A. boskianus* locality (described below), on dead wood covering the mouth of a cistern; *P. rupestris* would normally be found in a somewhat more rocky or stony environment than *A. boskianus*. A single *Pseudotrapelus sinaitus*, the Sinai agama, was found on stony ground near bedrock outcrops not far from the second *A. boskianus* locality.

The only prior records of *A. boskianus* from the UAE are from the gravel outwash plains bordering the Hajar Mountains, and more specifically from the interface between the gravel plains and the active sand dunes to the west (Arnold 1984). Arnold (1984) considered it probable that *A. boskianus* was limited to that habitat. That view was repeated by Jongbloed (2000) and has gone unchallenged by most other authors. Hornby (1996) described the habitat of *A. boskianus* as "Desert, wadis, coast" but the reference to coast was based on a photo record since reckoned to show an unusually well striped *Mesalina adramitana* (Hornby *pers. comm.*, Gardner *pers. comm.*). The foothills wadi environment therefore represents an expansion of the generally accepted habitat of *A. boskianus* within the UAE.

Reviewing this point with the benefit of hindsight, it is evident that, by design, Arnold largely excluded the foothills environment from the scope of his UAE field investigations. His pioneering study was focused on the ecology of "desert lizards", then understudied in Arabia, and he expressly distinguished "really desertic regions" from "the more mesic, peripheral areas, such as the mountains of northern Oman", which he considered had already received a measure of scientific attention (Arnold 1984). Cunningham's data, previously unpublished, bridges the gap to some extent; he reports "seeing [*A. boskianus*] in lower foothills and gravel plains, often in association with vegetated small ephemeral drainage lines" (Cunningham, *pers. comm.*).

Descriptions from other countries indicate that *A. boskianus* is an environmentally plastic species (Jongbloed 2000, Khanoon 2009). In Egypt, for example, it has been called a "sand lizard" (El-Masry & Hussein 2001) and in north-western Iran it has been collected from under spiny *Astragalus* bushes on a sand hill (Rastegar-Pouyani 1999). Its general restriction to firmer substrates in the UAE may be an example of character displacement resulting from niche competition with other *Acanthodactylus* species. Arnold (1980) has previously suggested character displacement as an explanation for the larger size of *A. boskianus* in Arabia, where it is often sympatric with the smaller *A. opheodurus*, than in North Africa, where it is not.

Population size, density and structure

The core area of the study population appears to be near the upstream extremity of the site, where continuous soil cover is most extensive (Fig. 8). There, at mid-morning in early August 2013, we recorded 14 individuals within a rectangular area of approximately 55 by 40 metres, or 2200 square metres. Only one lizard was an adult male (as determined by size and colour pattern); four were adult females (as determined by light brown ground colour and pale longitudinal stripes, with darker stripes extremely subdued or absent); and eight were adolescent (as determined by size and residual dark longitudinal stripes bordering the pale ones). Three more individuals (an adult female and two adolescents) were observed within about 20-30 metres of the core area.

Those observations permit us to calculate, very roughly, an average density in the core area of one lizard per 157 square metres, equivalent to a 12.5 metre (41 foot) square per individual. By way of comparison, Cunningham (2001) estimated a home range of roughly 200 square metres per individual in his study of *Acanthodactylus opheodurus* on sand and gravel plains north of Jebel Hafit, in Al Ain, UAE, with individuals typically being found 10-20 metres from each other.

Fig. 8: A view of the core zone of the *A. boskianus* site reported in this paper. [GRF]

The following morning we surveyed the downstream extension of our area and observed an additional 11 individuals over approximately 500 metres, in similar but somewhat more discontinuous and more heavily treed habitat. These included one adult male and an estimated two adult females and eight adolescents, all of the adolescents approaching adult female colouration and several showing a reddish patch dorsally at the base of the tail, as described above.

In all, we observed 28 individual lizards foraging along *ca*. 600 metres of wadi. From this we estimate the total population in the area to be approximately 50 ± 10 individuals. The lizards were not difficult to observe and, given the limited scale of the area of preferred habitat, we believe it is reasonable to suppose that we observed approximately 50% or more of the total population. The areas upstream and downstream of our site are disturbed by construction and do not preserve similar habitat.

The apparent scarcity of adult males seems anomalous, but more information about the social structure of *A. boskianus* (or other *Acanthodactylus* species) might suggest an explanation. It is known, for example, that *A. boskianus* is territorial and that males acquire dominance hierarchies in captivity (Khanoon 2009). If social dominance can regulate the expression of male breeding colours, then it is possible we have been mistaken in some of our field determinations of adult gender.

Reproductive cycle

A summary account of reproduction by *A. boskianus* in North Africa says that, "This lizard lives in a burrow of 30 to 40 cm in depth which it excavates at the foot of a clump of vegetation. The female deposits 2 to 4 eggs which incubate for 75 days, hatching taking place in August" (Sahara-Nature).

At our UAE site, our observations provide circumstantial evidence for an annual life cycle featuring egg-laying in late summer to mid-winter (late August to perhaps as late as February) and hatching in mid-autumn to early spring (late October to perhaps as late as early May), as elaborated below. However, the presence of juvenile lizards in both early December and mid-August leaves open the possibility that reproduction could be multi-seasonal or relatively continuous, or, even if reproduction is generally seasonal, that the potential exists for opportunism.

The predominance of adolescent lizards in August 2013 may reflect enhanced breeding success as the result of above average rainfall during the preceding autumn, winter and spring. The autumn of 2012 was probably somewhat wetter than normal, with (anecdotally) some rain having fallen in each of September, October and November. At the time of our initial visit to the site in early December 2012, a grove of flowering and seeding *Datura stramonium* was flourishing in silt where flood water had backed up at a road crossing. Subsequently, major rainfall events occurred over mountain areas of the UAE in mid-December 2012 (*pers. obs.*), early April 2013 and late April into early May 2013 (J. Judas, *pers. comm.*).

Development and maturation times for *A. boskianus* are not known, but Arnold (1984) has reasoned from field evidence in the UAE that the similar sized *A. schmidti* matures within one year: *A. schmidti* "are common as adults in the spring, but virtually no juveniles are present until eggs laid that year hatch, so these presumably reach full size by the next spring."

Assuming that a minimum of approximately 75 days are spent as a juvenile (equivalent to the reported North African incubation period), the many *A. boskianus* lizards we observed as adolescents in early August must have hatched no later than mid-May. Adding the reported 75-day incubation period, mating and egg laying would have occurred no later than end-February. But the adolescents seen in August 2013 were variable in size and the largest of them, at or near adult size, could reasonably correspond to the juveniles seen in December 2012; some may even have reached sexual maturity, as possibly indicated by the reddish patches at the base of the tail. In turn, the juvenile lizards present in early and mid-December 2012, *ca*. 9cm in size, must have hatched by mid

Fig. 9: An adult male *A. boskianus* anticipates making a meal of a large ant, *Cataglyphis* sp. This individual exhibits a re-grown tail. [BR]

or late November, and therefore, if we accept the reported 75-day incubation period, from eggs laid by early September 2012. These estimates dovetail nicely to frame an annual cycle commencing with egg-laying in late summer through mid-winter, followed by hatching and maturation in time for first-year individuals to participate in egg-laying at the next annual cycle.

Arnold found that for many species of UAE lizards, dates of egg carrying are spread over two months or more (his dates for *A. schmidti* span five months, from January through May), suggesting that breeding is repetitive and several clutches are laid (Arnold 1984). We did not directly investigate reproductive status or observe reproductive activity in our study population of *A. boskianus*, but our observations of population structure are consistent with an extended breeding season. However, Arnold (1984) also generalised that most egg carrying in UAE lizard species takes place in the spring. That generalisation is not well supported by our study population, for which, as indicated, our data instead suggest a breeding season centered on autumn and winter. We cannot assess, from observations within a single year, whether this represents the normal pattern for *A. boskianus* in the UAE or whether, perhaps, in the context of the relatively unpredictable UAE rainfall regime, the breeding period can be shifted facultatively to take advantage of unseasonably clement conditions.

Unfortunately, we were unable to make field observations during spring 2013 and our field time in late summer 2013 was devoted to the search for additional *A. boskianus* sites. In hindsight, additional observations during either or both of those periods might have helped to better resolve the timing of breeding activity.

Behaviour: foraging and tail movements

All *A. boskianus* were observed principally on relatively firm, silty soil with scattered rocks and shrubs. If approached too closely or too rapidly, they retreated to the cover of shrubs, mostly *Pulicaria glutinosa*, which grows in more or less cushion-like clumps and spreads close to the ground.

When not taking cover, the lizards foraged actively on the firm soil, moving, pausing, watching, waiting, then moving again. Sometimes they stopped on local high points (minimally so, on relatively flat ground) as if to have a better view. Forward movement was generally purposeful and sometimes rapid. Upon stopping, the lizards

normally exhibited the tail swishing movement characteristic of at least some other *Acanthodactylus* spp., e.g., *A. schmidti* and *A. gongrorhynchatus* (*pers. obs.*) and *A. opheodurus* (Arnold 1980, Cunningham 2001). The tail was swung to one side or the other, ± 90°, with a modest but distinct extra flourish of the tip. In this position the lizard is alert, with head up. On one occasion when we watched a lizard stop with its head down, to examine the ground beside a small stick, it did not swish its tail. A lizard digging for termites moved its tail regularly, but evidently primarily to counterbalance frequent changes of body position.

Why do the lizards swish their tails? Flexing the tail perpendicular to the body probably facilitates rapid acceleration by conferring a mechanical advantage, which may explain why alert lizards do this and preoccupied lizards do not. But there seems to be more to the movement than simply positioning the lizard on the starting block.

Many *Acanthodactylus* spp. and other lacertids are known to exhibit tail autotomy (i.e., tail shedding) in response to attack (Arnold 1984, Jongbloed 2000, Cunningham 2001). This appears to be the case for *A. boskianus* as well. At least one of our adult lizards exhibited a re-grown tail (Fig. 9); so does the adult *A. boskianus* shown in Gardner (2005a) (at p. 234). In such species, tail swishing behaviour has been tentatively interpreted as a defence mechanism to mislead would-be predators (Cunningham 2001). This makes intuitive sense. In case the movement of the lizard on open ground attracts the attention of a nearby predator, it is advantageous if the predator is promptly misdirected to the disposable tail rather than the head or body. By the same token, a single initial swish may be optimal, since the likelihood that the lizard has been observed and will be attacked probably diminishes with the passage of time, and further movement only increases the risk of attention.

Notwithstanding the appeal of the foregoing logic, since different sympatric species of *Acanthodactylus* have different tail colours (a useful field characteristic to discriminate among them), a sexual signalling function for tail movements cannot be ignored, as has been documented for other regional diurnal lizard species (Arnold 1980, Ross 1990, Feulner 2004).

Shelter

A North African account generalises that *A. boskianus* "lives in a burrow of 30 to 40 cm in depth which it excavates at the foot of a clump of vegetation" (Sahara-Nature). At our own site, we saw numerous examples of probable *A. boskianus* burrows (Fig. 10) under clumps of vegetation; not many other species are present that are likely to have constructed them. More generally, the availability of a substrate suitable for burrowing suggests itself as one of the principal factors localising our UAE population.

Fig. 10: An *A. boskianus* burrow entrance under a *Pulicaria glutinosa* shrub. This burrow was thought to have at least two entrances. [GRF]

Sometimes we saw multiple burrow entrances under the same small shrub. We watched one adolescent lizard retire to such a burrow at the end of a late afternoon sortie. But we also saw another type of burrow, an inconspicuous slot in flat, open ground. We saw two adolescents stationed near such burrows (Fig 11), each 1-2 metres from small shrubs, while out in late afternoon, and we watched one of those lizards actually retire to the nearby burrow, only about 15 minutes before darkness. Thus we suggest that, in addition to burrows used for breeding and or permanent residence, *A. boskianus* (at least immature lizards) may also excavate more rudimentary burrows for temporary use. The entrance to some of these latter burrows appeared to be partly blocked, whether by accident or design.

Diet

We observed at least a half dozen individuals catch and eat ants, mostly very small ants. The one adult male found in the core zone was especially active and fed on several ants, including larger ones, in the space of less than a minute. An adolescent foraging in late afternoon ate an estimated dozen ants in an hour of observed foraging. One small adolescent attempted to take a very large and robust ant, apparently the soldier

Fig. 11: An adolescent *A. boskianus* in late afternoon, beside its simple burrow on open ground. [GRF]

Fig. 12: This adolescent lizard, the same individual shown in Fig. 11, revealed an unsuspected talent when the piece of wood at left was tossed towards it, about 30 cm away. Instead of fleeing, the lizard tracked its trajectory and "caught" the stick in its mouth at the instant of contact with the ground. [GRF]

caste of an unknown species (possibly *Camponotus sp.*), but released it after a brief attempt.

At least six types of ants were distinguishable: (i) the common large black *Cataglyphis* workers (Fig. 9); (ii) the still larger soldier ant mentioned immediately above; (iii) a medium-sized but robust red-orange ant; (iv) a similar-sized but more delicate red-orange ant; (v) a medium-sized, thin ant with a red head and thorax and a short, heart-shaped black abdomen; and (vi) a very small, thin black ant. Only (i) and (vi) were common, and (vi) appeared to be the principal prey item. The only other ground insects we observed were a few Tenebrionid beetles, probably of the genus *Adesmia* (the so-called Pitted Beetles).

Our observation of repeated predation on ants, the fact that all of the lizards foraged on open ground, and the relative scarcity of other suitable prey, all point to ants as a principal prey of our *A. boskianus* population. That is consistent with Arnold's (1984) assessment for *A. schmidti* and Cunningham's (2001) generalisation that ants seem to be the favoured diet of *Acanthodactylus* species generally, notwithstanding anecdotal evidence of other prey items. Nevertheless, the dietary contribution of other prey items may be important, although less frequently documented.

We watched one adult male lizard dig for and consume small termites. The male, which had already travelled *ca*. 10 metres from where we had first seen it, took shelter at one point under an accumulation of twigs in the shade of low branches of a *Pulicaria glutinosa* shrub. There it soon began to scrape purposefully in the dirt with its forefeet and snout, picking at and gobbling up something we could not discern. When it had moved on, we investigated and found, just below the surface, a few very small white termites of a kind we had noticed half an hour before at a piece of discarded lumber. On another occasion we watched an adolescent lizard dig repeatedly and unsuccessfully, probably for suspected termites, at the spot where a thin branch from a dead and toppled small tree poked into the soil.

Still another adolescent was seen to taste a small piece of potato crisp that we had inadvertently dropped nearby. The lizard briefly masticated one corner but did not ingest the crisp; we speculate that it was probably licking the surface salt.

A casual experiment revealed an unsuspected talent with dietary implications (Fig. 12). An adolescent lizard had been alert but motionless for some time on open ground in late afternoon. One of the authors tossed a small piece of dead wood in front of it, about 30 cm away. Instead of fleeing, as expected, the lizard darted forward, evidently following and foreseeing the descent trajectory, and seized the stick in its mouth at the instant of contact with the ground. It was only then that we realised that the piece of wood was, coincidentally, about the same size, shape and colour as a medium-sized local grasshopper (e.g., *Sphingonotus* spp.). From this we infer that geophilous grasshoppers and other insects alighting on bare ground in the vicinity of *A. boskianus* are in danger of being tracked and caught by waiting lizards.

The UAE's most common fringe-toed lizard, *A. schmidti*, is known on occasion to hunt and eat juveniles of other lizards, including other *Acanthodactylus* species (Baha El Din 1996). Since *A. boskianus* is the largest of the UAE's *Acanthodactylus* species, we cannot rule out the possibility that it too may sometimes take other,

smaller lizards. As mentioned above, we have recorded no other reptiles within the area of our *A. boskianus* population.

It should be noted that the behaviour, foraging habits and diet of *A. boskianus* in North Africa have been described somewhat differently (in translation from French): "*Acanthodactylus boskianus* is active by day, especially in the morning, it hibernates until April. . . . [It] feeds on small insects, beetles, flies, it hunts visually and is very agile, it likes to climb and perch in bushes" (Sahara-Nature).

Predators and predator avoidance

A relatively dense population of lizards would seem to present a tempting opportunity for predators. However, the study population is limited in extent and, as far as we have been able to determine, is singular, so it may not be worth the while of local predators to specialise in predation on *A. boskianus*. That reasoning will have to be revisited if, as we suspect, *A. boskianus* proves to have been, in the recent past, more common and widespread than previously recognised.

Red foxes are probably the most likely terrestrial predators. They might also be attracted to the area in winter by the litter left by picnickers, although we saw no fox prints or droppings at any time. Avian predators are also a possibility, but birds have not been much in evidence when we have been present at the site. The only species we have seen that might be possible predators on *A. boskianus* are the Southern Grey Shrike *Lanius meridionalis* and the Indian Roller *Coracias benghalensis*. Tracks of ground birds were most likely those of Grey Francolin *Francolinus pondicerianus*, heard at a distance. The presence of owls along the foothills, e.g., the Desert or Pharaoh Eagle Owl *Bubo ascalaphus*, may be one reason why our lizards retired to their burrows before dark (see below, "Diurnal schedule").

Like other *Acanthodactylus* species (Arnold 1980, Cunningham 2001), *A. boskianus* probably relies principally on vigilance, speed and vegetation cover to avoid predators. As noted above, the lizards normally responded to potential threats by retreating to the shelter of a low shrub, usually *Pulicaria glutinosa*. There they remained motionless, evidently relying on their camouflage. We did not observe the "doubling up" posture reported by Cunningham (2001) for *A. opheodurus*, but we never attempted to actively alarm any lizards.

Reactions can be very cautious, however. In one instance, a small piece of litter (*ca*. 1 cm square) was accidentally dropped above a lizard that had approached at close range to where we stood on open ground. The lizard reacted instantly to this small object falling vertically, about 7-10 cm in front of it. It shot off to the rear, but stopped only about 60 cm away, still on open ground.

Diurnal schedule

Like most *Acanthodactylus* species, *A. boskianus* is diurnal. In early December, we found lizards active until at least midday. In early and mid-August, the first lizards were observed at 0700-0800 hrs on generally slightly overcast mornings, at air temperatures of *ca*. 32°C (90°F). More were observed, and they became more active, as the sun broke through at *ca*. 0830 hrs. Observations declined after about 1000 hrs (with sightings then often in shade and air temperature at 38°C (100°F)) and we saw no lizards after 1100 hrs, by which time the air temperature had reached 40°C (104°F). Cunningham (2001) likewise observed that *A. opheodurus* in the UAE retreated to its burrows when air temperatures approached 40°C.

Where it has been studied in North Africa, *A. boskianus* is active principally in the morning; it does not have a bimodal activity pattern (Cunningham 2001, citing Perez-Mellado 1992; Sahara-Nature). The same is true of at least two other *Acanthodactylus* species that have been studied in the UAE, *A. schmidti* (Cunningham 2001, citing Haas 1957) and *A. opheodurus* (Cunningham 2001). In contrast, *A. gongrorhynchatus*, studied in eastern Saudi Arabia and Abu Dhabi, is reportedly active in both morning and late afternoon (Baha El Din 1996).

We paid a late afternoon visit to our site in mid-August and found three individuals, all adolescents, active in the core zone beginning from at least 1700 hrs (when we commenced observations) until 1900 hrs, at a temperature of *ca*. 32°C (90°F). One lizard, the largest, foraged relatively actively, traversing and re-traversing open ground and circling small shrubs, eating an estimated dozen small ants. The other two were largely motionless but alert on open ground; one was the individual which "caught" a tossed piece of wood, as described above under "Diet". The most active individual retired to its burrow at the base of a bush at *ca*. 1815 hrs. The wood-catcher retired at *ca*.1900 hrs (only 10-15 minutes before darkness) to its simple slot burrow in open ground (Fig. 11). From these observations we generalise that although *A. boskianus* is active principally during the morning, some individuals, particularly adolescents, may also forage in late afternoon. In

Fig. 13: In pleasant weather, the *A. boskianus site* is shared on weekends with local picnickers. Litter is an aesthetic problem but more serious habitat damage is probably done by vehicles and destruction of plants for firewood. [GRF]

addition, there may be a tendency for the afternoon hunting strategy to shift from active hunting to "sit and wait".

Thermoregulatory behaviour

As has been reported for other *Acanthodactylus* species (Arnold 1984, Cunningham 2001), *A. boskianus* was increasingly seen in the shade of shrubs and trees as air temperatures increased during its activity period. But, with a single exception, we saw no other examples of postures or behaviours (e.g., climbing shrubs) that we interpreted as thermoregulatory.

The exception was the adolescent lizard, mentioned above, which dug repeatedly, probably for suspected termites, at the spot where a branch from a fallen tree poked into the silty soil. Roobas took a video of that effort, in partial shade at about 0845 hrs, which records a number of furious but unsuccessful bouts of excavation, using both forelimbs. Studying the video at leisure, we saw that in the course of its exertions, the lizard paused twice to rest for a few seconds in the disturbed soil, lying on its belly with its forelegs and head in the air, and its hind legs splayed and weightless.

Arnold (1984) noted that, as surface temperatures rise, some diurnal desert lizard species dig into the substrate so that they can place their bodies in contact with cooler layers beneath. We tentatively interpret the behaviour we observed as an effort by the lizard to reduce its body temperature, elevated due to physical activity, by lying in cooler, subsurface soil exposed by digging. Cunningham (2001) recounted a similar phenomenon in *A. opheodurus*: "When actively pursuing prey on warm surfaces they often rested their bodies on the ground and raised their forelegs momentarily."

Does *A. boskianus* hibernate in the UAE?

In Egypt, *A. boskianus* undergoes hibernation (perhaps better termed winter dormancy in ectotherm species) from December through February, triggered by reduced photoperiods (El Masry & Hussein 2001). Our observations leave open the question whether *A. boskianus* also hibernates in the UAE.

A morning visit in mid-December 2012 turned up no lizards in the core zone and only one juvenile overall, at the downstream extremity of the population, but the weather that day was breezy, mostly cloudy and there was some drizzle. A late December visit encountered no lizards at all; the day was sunny, but also cool and extremely windy. In both cases, our observations (or lack of them) are consistent with the hypothesis of winter

dormancy beginning in mid-December, but they could also be attributable to the weather conditions prevailing at the time of our visits.

Other commitments made it impossible for us to re-visit the site during the winter and spring to resolve the question definitively, but the presence of juvenile lizards in early December, particularly if that reflects the normal annual reproductive cycle as suggested above, is arguably evidence against hibernation, since it would be unusual for hatching to closely precede seasonal dormancy.

A second site: Has *A. boskianus* been overlooked and under-recorded?

In mid and late August 2013 we undertook to see if, making use of our experience, we could find *A. boskianus* at other, similar sites. This exercise was not as straightforward as it may sound, because a great deal of the potential *A. boskianus* habitat in foothills wadis for *ca.* 20 kilometres to the north and south of our site has been not merely disturbed, but totally destroyed by quarrying or by the construction of dams, highways, pipelines and/or power lines (see also "Conservation concerns" below). In the end, our results were mixed. We were able to find another *A. boskianus* site within the Wadi Isfani watershed almost immediately, but we found no evidence of these lizards at three other search areas to the south.

We knew of a promising area in mid-Wadi Isfani, only about 3 kilometres distant as the crow flies, but some 9 kilometres away along wadi beds. Scouting by car, we found a lizard almost immediately at our second vehicle stop, evidently a young male (Fig. 3) – not very large but with full male colouration, except that it still retained a relatively high proportion of vivid intermittent dark scales. At our third stop, in and adjacent to recently cultivated fields, we encountered an adolescent and a boldly striped, blue-tailed juvenile, both foraging actively on silty soil. We also found occasional tracks probably made by *A. boskianus* among the natural wadi bank vegetation (*Saccharum griffithii*, *Tamarix* sp. and *Juncus* sp.) bordering the fields in this area.

We saw no other *A. boskianus* there, however (and only a single *Pristurus rupestris*), despite patient inspection before mid-morning (1000 hours). We asked ourselves why there were not more, in what seemed like congenial habitat. Tree cover was similar but the ground level vegetation was different from our main *A. boskianus* site. *Pulicaria glutinosa* was all but absent; the main shrubs were *Fagonia indica* and *Rhazya stricta*, the latter indicative of overgrazing by camels and goats (of which we saw approximately 4 dozen in 3 small herds during our visit). But we also took note that almost the entire width of the broad wadi bed and its lower banks was covered with a thin layer of fresh silt, and flotsam debris draped almost every shrub on the upstream side, the result of a major recent inundation.

Later in the day, an interested local resident directed our attention to the same phenomenon. In a discussion of the fish species that were (and were not) then present at a permanent pool in the wadi, he emphasised the need to take account of the massive flooding that had occurred just a few months earlier (S.M.S. Al Qaydi, *pers. comm.*), probably corresponding to an April 30 to May 1 rainfall event on the UAE's East Coast (J. Judas, *pers. comm.*). The headwaters of Wadi Isfani drain *ca*. 40 kilometres of mountain ridges that also drain, in the opposite direction, to the East Coast. They rise in a few places to more than 1000 metres. Our local acquaintance described the flooding in Wadi Isfani as unprecedented in his lifetime of some thirty years. We were left to contemplate the possibility that the *A. boskianus* population in mid-Wadi Isfani was perhaps temporarily depressed owing to mortality and habitat destruction occasioned by that event.

The discovery of a relatively dense local population and the fact that we were able to predict and find additional lizards elsewhere inevitably calls into question whether *A. boskianus* is (or was) quite as rare or as restricted as has heretofore been accepted. Our local resident acquaintance did not regard the striped adolescents we showed him as exceptional (Al Qaydi, *pers. comm.*) and there are no local species with which they could be readily conflated.

We therefore extended our search to other wadis along the western mountain front, taking advantage of relatively detailed local geographical knowledge. We searched fruitlessly, however, in abandoned fields along wadi banks above the dams in Wadi Shawkah and Wadi Baraq. In the latter, we found that small animal husbandry stations have proliferated, relying on the ability to pump ground water from depths of more than ten metres. One result is that overgrazing by camels and goats has effectively removed almost all of the small shrubs from the wadi bank terraces, eliminating both the cover and burrowing sites favoured by *A. boskianus* at our principal site. In Wadi Qawr, a historical transit route across the mountains, agricultural development on an industrial scale has transformed any suitable wadi bank habitat that might have existed.

Fig. 14: A quarry in the Hajar Mountain Foothills south of Siji. [GRF]

We conclude from these results that any new-found optimism about the historical or current status of *A. boskianus* must be countered by grounds for considerable pessimism concerning conservation of its foothills wadi habitat generally.

Conservation concerns

It is interesting to contemplate that humans may have unwittingly promoted the creation of favourable habitat for *A. boskianus* at the principal site reported here, and at other foothills wadi sites, by constructing the fields whose remains the lizards now exploit (and even by limited bulldozing in more recent times). But humans are surely now degrading that same habitat. A paved road runs through our main site and power lines parallel the road; a 4-metre high bulldozed berm blocks the view of the wadi from the road for some 30 metres; in winter, local picnickers occupy prime *A. boskianus* habitat, driving large vehicles onto the limited remaining field areas, and harvesting and cutting brush and trees for campfires.

More alarmingly, foothills habitats for tens of kilometres to the north and south along the mountain front, across the borders of several emirates, have been obliterated by extensive and indiscriminate quarrying and dam construction. The cumulative assault is massive, especially when these are added to multiple highway, pipeline and power line routes. The mountain front and foothills environment is probably the second most threatened environment in the UAE, after the coastal zone. This diminishes the possibility that *A. boskianus* can survive at historical levels in that habitat.

The discovery reported here, of a large and previously unsuspected population of a rare lizard, epitomises the more general problem that environmental destruction continues in ignorance of what is being lost. Other examples of lost or threatened natural heritage along the mountain front and foothills of the UAE are unique fossil localities such as the Palaeozoic Kub Melange (Robertson *et al*. 1990), Palaeolithic stone tool sites, representing evidence of the earliest human inhabitants of Arabia (Green 1999, Scott-Jackson *et al*. 2008), and the only UAE sites for the native freshwater minnow *Cyprinion microphthalmus*.

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