Captive husbandry of the Dwarf plated lizard, *Cordylosaurus subtessellatus* (Smith, 1844), with indications for ecological and behavioural characteristics

VICTOR J.T. LOEHR

Homopus Research Foundation, Kwikstaartpad 1, 3403 ZH IJsselstein, Netherlands
Email: *loehr@homopus.org*

ABSTRACT — A captive study, combined with observations in the wild, revealed preliminary ecological and behavioural information on *Cordylosaurus subtessellatus*. Captive specimens switched between a unimodal and bimodal activity pattern, depending on the season (i.e., unimodal in winter and spring, and bimodal in summer and autumn). Specimens in the wild showed a bimodal activity pattern in spring. In all seasons, daily activity time was limited to a few hours or less, and captive lizards remained inactive following days of feeding, perhaps to avoid predation. When lizards were inactive, or disturbed by the observer, they hid in shallow dry sand. Initially, captive specimens were intolerant towards one another, but this behaviour phased out within a year. Captive specimens fed on a variety of live and dead medium-sized arthropods, but these were only caught when they had moved close to the lizards. Lizards produced a late summer and spring clutch consisting of two eggs, but these did not produce hatchlings. Mating took place several weeks after oviposition.

THE Dwarf plated lizard (*Cordylosaurus subtessellatus*) is the smallest member of the sub-Saharan African Gerrhosauridae, with a reported maximum snout-vent length of 57.1 mm (Bauer *et al*., 1999). The smooth body with relatively small limbs superficially resembles that of a skink. It has a dark-brown to black ground colour, with two cream to yellow dorsolateral lines, running from the snout to the tail. On the tail, the lines gradually change to an electric blue colouration (Fig. 1; Branch, 1998). The limbs may have a reddish tint, and the belly is off-white. A characteristic that distinguishes the species from all other Gerrhosauridae is the presence of transparent discs on the lower eyelids (Branch, 1998).

Cordylosaurus subtessellatus has a large distribution range, extending from the Western Cape of South Africa north to southern Angola, and from the Atlantic coast as far inland as Windhoek in Namibia (Branch, 1998). Most of the area experiences summer rainfall (October to March), but the southern coastal parts receive most rain in winter. Rainfall in the entire area is limited to 10–500 mm per year (Müller, 1983; Branch, 1998). Within the large distribution range, the species may occur somewhat isolated since it is associated with rocky habitat (Fig. 2; Branch, 1998; Bauer & Branch, 2001) . In suitable habitat, it may be common (Bauer & Branch, 2001), and its conservation status in Namibia is listed as 'secure' (Griffin, 2003). Despite its apparent commonness, published observations are scarce. Reports are limited to notes on their size and distribution, with only a few words on ecology and behaviour (Branch & Bauer, 1995; Cooper *et al*., 1997; Branch, 1998; Bauer *et al*., 1999; Bauer & Branch, 2001; Loehr, 2004). This is surprising, as the bright blue tail of this diurnal species makes it easy to spot, identify, and study.

Of all Gerrhosauridae, *Gerrhosaurus* spp. are probably the most frequently kept in captivity. They are hardy species, but captive breeding is not widespread (Kirkpatrick, 1993; Slavens, 1999). Published results of captive husbandry of *C. subtessellatus* appear to be absent, except one remark by an anonymous author on the internet in 2003 referring to K. Adolphs stating that *C. subtessellatus* brought from Namibia in 1987 survived only a few months in captivity. Without details on the history of the lizards (e.g., period between capture and release in captivity, means of transportation) and husbandry methods (e.g., medical evaluation and treatment, facilities, group composition), it is difficult to interpret the negative findings. In general, captive husbandry can be a valuable tool to gather ecological information on a species, facilitating the development of *in situ* studies or wildlife conservation plans (e.g., see Loehr, in press). In addition, husbandry methods are much better now than they were in 1987, with successful breeding of lizards that used to be difficult to keep alive (e.g., *Uromastyx* spp., *Chamaeleon calyptratus*, *Sauromalus obesus*) as a result.

In order to increase the available information on the ecology and behaviour of *C. subtessellatus*, I combined a captive study with observations in the wild. Focused topics were (1) behaviour, (2) diet, and (3) reproduction.

MATERIALS AND METHODS

Observation in the wild

While conducting an ecological study on the Namaqualand specked tortoise, *Homopus signatus signatus*, records were made of sympatrically occurring *C. subtessellatus*. Three to four persons methodologically inspected the approximately 4 ha Succulent Karoo research area (Loehr, 2002, 2004) in spring, from 2nd September to 2nd October 2004. Searching continued from 08:00-17:00 hrs, with a one hour break between 11:00-15:00 hrs. For each specimen encountered, we recorded date and time of the day. In addition, we estimated the total size of each specimen.

Springbok Weather Station, located circa 2.5 km north of the research area, provided daily maximum ambient temperatures for the period 1990-2004. I compared 2004 values with 1990-2004 averages by means of a paired *t*-test (SigmaStat 2.03, SPSS Inc., Chicago, U.S.A.). Detailed temperature recordings from the research area are present in Loehr (2003).

Captive study

At the end of January 2004 (summer), I captured and exported one male and one female for a captive study. The couple was released in a 90 x 35 x 40 cm (l x w x h) indoor enclosure (enclosure 1) in the Netherlands, circa four days after collecting them in the field. This enclosure consisted of glass, and artificial rocks (PUR foam, tile glue, and paint) were present to form crevices. The soil layer consisted of a 4 cm deep layer of dry sand (grain 0.5-2 mm). Some artificial plants, cork bark and wood provided additional retreats. The enclosure was heated by two 25 W spotlights, from 1st May 2004 switched via a Habistat dimming thermostat (Living Earth Electronics, UK), adjusted to a maximum temperature of 30°C in one of the coolest retreats. As a result, the spotlights usually switched off between 11:00-17:00 hrs when the room temperature was high (June - August). In winter, I switched off the spotlights entirely for two weeks (29th March 2004 until 12th April 2004), to provide a cooler period. Initially, an 18 W TLD 840 bulb provided illumination, but a 36 W PLL 840 bulb replaced this on 8th May 2004.

On 18th November 2004, the specimens moved to a larger indoor enclosure, measuring 150 x 60 x 40 cm (l x w x h) (enclosure 2; Fig. 3). Decoration was similar. The two 25 W spotlights were connected via a dimming thermostat (adjusted to 30°C) on 4th April 2005. I switched off the spotlights between 15th January 2005 and 29th January 2005. A 54 W T5 840 bulb provided illumination.

Adjusting the lizards from southern to northern hemisphere climatic conditions was accommodated by skipping the remainder of the southern hemisphere summer, and compressing the first autumn, winter, and spring in the period January - May 2004 (Fig. 4). After that, heating and lighting switched via an astrotimer (Suevia Astra Nova, Germany), automatically adjusting the daily photoperiod to 35 degrees latitude North (Fig. 4). Ambient maximum temperatures were close to 32°C in summer (corresponding with a retreat temperature around 30°C), gradually decreasing to 25°C in winter when I switched off the spotlights.

Thermochron iButtons (Dallas Semiconductors, Maxim Integrated Products, Inc., Sunnyvale, U.S.A.) recorded retreat and spotlight temperatures (frequency 15 minutes) in enclosure 1 between 12th June 2004 and 17th July 2004. In enclosure 2, a PC-datalogger (Hygrotec Messtechnik, Titisee-Neustadt, Germany) recorded retreat and spotlight temperatures every 10 minutes.

Immediately upon arrival, a number of different food items offered provoked the lizards to commence feeding. After two months, feeding regime consisted of once weekly feedings on 10-15 crickets (5-10 mm), dusted with Calcicare 40+ (Witte Molen, Meeuwen, Netherlands) and calcium lactate, mixed in a ratio of 1:1. Occasional feedings with other food items provided some variation. Initially, I inspected the faeces of the lizards microscopically for parasites (e.g., protozoa, nematodes, cestodes), and treated the specimens with fenbendazole (Panacur, 22 % granulate; Hoechst AG, Frankfurt am Main, Germany) at circa 50 mg/kg body weight, repeated after 14 days. A buffalo worm (*Alphitobius diaperinus*) offered by means of forceps hid the drug.

Further husbandry included spraying enclosure 1 twice weekly in spring, summer and autumn, and three times weekly in winter. Enclosure 2 had an automatic spraying installation, switched on three times weekly (app. 420 ml per spraying). In both enclosures, spraying never left the soil layer uniformly moist. Most of the soil remained dry, to allow the lizards to hide in the sand. I observed the specimens in the weekends, and in the afternoons and evenings of weekdays, and noted qualitative recordings in a spreadsheet.

RESULTS AND DISCUSSION

Observations in the wild

Cordylosaurus subtessellatus activity occurred between 08:25-16:45 hrs, with the majority of observations recorded in the morning and afternoon (Fig. 5). Even compensated for our one hour break between 11:00-15:00 hrs, most observations were made in the morning and afternoon. This indicates a bimodal activity pattern, as reported by Loehr (2004), working at the same location in summer. Daily maximum temperatures were not higher than the long-term average (respectively 21.8 and 21.1 °C, paired *t*-test $t_{30} = 0.727$, $P = 0.47$), thus the bimodal pattern may be usual for September. Start and end of activity were later, respectively earlier than in February (Loehr, 2004), and this is probably the result of different photoperiod.

We observed specimens in many size classes (total length circa 50-140 mm), but did not take accurate size measurements. One juvenile (total length circa 90 mm) hid in shallow sand (1-2 cm, soil temperature 19.2°C at 10:25 hrs), under a small flat rock (circa 25 x 15 x 2 cm). This site was positioned on a large rock slab. The next two days we rechecked the hiding place, and found what appeared to be the same specimen (temperatures 23°C at 11:50 hrs, and 21.4°C at 09:35 hrs). After this period, it disappeared, perhaps because of disturbance by the observers.

Food item	Accepted
Buffalo worms - larvae (*Alphitobius diaperinus*)	Yes
Buffalo beetles (*Alphitobius diaperinus*)	Occasionally
Crickets - live (*Gryllus domestica*)	Yes, 2-7 mm
Crickets - dead (*Gryllus domestica*)	Occasionally
Fruit flies (*Drosophila melanogaster*)	No
Flies - larvae (*Musca domestica*)	No
Flies (*Musca domestica*)	No
Grasshoppers (*Chorthippus* sp.)	Yes, <17 mm
Woolice (*Oniscus asellus*)	Occasionally
Wax moths - live larvae (*Galleria mellonella*)	Yes, <8 mm
Wax moths - dead larvae (*Galleria mellonella*)	Yes, <8 mm
Wax moths (*Galleria mellonella*)	No

Table 1. Food items provided to *Cordylosaurus subtessellatus.*

Captive study: diet

The faeces of the captive couple contained numerous nematode eggs. After treatment with fenbendazole, no further eggs or other parasites were observed. The lizards readily started feeding on buffalo worms (*Alphitobius diaperinus*), and other arthropods (Table 1). Within a week, they accepted food items offered by means of forceps. It was striking that they accepted relatively large grasshoppers (*Chorthippus* sp.), but refused similar sized fly larvae or flies (*Musca domestica*).

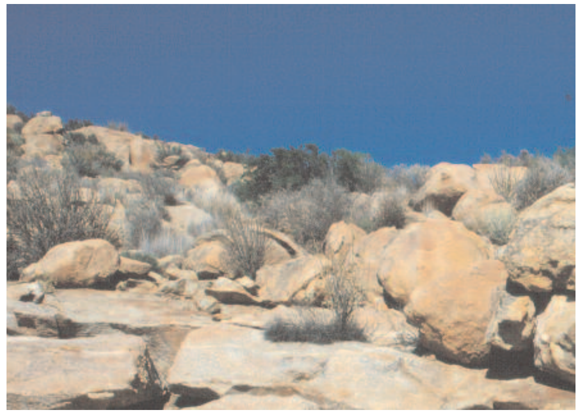

Figure 1 (top left). *Cordylosaurus subtessellatus* in the wild, demonstrating appearance and colouration. All photographs by author.

Figure 2 (top right). Natural habitat of *Cordylosaurus subtessellatus*, near Springbok, South Africa.

Figure 3 (centre left). Enclosure 2, in which a pair of *Cordylosaurus subtessellatus* has been housed since 18th November 2005.

Figure 6 (below). Male and female *Cordylosaurus subtessellatus*, following mating.

Wax moths (*Galleria mellonella*) were probably too large. Lizards usually did not hunt food items that were further than circa 10 cm away, although *C. subtessellatus* proved to be extremely skilful chasing fast insects (e.g., crickets) in their direct vicinity. They also accepted several dead prey items (Table 1), as do other Gerrhosauridae.

Cordylosaurus subtessellatus has a small head and pointed snout, suggesting small prey items. However, they refused *Drosophila* and very small crickets (2 mm). In addition, prey items accepted were medium-sized, but still large in comparison to the size of the head and body of *C. subtessellatus*. Crickets, that formed the main food source, tended to hide rapidly after releasing them in the enclosure. The lizards used their pointed snout to check narrow crevices and loose bark, eating any crickets encountered. There appear to be no published reports of natural food items for *C. subtessellatus*.

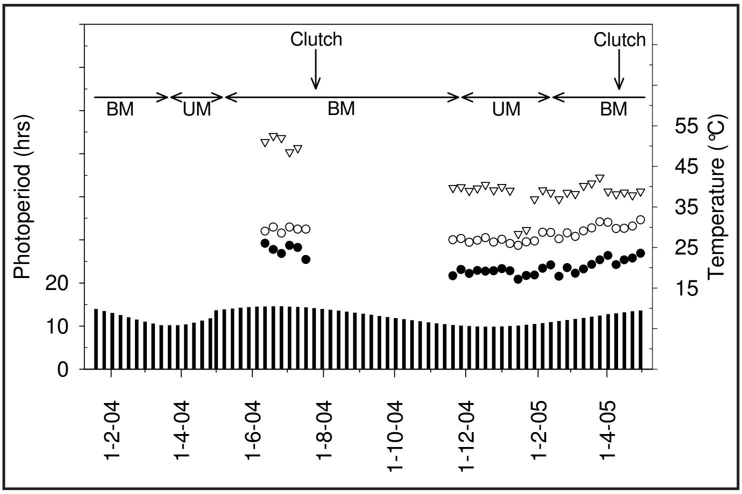

Figure 4. Photoperiod (bars), daily minimum (closed circles) and maximum (open circles) retreat temperatures, and daily maximum spotlight temperatures (open triangles) in two enclosures that housed *Cordylosaurus subtessellatus*. BM indicates periods when the lizards had a bimodal activity cycle, and UM when their activity cycle was unimodal. Two clutches were produced, on 25th July 2004 and 12th April 2005.

Captive study: behaviour

Like *C. subtessellatus* in the wild (Loehr, 2004), captive lizards exhibited a bimodal activity pattern in summer (Fig. 4), with most activity occurring in the morning and afternoon. However, in winter they switched to a unimodal pattern, that they continued in early spring (Fig. 4). During this period, most activity occurred around noon. Daily activity time was typically circa 1-3 hours, regardless of the season. Activity episodes started with basking, first at some distance from the spotlights, and later in the direct beam. In enclosure 1, they continued the latter for a short period, compared to enclosure 2. This was probably the result of the shorter distance to the spotlight in enclosure 1, leading to higher temperatures (Fig. 4). In enclosure 1, they often continued basking outside of the beam. In both enclosures, lizards preferred basking under cover (e.g., twigs, artificial plants) rather than at exposed sites.

Inactive lizards, captive or wild (Loehr, 2004; this study), hid in dry portions of the sandy soil. This behaviour may explain the remark from Bauer & Branch (2001), referring to microhabitats of the species consisting of rocky areas with sand or soil-filled interstices. The small body size, smooth scales, small limbs, and transparent discs on the eyelids in *C. subtessellatus* probably facilitate moving through the soil.

In winter, activity reduced to basking (estimated 90-95 % of activity time), whereas in summer lizards actively traversed their enclosure after basking (estimated 50 % of activity time), inspecting decoration materials for prey. They interrupted this activity repeatedly by brief (1-5 minutes) periods of basking. Cooper *et al*. (1997) predicted *C. subtessellatus* to be an active forager, based on a small sample size. Qualitative observations in the current study support this. I usually released prey items in the enclosure during activity episodes. Once the lizards had ingested a number of prey, they ceased all activity and retreated. Also the first day after feeding days usually lacked activity.

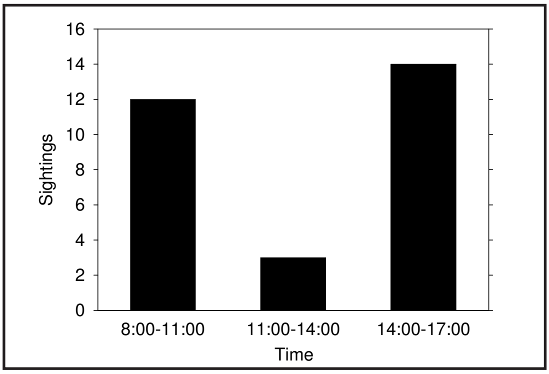

Figure 5. *Cordylosaurus subtessellatus* observations in the wild in September - October 2004.

Winter activity (i.e., basking) continued when I had switched off the spotlights. This might be the result of the ambient temperature remaining suitable for activity due to the fluorescent lighting and the room temperature, but the species may also remain active in winter in the wild. Loehr (2003) reported winter soil temperatures around 25°C.

Initially, encounters between the two specimens resulted in excitement, quick movements of the posterior 2-3 cm of the tail, and chasing each other, until one would move into a retreat. Within approximately one year, this behaviour phased out (except occasional tail movements), ultimately resulting in basking on top of each other.

In summer, dimming thermostats usually switched off the spotlights around noon, potentially affecting the activity cycle of the lizards. However, it appears that it was not the sole cause of the bimodal activity pattern, as specimens followed the same pattern on cool summer days when thermostats did not switched off the spotlights, and continued activity while the spotlights had switched off on other days. It is an intriguing question why wild and captive *C. subtessellatus* had such limited activity periods, while environmental conditions appeared to allow activity, and sympatrically occurring lizards in the wild were active throughout the day (Loehr, 2004). The colouration and active foraging behaviour of *C. subtessellatus* may expose lizards to high predation pressure, necessitating reduction of its activity time.

Captive study: reproduction

Observation of mating activity was limited to one instance, on 2nd May 2005 at 14:45 hrs. Male and female had just completed mating, and the male was biting the female in the left flank, behind the forelimb (Fig. 6). Previously, the flank scutes of the female showed slight damage on 14th August 2004, possibly indicating another mating. Two clutches consisting of two eggs were produced 20 days before these dates, respectively on 25th July 2004 (12.0 x 5.0 mm, and 11.6 x 5.5 mm), and 12th April 2005 (eggs not measured).

The female produced both clutches on top of the soil close to the spotlights, and they were dehydrated when found. Nesting sites offered included closed and open plastic boxes in different sizes, filled with *Sphagnum*, peat, or sand/peat mixture, covered with cork bark, rock, or plastic. The female inspected nesting sites, but additional experimenting will be required to determine its requirements.

Branch & Bauer (1995) reported enlarged follicles and eggs in wild *C. subtessellatus* in spring and early summer, respectively on 18th September 1993 and 2nd November 1992. Egg size reported (12.4 x 4.9 mm) is close to that found in this study. The captive female produced its first clutch in late summer (Fig. 4), but adjusting climatic conditions to northern hemisphere may have interfered. The second clutch was produced in spring (Fig. 4).

Prior to oviposition, female behaviour changed in several ways. Several weeks before oviposition, basking episodes became longer, and the last few days basking took place throughout the day. While specimens normally disappeared during sprayings, the female maintained activity and drunk one week before oviposition, and at the same time refused food items offered, perhaps as a result of intestinal compaction or displacement by the relatively large eggs.

Conclusions regarding husbandry of *Cordylosaurus subtessellatus*

Cordylosaurus subtessellatus can survive in captivity. Additional experimenting will be required to breed the species in captivity. Considering the fact that no published reports on captive husbandry of *C. subtessellatus* appear to exist, the results presented here are promising. Crucial for successful husbandry might be diagnosing and treating any possible parasites in wild-caught specimens, as these may quickly exhaust a small species such as *C. subtessellatus*. The species is not likely to be a suitable species for the average terrarium keeper, as their activity episodes are extremely limited.

ACKNOWLEDGEMENTS

I would like to thank Northern Cape Nature Conservation for issuing permits (NNO 1/10/2 145/2003, and NNO 1/10/3 7/2004) to initiate the captive study on *C. subtessellatus*. Patrik Abramsson, Mats Blohm, Lin Lagerström, and Peter van Putten are thanked for their assistance in the field. Furthermore I am grateful to South African Weather Services for providing temperature data.

REFERENCES

Bauer, A.M. & Branch, W.R. (2001). The herpetofauna of the Richtersveld National Park and the adjacent northern Richtersveld, Northern Cape Province, Republic of South Africa. *Herpetol. Nat. Hist.* **8**, 111–160.

Bauer, A.M., Lamb, T. & Branch, W.R. (1999). *Cordylosaurus subtessellatus*, dwarf plated lizard, maximum size. *Afr. Herp News* **30**, 30.

Branch, B. (1998). *Bill Branch's Field Guide to Snakes and Other Reptiles of Southern Africa*. 3rd ed. Cape Town: Struik Publishers.

Branch, W.R. & Bauer, A.M. (1995). Herpetofauna of the Little Karoo, Western Cape, South Africa with notes on life history and taxonomy. *Herp. Nat. Hist.* **3**, 47–89.

Cooper, W.E., Whiting, M.J. & Vanwyk, J.H. (1997). Foraging modes of cordyliform lizards. *S. Afr. J. Zool.* **32**, 9–13.

Griffin, M. (2003). *Annotated Checklist and Provisional National Conservation Status of Namibian Reptiles*. First edition. Windhoek: Namibia Scientific Society.

Kirkpatrick, D.T. (1993). Plated lizards of the genus *Gerrhosaurus*: an alternative to iguanas. *HerpTales* **1993**, 5–6.

Loehr, V.J.T. (in press). Egg and hatchling characteristics of the Namaqualand speckled padloper (*Homopus signatus signatus*): preliminary data from a captive population. Chelonii - *Proceedings of the 2nd International Congress on Chelonian Conservation*.

Loehr, V.J.T. (2002). Population characteristics and activity patterns of the Namaqualand speckled padloper (*Homopus signatus signatus*) in the early spring. *J. Herpetol.* **36**, 378–389.

Loehr, V.J.T. (2003). Annual temperature fluctuation in the natural habitat of Namaqualand speckled padloper, *Homopus signatus signatus*. *Radiata* **12**, 25–27.

Loehr, V.J.T. (2004). *Cordylosaurus subtessellatus*, dwarf plated lizard, bimodal activity pattern. *Afr. Herp News* **37**, 23–24.

Müller, M.J. (1983). *Handbuch Ausgewählter Klimastationen der Erde*. Ruwertal: Forschungsstelle Bodenerosion der Universität Trier Mertesdorf.

Slavens, K. (1999). *Reptiles and Amphibians in Captivity: Breeding, Longevity and Inventory*. Seattle, Washington: Slaveware Publishing.