

Field Observations of the Lizards *Gonatodes humeralis* and *G. ocellatus* (Gekkonomorpha: Sphaerodactylini) in Trinidad and Tobago.

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ABSTRACT

This report, derived mainly from intensive observations of *Gonatodes humeralis* (on trees) on Trinidad and *G. ocellatus* (in culverts) on Tobago, islands of the West Indies, in May-June, 2000. It shows that these geckos are sit-and-wait foragers that prefer a perch posture with the head pointing down, irrespective of the height above the ground. This posture apparently enables better detection of better-illuminated prey. The height of the gecko above ground and its posture were not significantly affected by temperature or light. The coincidence of captive geckos dying when sloughing is discussed. Locality records presented include *G. ocellatus* from a new locality in Tobago, the Tobago mountains at approx. 11°17'N, 60°36' W, altitude 460m. An additional, as yet unreported, species of *Gonatodes* may occur on Tobago.

INTRODUCTION

A brief description of the presumably diurnal genus *Gonatodes* (Reptilia: Gekkonomorpha: Sphaerodactylini) is given in the accompanying paper (Quesnel *et al.* 2002). Knowledge of most species includes little information on their life in nature (Underwood 1954; Quesnel 1957; Peters & Donoso-Barros 1970; Seuffer 1991; Roesler 1995; Murphy 1997). Therefore we report here on field observations made in Trinidad and Tobago, some by VCQ during decades of residence, and the majority by NW and YLW between 20 May and 14 June 2000, incidental to a study of *Gonatodes* foraging behaviour (Persaud *et al.* in press). Altogether we observed three of the five species of the genus reported from Trinidad and Tobago (Boos 1977; Murphy 1996 & 1997). Here we present our observations of *G. humeralis* and *G. ocellatus*. Those of *G. vittatus* appear separately (Quesnel *et al.* 2002).

Gonatodes humeralis (Guichenot 1855) reach a rostrum to anus (RA, snout to vent) length of 38mm in males and 37mm in females; the tail is 130-140 PERCRA (% of RA, Werner 1971) in males and 110-130 PERCRA in females (in Surinam - Hoogmoed 1973). The animals appear brown or olive, the flank in front of the humerus (forelimb) carries a light, dark-rimmed, vertical line, the pair almost meeting dorsally. On the tip of the snout a whitish spot is often noticeable.

The sexual dichromatism is less striking than in *G. vittatus* (Quesnel *et al.* 2002). The male's head and body are vermiculated with multicoloured darker and lighter dots and dashes, and usually a whitish or yellowish u-shaped band connects the posterior corners of the eyes over the nape (Plate I. 1). The female has a light stripe running down the middle of its brown back, which has darker and lighter spots. The white ante-humeral line distinguishes it from *G. vittatus* (Plate I. 2). *G. humeralis* has a wide Amazonian distribution and occurs throughout Trinidad; it is mainly found on the lower parts of forest tree trunks (Hoogmoed 1973; Murphy 1997), and is especially accessible in cacao plantations (H.E.A. Boos, personal communication).

Gonatodes ocellatus (Gray 1831) reach a rostrum to anus length of 48mm in males and 43mm in females; the tail is 120 PERCRA. Both sexes are primarily grey-brown with a yellow black-rimmed vertical line in front of the forelimb and at least one light-blue black-rimmed ocellus behind it. The male (Plate I. 3) has a reddish, spotted head, and the ocellus-spots on his shoulders are much more prominent than those in the female, which has a faint mid-dorsal stripe (Murphy 1997). This species is endemic to the islands of Tobago and Little Tobago, occurring in the forest in relatively damp situations (Murphy 1997), but practically being accessible mainly in roadside culverts

(H.E.A. Boos, personal communication).

Further information on these species, including photographs, is found in Boos (1977) and Murphy (1997).

MATERIAL AND METHODS

Sites and Observation Times

Field work was conducted in Trinidad and Tobago, between 21 May and 13 June 2000. The daily maximum temperature averaged, on Trinidad, 32°C (May), 31°C (June) and on Tobago 31°C (May), 30°C (June); and the daily minimum averaged on Trinidad 24°C and on Tobago, 25°C (both months). The averages for the actual study days were similar. The total monthly rainfall in May and June was on Trinidad 137 and 201mm and on Tobago 178 and 179mm respectively. On the study days the daily rainfall averaged on Trinidad 7mm and on Tobago 8mm.

Gonatodes humeralis was studied at two sites in northern Trinidad. Cleaver Woods Recreation Park, west of Arima (10°37' N, 61°18' W, altitude 53m), is a dense forest of assorted tall trees. Air temperature was between 24.7 and 26.5°C, and substrate temperature 0.2 to 1.0°C lower, presumably because the tree trunks were moist and cooled by evaporation. *G. humeralis* occurred on the trunks and buttresses of several species, especially on milkwood trees, *Sapium glandulosum* (Plate I. 4). The La Reunion cacao plantation of the Ministry of Agriculture, south of Piarcó (10°35' N, 61°18' W, altitude 23m), is a typical cacao plantation with low closed canopy and poor illumination (Plate I. 5). Individuals inhabited the trunks (Plate I. 1), with some preference for axillae of forking trunks (Plate I. 2). Four observers operated for a combined total of 9 hours on 7 and 8 June 2000, between 10:00 and 16:00. At both sites it occasionally drizzled, especially in the afternoon.

Grid references of Trinidad localities were determined with a Garmin GPS (12XL) instrument and confirmed on maps.

Gonatodes ocellatus was observed in two places in north-eastern Tobago: Charlotteville village centre (Plate I. 6), 11°19' N, 60°33' W, altitude 3m, and the Flagstaff junction on the Speyside-Charlotteville road, 11°18'50" N, 60°32'30" W, altitude 220m. In both places, it inhabited culverts of the rainwater drainage system (Plate I. 7 a, b & c). Two observers worked for a combined total of 16 hours on 3 to 6 June 2000, between 08:30 and 18:00.

Grid references for Tobago localities are from the 1:50,000 map from the Mapping & Control, Lands &

Surveys Division (n.d.).

Observation Methods

The methods resembled those described by Quesnel *et al.* (2002). In essence, based on prior advice we visually scanned likely spots from maximum reasonable distances, depending on illumination, sometimes with binoculars (Nikon 10x25, which focuses as close as 2.8 m) (Plate I. 7c). When a gecko was located and appeared undisturbed, we observed it from a distance of 3-6m, again depending on illumination. Observations (environmental and behavioural data) were recorded with a tape recorder and later transcribed to paper. Air temperature, sometimes also substrate temperature, was taken following the observation near the gecko's location, with a Miller-Weber quick-responding small-animal mercury thermometer; illumination was measured by a Gossen Lunasix-F photographic exposure meter graded in lux.

We did not catch and mark the observed animals (and requested no such permit), and took no body temperature, in part because the skin of some species of *Gonatodes* tears when the animal is seized (*G. humeralis*, Vitt & de la Torre 1996; *G. vittatus*, Murphy 1997; general, Bauer *et al.* 1989 & 1993). We avoided repeated observation of the same animal by changing the location, assuming that the geckos have some degree of site fidelity.

Statistics

We tested the significance of deviations of observed distributions of the geckos over a series of classes (such as different postures) from the expected distributions, by the χ^2 test (Zar 1999). We tested the significance of effects of environmental factors on gecko behaviour by a non-parametric test. The Kolmogorov-Smirnov two-tailed two-sample test (K-S) yielded the significance of the difference between the distributions of selected behaviours or populations as a function of environmental factors, such as temperature (Siegel 1956).

OBSERVATIONS on *Gonatodes humeralis*

Observations were made on cloudy days and the poor illumination (250-11,050 lux) in the forest-type habitat usually prevented the identification of the sex. However, the 28 records taken included 24 animal sightings, mostly with details of position and posture; 3 weather records; and one additional photographic record. All animals were in shade.

All individuals for which the posture was recorded, sat vertically along the trunk, 15-100 (in one case 200) cm above the ground: 6 with the head up, 18 with the head down. This difference was significant (χ^2 test, $P < 0.015$). As in *G. vittatus*, the head was sometimes tilted away from the substrate. One gecko was seen climbing on thin branches to its position on the trunk. Using the Kolmogorov-Smirnov two-tailed two-sample test, we found that posture, whether with head up or down, was not affected by the temperature ($P > 0.95$) or the illumination ($P > 0.97$) and also was not related to the gecko's elevation up the trunk ($P > 0.60$).

In two cases a male and female were seen on the same tree. Their interaction included the female arching her tail over the body and then being chased away by the male. We saw no mating or small juveniles.

In captive animals, one of us (VCQ) noted on two occasions (28 April, 1955 and 3 June, 1955) sloughing (moulting) was followed by death.

We have observed *G. humeralis* at several localities not listed by Murphy (1997). These are listed in Table 1 (VCQ).

Table 1. New locality records for *G. humeralis* on Trinidad.

Location	Coordinates	Altitude m	Date	Comments
Botanic Gardens, Port of Spain.	10°40'N, 61°31'W	35	19 December 1954	3 females and 1 male. Also in bamboo clumps in the nearby Emperor Valley Zoo and Lady Chancellor Hill.
River Estate, Diego Martin.	10°44'N, 61°34'W	45	25 November 1955	On cacao tree. This was then a cacao estate but is now a housing project.
Forest Reserve, Valencia.	10°39'N, 61°12'W	60	29 January 1956	1.5m up unidentified tree.
Henry Estate, Moruga.	10°05'N, 61°17'W	1	13 February 1964	The estate surrounded Moruga down to the coast. It is now subdivided but still agricultural.
Las Hermanas Estate, Brazil.	10°34'N, 61°16'W	30	16 May 1992	
Haven Hill Farm, Talparo.	10°31'N, 61°16'W	50	28 April 1992	On a water tank.
Aripo Cottage, Aripo Heights.	10°42'N, 61°14'W	235	25 March 2000	30cm up a tree trunk.
Haven Hill Farm, Talparo.	10°31'N, 61°17'W	100	1 February 2001	On the ground.

OBSERVATIONS on *Gonatodes ocellatus*

We found *G. ocellatus* only in the culverts (sinks, pipes and outlets) of the roadside rainwater drainage system. In one case (Charlotteville), we also found it inhabiting crevices in the concrete walls of an open ditch leading away from a culvert outlet. The ditch was about 30m long, 1m deep and 1m wide, and at one point, 12 m from the culvert outlet, it was roofed over by a small concrete footbridge. Individuals occurred under and near this bridge, and between it and the outlet. However, our inspection of nearby trees was not thorough.

Our 41 records include 36 sightings of animals and 5 records of the weather, which was cloudy most of the time, with outside light readings ranging 1,000-35,750 lux. Sex was easily identified except for sightings in very poor light, but it was often too cumbersome to fully describe the position and posture, especially if an individual moved.

Individuals were seen from the earliest beginning of observations at 08:39 but these were inside the pipe. The earliest sighting outside the pipe (within the culvert "sink") was at 09:44. Individuals were seen throughout daytime, both inside and outside (air temperature, 25.1-29°C). The latest sighting outside was at 17:46 and the latest sighting in the pipe was at 17:51, when observation stopped for lack of light.

When outside, individuals were oriented either vertically with the head up ($n=4$), vertically with the head down ($n=3$) or horizontally ($n=3$). But when inside, all were oriented either vertically with head down ($n=7$) or horizontally ($n=7$). The horizontal posture occurred either on the bottom, or, quite often, by hanging from the ceiling. The distribution of locations, outside or inside, was not affected by the illumination or temperature (K-S test, $P > 0.449$). The distribution of postures, whether horizontal or vertical, did not significantly deviate from random (χ^2 test, $P > 0.15$). For those in a vertical position, the direction, head-up or head-down, likewise did not significantly deviate from random (χ^2 test, $P > 0.10$). Posture and direction were unaffected by light and temperature (K-S tests, all $P > 0.50$). Vertically oriented animals often had the head tilted off the substrate.

We saw a few social interactions, geckos arching and waving the tail, stalking and chasing each other. We saw no mating or juveniles.

G. ocellatus is endemic to Tobago and Little Tobago Islands (Boos 1977; Murphy 1997), and according to Murphy's (1997) Map 48, it is restricted on Tobago to

the coastal circumference of the north-eastern third of the island. Our observations of this species at the Flagstaff Junction (see Study Sites), and 1km further up Flagstaff road towards the navigational beacon, add little to Murphy's map. However, we also found the species on top of the Main Ridge on the road from Roxborough to Bloody Bay, about 11°17'N, 60°36' W, altitude 460m. On 06 June 2000, at 11:15, we saw one male in a culvert 6km from Roxborough, and another male in a second culvert 8km from Roxborough (Plate I. 8). Both were too wary to be photographed.

AN ENIGMATIC OBSERVATION

What appeared to be a *Gonatodes* female of a species unknown to us was observed (YLW) in Charlotteville, Tobago (11°19'00"N, 60°33'05"W, altitude 3m). This animal was the size of a female *G. vittatus*. Its ground colour was a conspicuously bright, light, brownish orange. All over the trunk, or at least the flanks, were black spots, about the size of the pupil, separated by spaces exceeding the spot diameter. It was briefly seen twice (on 4 June 2000 at 17:02 and on 5 June at 09:50) on the west-facing side-wall of the ditch described above (Plate I. 7A), about 3m from the pipe outlet to the ditch and fairly high up the wall, among the *G. ocellatus*. On both occasions it precluded photography and close observation, by moving around too rapidly, and disappearing into a crevice.

DISCUSSION

Penetration into Houses

Many species of geckos are considered house geckos and rightly so. The association of geckos with man in his abode is ancient. A biblical proverb, 2500 years old, says, "The gecko climbs with its hands, yet is in kings' palaces" (Proverbs: 30:28). Admittedly the interpretation of the biblical name "semamit" as "gecko" is sometimes disputed but in Egypt one of the vernacular names for the fan-toed geckos, genus *Ptyodactylus*, is "abu kaf" (Anderson 1898), literally "father of the hand", meaning possessor of hands. *Ptyodactylus*, at least in the Levant, live in rocks and in masonry structures (such as kings' palaces), not in Bedouin tents and rarely in shacks of mud-bricks.

Species that are considered to be house geckos are usually nocturnal or crepuscular. One of the factors that attract geckos inside dwellings is, presumably, the insects attracted by artificial lighting (in the past, fire). Because this factor is excluded in daytime, the penetra-

tion of diurnal geckos into houses is of special interest. This phenomenon cannot be fully discussed here, and we only note that *Gonatodes*, which are diurnal, have occasionally been found on or even in houses: *G. albogularis* lived inside a building (Beebe 1944) and was "often edificarian" (Schwartz & Henderson 1991). *G. annularis* occasionally entered a building (Beebe 1944). *G. humeralis* has been reported to sometimes occur in and on houses in both Surinam (Hoogmoed 1973) and the vicinity of Iquitos, Peru (Dixon & Soini 1975, 1986). We (NW & YLW) have seen it in and around plastic greenhouses in Villavicencio, in the Llanos of Colombia (8 September 1983). Recently Vitt *et al.* (1997) reported that unlike the situation at four Brazilian localities where *G. humeralis* inhabited primary forest, on the Rio Cuyabeno, Ecuador, it occurred mainly on buildings and appears to have been introduced (it is not stated to what extent it occurred inside the buildings). However, we have only one record of *G. humeralis* in a house, in Talparo: "A day or two ago I found a male *G. vittatus* and a male *G. humeralis* trapped in a glass cup into which they had fallen. This was on the drainboard of the kitchen sink, so *G. humeralis* is in the house" (VCQ, 22 July, 2001). We had no opportunity to see *G. ocellatus* in houses, as we had with *G. vittatus* (Quesnel *et al.* 2002).

Activity and Diel Cycle

Our observations on *G. humeralis* resemble those in the literature (see reviews by Hoogmoed 1973, and especially Avila-Pires 1995). Vitt *et al.* (1997, 2000) confirmed that the species is diurnal and active throughout the day but the details varied. Data pooled from three Amazonian localities, activity was high throughout most of the day but lower in the early morning and again in late afternoon (Vitt *et al.* 1997). In contrast, at one location in Rondonia, Brazil, the data exhibited a clear dip of activity at midday (Vitt *et al.* 2000). Our own sample was too small to detect such variations. We also did not observe this species active at night, near streetlights or inside houses (Dixon & Soini 1975), as we did with *G. vittatus* (Quesnel *et al.* 2002).

Our not having encountered juveniles of the three studied species in the field (NW & YLW) is significant. These geckos appear to reproduce throughout the year. At least this is true of *G. vittatus* in Trinidad (Quesnel 1957) and of *G. humeralis* in the upper Amazon basin (Dixon & Soini 1975; Avila-Pires 1995), so juveniles should have been present. Perhaps the juve-

niles lead a more secretive life.

Foraging Behaviour

Our finding that all three species, *G. vittatus*, *G. humeralis* and *G. ocellatus*, prefer a vertical head-down posture, requires interpretation. All three are diurnal, and like *G. albogularis fuscus* (Perry 1995), are sit-and-wait foragers (Persaud *et al.* in press). Sit-and-wait foraging lizards are usually visual hunters (Huey and Pianka 1981; Cooper 1995). The eyes are larger in nocturnal than in diurnal gecko species (Werner 1969), implying visual hunting even in the former. Visual hunting has been experimentally confirmed in two nocturnal gekkonines (Chou *et al.* 1988). Hence it seems probable that *Gonatodes* are visual foragers.

Some arboreal geckos, such as *Gekko hokouensis* on Okinawa (Y.L. Werner, unpublished observations), frequently assume a vertical head-down posture, perched only 20-30cm above the bottom of the tree trunk, scouting for prey on the ground. But *Gonatodes vittatus* and *G. humeralis* assume this posture regardless of their distance from the ground. The most plausible explanation is that prey is easier to detect visually when the light is behind the gecko and illuminates the prey, than when the gecko looks into the light at the shaded side of the prey.

Additional observations point to the dependence of *Gonatodes* on light for foraging. First, in the evening, shortly before retreating, *G. vittatus* often shifts its perch from a protected and shaded position to an open and better-illuminated site. Second, *Gonatodes* spp. are occasionally active at night with artificial lighting. Lastly, Persaud *et al.* (2002) showed, by comparison with the data of Vitt *et al.* (1997 & 2000), that the foraging activity of *G. humeralis* depends on light intensity, and they also noted that the activity of the three species that they observed ranked with the illumination.

In contrast with *G. vittatus* (Quesnel *et al.* 2002), *G. ocellatus* and *G. humeralis* showed no significant effects of temperature on behaviour. This was probably due to the short periods of observation of these two species, the limited temperature ranges, and the small samples. Although *G. humeralis* forages more actively at higher light intensities (Persaud *et al.* in press) its perch elevation and posture appeared to be unaffected.

The perching posture with the head tilted up from the substrate, observed in all three species, resembles the posture that is characteristic of *Cnemaspis* (Werner & Chou 2002). However, unlike *Cnemaspis*, *Gonatodes*

does not usually lift its tail as well. The function of this head up posture is, presumably, to increase its field of vision for prey, in parallel with the erect-limb posture in some cursorial geckos (Werner & Broza 1969).

Sloughing and Death

It is exceedingly rare to find dead or dying geckos in nature, presumably because they are soon eaten. In captivity, death has occasionally been observed to occur during or soon after partial or complete sloughing (see above and Quesnel *et al.* 2002). This connection between sloughing and death of gekkonines in captivity is familiar to many gecko keepers (Y.L. Werner, unpublished) but is largely ignored in the captive-care and veterinary literature. It is unclear whether faulty sloughing causes death in healthy geckos, or sickly or ageing geckos die during or shortly after sloughing.

New Records

Our locality records for *G. humeralis* on Trinidad resemble those already reported (Murphy 1997). Our record of a new locality on Tobago for *G. ocellatus* may be due either to the species expanding its range or, more probably, to the additional search effort. The two sightings of the leopard-coloured individual, possibly a congener not previously reported from Trinidad and Tobago, are interesting but cannot yet be interpreted.

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PLATE I



1



2



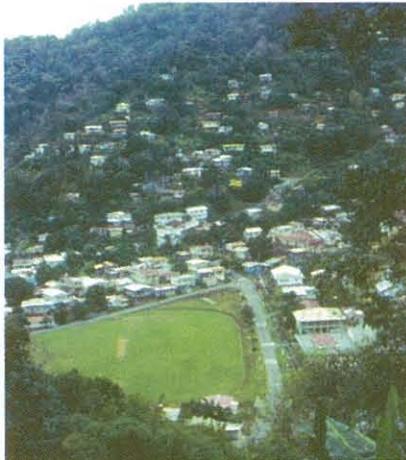
3



4



5



6



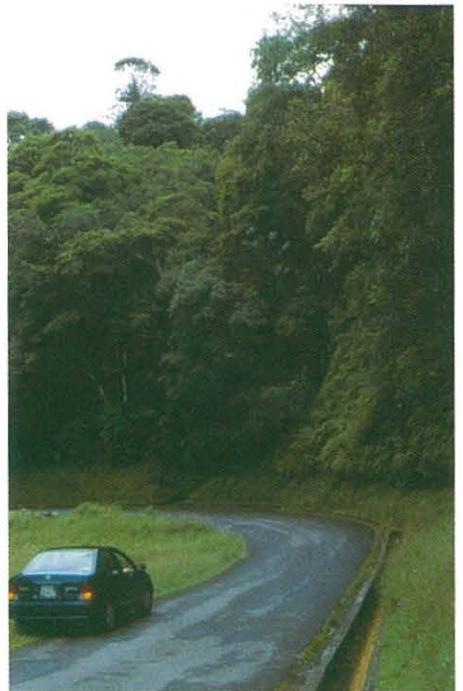
7a



7b



7c



8

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LEGENDS TO PLATE I

1. Male *G. humeralis* perched head-up on a cacao tree stem, minutes after having fought with another male. La Reunion plantation near Piarco, Trinidad (8 June 2000).
2. Female *G. humeralis* perched head-down in the axilla of a forked cacao tree stem, La Reunion plantation near Piarco, Trinidad (8 June 2000).
3. *G. ocellatus* male from Charlotteville, Tobago (July 1970, courtesy Robert G. Tuck).
4. Habitat and study site of *G. humeralis*: Cleaver Wood near Arima, Trinidad. Note tree buttresses (7 June 2000).
5. Habitat and study site of *G. humeralis*: La Reunion cacao plantation near Piarco, Trinidad (8 June 2000).
6. General environment and study site of *G. ocellatus*, Charlotteville, Tobago (3 June 2000).
7. Habitat and study sites of *G. ocellatus* on Tobago (June 2000): (7A) Outlet of culvert, Charlotteville. The right-hand wall was the site of the discovery of the unidentified *Gonatodes*. (7B) Drainage canal of the preceding. (7C) Roadside drainage canal and culvert, Flagstaff road junction. The structure behind the parked car is the site of observation of *G. vittatus* (Quesnel *et al.* 2002).
8. Location of discovery of *G. ocellatus* between Roxborough and Bloody Bay, Tobago (see text). Culverts of the roadside drainage canal are barely discernible (6 June, 2000).

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