

Intraspecific and intergeneric behavioural interactions of *Sphaerodactylus kirbyi* and *Gonatodes daudini* (Squamata: Sphaerodactylidae) on Union Island, St. Vincent and Grenadines

MEL JOSÉ RIVERA RODRÍGUEZ¹, EHREN J. BENTZ², REBECCA R. JOHN³ & ROBERT POWELL⁴

¹) Department of Biology, University of Puerto Rico, Mayagüez, Puerto Rico 00681

²) Feather River College, Quincy, California 95971, USA (current address: Department of Biology, Oregon State University, Corvallis, Oregon 97331, USA)

³) REBECCA R. JOHN, Departments of Environmental Studies and Biology, University of California, Santa Cruz, California 95064, USA

⁴) ROBERT POWELL, Department of Biology, Avila University, Kansas City, Missouri 64145, USA

Corresponding author: ROBERT POWELL, e-mail: robert.powell@avila.edu

Manuscript received: 10 September 2010

Abstract. In June 2010, on Union Island, St. Vincent and the Grenadines, we staged intraspecific and intergeneric interactions between *Sphaerodactylus kirbyi* and *Gonatodes daudini* (Sphaerodactylidae), which occur in sympatry and occasional syntopy on the slopes above Chatham Bay. Frequencies of most behaviours and frequencies of aggressive, submissive, and neutral behaviours did not differ significantly between sexes within species or between the two species. In general, the behavioural repertoires of the two species were similar to those previously described for congeners. Visual cues appeared to be important in sex- and species-recognition, although vomerolfaction seemed to assume an increasing level of importance with proximity. Intergeneric interactions generally involved behaviours employed for species recognition, with neither species exhibiting aggressive behaviours that might facilitate niche partitioning.

Key words. Aggressive behaviours, intergeneric interactions, intraspecific interactions, neutral behaviours, sex recognition, social behaviour, species recognition, submissive behaviours.

Introduction

The genera *Gonatodes* and *Sphaerodactylus* are sympatric throughout much of the mainland Neotropics. In the Caribbean, they occur sympatrically on Jamaica, Cuba, Hispaniola, Trinidad and Tobago, and on Union Island in the Grenadines. Relatively little has been published about the social behaviour of species in either genus, and no studies have addressed intergeneric interactions of species in areas of sympatry.

DEMETER & MARCELLINI (1981) examined courtship and aggressive behaviours of *Gonatodes vittatus* in captivity. LEUCK et al. (1988) provided a brief account of social behaviour in *Sphaerodactylus clenchi*, which suggested that visual signals play a major role in sexual recognition. REGALADO (1997, 2003) examined social behaviour and sex recognition of *S. elegans* and *S. nicholsi*, respectively. WISSMANN et al. (2005) studied the social behaviour of *S. saba-nus* and *S. sputator* from St. Eustatius, and MARCUM et al. (2008) described behaviour of *S. vincenti* from St. Vincent.

On Union Island, *Gonatodes daudini* and *Sphaerodactylus kirbyi* (Fig. 1) occur in close proximity at elevations from near sea level to over 300 m on the slopes above Chatham Bay. *Gonatodes daudini* is the larger of the two species, with a maximum snout vent length (SVL) of 31 mm whereas *S.*

kirbyi reaches a maximum SVL of 29 mm (BENTZ et al. in press). Although both species are active during the day and found in the same general area and habitat, *G. daudini* is more closely associated with rock outcrops, boulder jumbles, and large logs, whereas *S. kirbyi* is found mainly in the leaf litter and under surface debris such as small to medium-sized rocks and deadfall (Fig. 2; BENTZ et al. in press). However, the former is occasionally found in leaf litter and the latter in rock outcrops and both occur in association with termite mounds. The potential syntopy of two geckos of similar sizes and presumably similar diets led to questions regarding the possibility of niche partitioning and whether this might be reflected in the nature of encounters and interactions with one another in nature. Because essentially nothing is known about the social behaviours of either species, we staged intraspecific and intergeneric interactions between *G. daudini* and *S. kirbyi* in order to gain an understanding of behaviours that might influence microhabitat use by either or both species.

Materials and methods

During 4–19 June 2010 on Union Island, we collected by hand 21 *Gonatodes daudini* and 10 *Sphaerodactylus kirbyi*

for staged interactions. All geckos were collected from the slopes above Chatham Bay (N 12° 36.036', W 06° 26.641') at elevations ranging from sea level to the highest point on the island (Mt. Taboi at 330 m). Individual *S. kirbyi* were mostly (8 of 10) in leaf litter, and most *G. daudini* (17 of 21) were associated with large boulders and rock crevices, but one individual of each species was found under a termite mound. We employed only adult geckos with complete tails and not in the process of shedding in order to avoid putting such animals at a disadvantage when encountering a healthier, larger, or more active animal. We released all lizards at the exact sites of capture.

We staged 24 conspecific and intergeneric male/male, male/female, and female/female interactions between pairs of geckos. All interactions were videotaped for subsequent analysis with a Sony Handycam® 990x video Hi8 (Sony Corporation, Tokyo). As in REGALADO (1997, 2003), no individual took part in more than three interactions or in consecutive interactions (individuals were “rested” for at least 2 h between sessions).

Although *Sphaerodactylus kirbyi* is active throughout the day, peak activity for *Gonatodes daudini* is early morning (BENTZ et al. in press); consequently, all interactions were staged during morning hours. Geckos were housed in naturally illuminated individual plastic cages (19 x 12 cm) for at least one hour before introductions. Lizards were then simultaneously placed into a neutral cage of the same size with a moist paper-towel substrate. Cages were cleaned and the substrate replaced between trials in order to eliminate chemical traces of other geckos. We recorded all sequences of behaviours, beginning when an individual displayed a position or behaviour toward the other individual and stopped when both individuals were inactive for 20 min (N = 16), if the animals ignored each other for more than 15 min after initial contact (N = 6), or if an animal constantly tried to escape from the cage (N = 2).

We recorded behaviours previously identified by REGALADO (1997, 2003) that included tongue-flick (fast extension and retraction of the tongue), approach (movement toward the other animal at a normal pace), withdrawal (movement away from the other individual), bite (biting the other individual), stand (stationary with the body slightly separated from the substrate), head-turn (stationary with the head moving to form an angle 45–90° from the longitudinal axis of the body), stiff (legs extended posteriorly, almost flat on the substrate), head-bob (head moves up and down), and crouch (trunk held close to the substrate, legs alongside the body, and head not in contact with the substrate). We also observed behaviours characterised differently by WISSMANN et al. (2005) than by REGALADO (1997, 2003). We defined raised-tail as “tail elevated and curved upward” and lick as a “fast extension and retraction of the tongue while in contact with the other animal”.

Recorded behaviours described by WISSMANN et al. (2005) included stare (focal animal intently watches the other animal), walk (moves about the cage without any evident interaction with the other animal), sniff (animal touches other animal with its snout without tongue-flicking), tail-wave (tail quickly and rhythmically moved from side to side), touch (part of an animal's body touches the other animal), root (animal places its nose in the sub-

strate), mount (animal mounts the other animal), and on-wall (animal climbs a wall of the cage). We also observed gular-pumping and attack as described by MARCUM et al. (2008), but we did not observe displays or approaches involving a “limp”.

We observed nine behaviours not previously described in the context of social interactions among sphaerodactylid geckos. These were looking-up (head elevated and held motionless), licking-eyeball and/or face (licking snout or eyeball), licking-substrate (licking floor), escape (rapid withdrawal after having been approached or contacted by the other animal), copulation attempt (male mounting female followed by copulatory movements with body and tail but without intromission), showing-colours (animal raising its body completely from floor and displaying its dorsal patterns), push-with-shoulder (animal walking sideways with back raised while in contact with the other animal), sideways head-bobs (moving head quickly from side to side), mouth-snap (animal quickly opening and closing mouth while facing the other animal), and walking-sideways (animal walking sideways toward the other animal while keeping its body low but not in contact with the ground).

We characterised all behaviours as aggressive (16), submissive (3), or neutral (13) (Table 1). Aggressive behaviours featured the displaying individual attempting to initiate contact or assert dominance over the other animal. Submissive behaviours were characterised by an individual avoiding contact with another animal or engaging in an effort to make itself appear less obvious. Behaviours that were not directed toward the other animal were classified as neutral.

We quantified behaviours as repetitions per minute, with each instance terminating when another behaviour was initiated or all recognisable behaviours ceased. We used non-parametric Mann-Whitney U-tests (Statview 5.0; SAS Inst., Cary, North Carolina) to compare frequencies of behaviours between sexes or between species. For all statistical tests, $\alpha = 0.05$.

Results

During the 24 interactions with durations of 16–72 min, we observed a total of 32 different behaviours, eleven of which were displayed only by *Sphaerodactylus kirbyi* and three exclusively by *Gonatodes daudini* (Table 1).

Intraspecific interactions of *Sphaerodactylus kirbyi*

During intraspecific interactions of *Sphaerodactylus kirbyi*, tail-wave, sideways-head-bob, and mouth-snap were employed only in male/male encounters. Females did not engage in any behaviours exclusive to same-sex interactions. Bite, sniff, root, copulation attempt, licking-eye/face, stiff, and attack were exhibited only in male-female encounters. Bite was more commonly displayed by males. Males only displayed sniff, root, copulation attempt, and licking-eye/face, whereas stiff and attack were used exclusively by females.

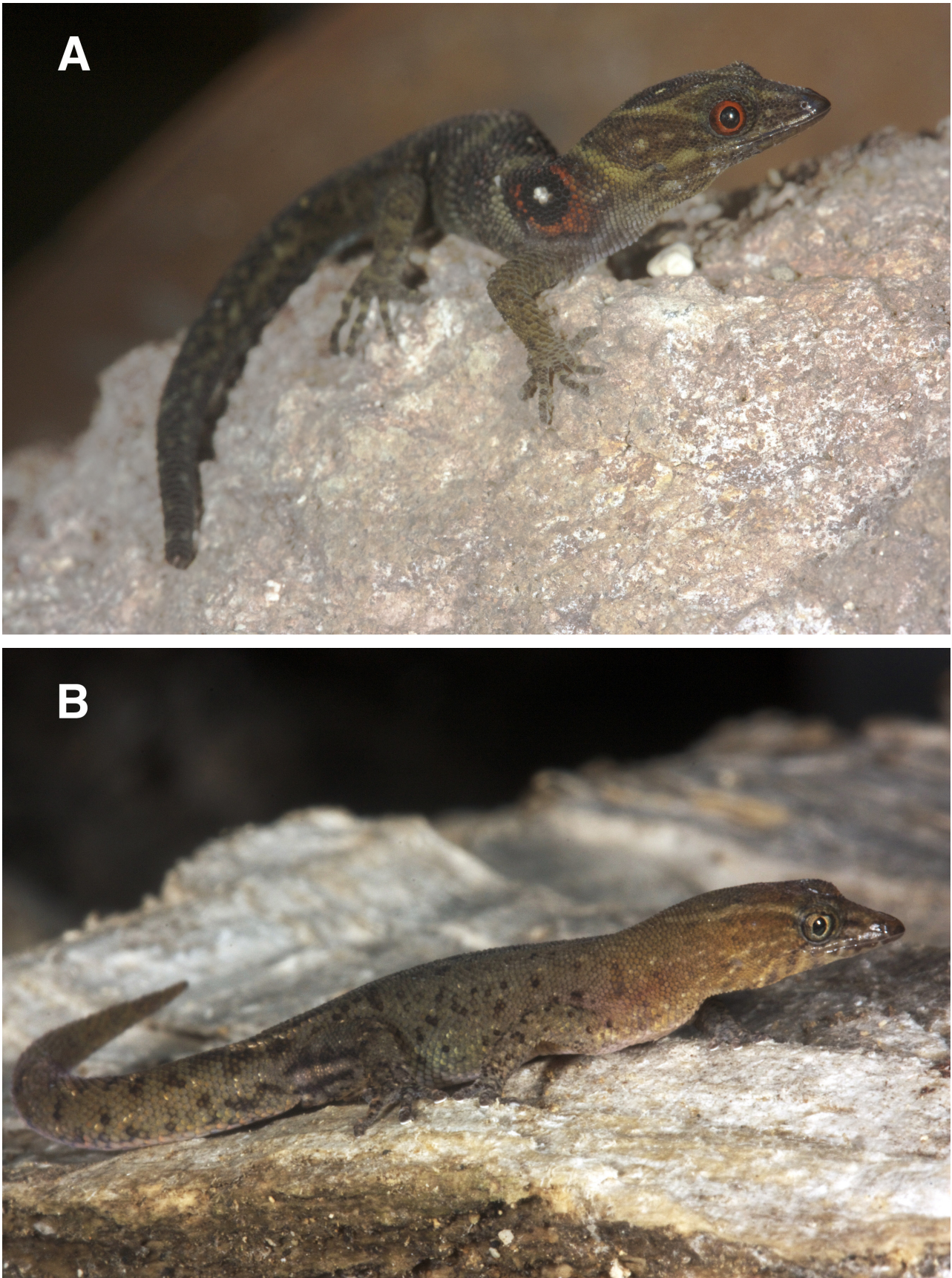


Figure 1. *Gonatodes daudini* (A; adult male, SVL = 29 mm) and *Sphaerodactylus kirbyi* (B; adult male, SVL = 27 mm) occur in close proximity on the slopes above Chatham Bay on Union Island, St. Vincent and the Grenadines. Neither species is sexually dichromatic. Photographs by MEL JOSÉ RIVERA RODRÍGUEZ.

Some behaviours (withdrawal, stand, head-turn, raised-tail, lick, stare, mount, and on-wall) were used both in same sex and male-female encounters and were employed at comparable rates by males and females. Males displayed approach, bite, walk, touch, gular-pumping, and licking-substrate more frequently than females, whereas females displayed tongue-flick, crouch, and looking-up more frequently than males. However, none of the frequencies of individual behaviours differed significantly by sex in intraspecific interactions (all $P \geq 0.15$, except for head-bobs, for which the difference approached significance at $P = 0.057$, with males head-bobbing more frequently than females). Nor did males and females differ significantly in the frequency of all submissive behaviours combined ($Z = -1.17$, $P = 0.24$), all aggressive behaviours combined ($Z = -1.45$, $P = 0.15$), or all neutral behaviours combined ($Z = -0.97$, $P = 0.33$).

A single copulation attempt began with the male starting and throat-pumping at a distance of about 3 cm while the female stared and remained motionless. The male approached the female with his tail raised, pausing to lick the substrate and performing push-ups for 36 sec before making physical contact. After contact, the male licked the female's dorsum once before placing his front legs on her back. The male rubbed the female on the back, nape, and head with his snout for 2 min before the female began to move away. At that point, the male attempted copulation by holding her with his front legs at mid-body, biting her neck, and moving his tail and posterior body from side to side in an apparent effort at intromission. The female continued to move away while keeping her body low to the ground to prevent access. The male remained on the female's back with his tail raised and performed gular-pumping until she escaped from under him and assumed a "stand" posture. Both remained motionless for 3 min until the male started to lick her on the neck and resumed copulation attempts. The female began to look-up and moved, but retained an elevated posture while the male continued to cling to her back. She escaped a second time, but he continued to follow her and began to bite her on the back legs. When she stopped moving, he approached and again start-

ed to lick her body. The female quickly turned and bit the male on the face. After this attack, the male remained stationary while gular-pumping, before licking her again. The male then licked his eyes and the substrate and withdrew with his tail raised. After 4 min, he turned back and again attempted to copulate, licking her hind-legs and tail while doing push-ups and mounting her for a brief time. The female then climbed the wall of the enclosure to escape. The copulation attempt lasted a total of 20 min.

Intraspecific interactions of *Gonatodes daudini*

During intraspecific interactions of *Gonatodes daudini*, lick, mouth-snap, and escape were displayed exclusively in male/male interactions, whereas head-bobs, touch, push-with-shoulder, and sideways-head-bobs were displayed only in female/female encounters. Walking-sideways was the only behaviour observed solely in male-female encounters, and was performed exclusively by females.

Other behaviours (withdrawal, bite, on-wall, and gular-pumping) were displayed with similar frequencies in different pairings. Males displayed licking-eye/face and mouth-snap more frequently than females, whereas females exhibited tongue-flicking, approach, stand, head-turn, stare, walk, looking-up, showing-colours, and escape more frequently than males. However, none of the frequencies of individual behaviours differed significantly by sex in intraspecific interactions (all $P \geq 0.14$). Males and females did not differ significantly in the frequency of all combined submissive, combined aggressive, or combined neutral behaviours ($Z = -0.90$, $P = 0.37$; $Z = -1.25$, $P = 0.21$; $Z = -1.20$, $P = 0.23$, respectively).

Intergeneric interactions

During intergeneric interactions, only *Gonatodes daudini* exhibited showing-colours, push-with-shoulder, and walking-sideways, and only *Sphaerodactylus kirbyi* exhibited



Figure 2. Typical habitats in which *Gonatodes daudini* (A) and *Sphaerodactylus kirbyi* (B) occur in close proximity on the slopes above Chatham Bay on Union Island, St. Vincent and the Grenadines. *Gonatodes daudini* is closely associated with rock outcrops, boulder jumbles, and large logs, whereas *S. kirbyi* is found mainly in leaf litter and under surface debris such as small to medium-sized rocks and deadfall. Photographs by EHREN J. BENTZ.

Table 1. Behaviours observed in *Sphaerodactylus kirbyi* (S.k.) and *Gonatodes daudini* (G.d.) from Union Island, St. Vincent and the Grenadines. Types of behaviours arranged alphabetically within categories (N = neutral, A = aggressive, S = submissive): head-turn (ht), lick (l), lick eye/face (lk), lick substrate (ls), looking-up (lu), root (r), stare (s), sniff (sn), touch (t), tongue-flick (tf), throat movements (tm), walk (wk), on-wall (wl), approach (a), bite (b), copulation attempt (ca), head-bob (hb), mount (m), mouth-snap (ms), push-up (ph), push-with-shoulder (ps), raised-tail (rt), showing-colour (sc), sideways head-bob (sb), stand (sd), stiff (st), attack (tt), tail-wave (tw), walking-sideways (ws), crouch (cr), escape (sp), withdrawal (w). Dashes (—) indicate that a particular behaviour did not occur during that type of interaction.

Behaviour	Types of interactions (repetitions/min)									
	♀ S.k./	♂ S.k./	♀ S.k./	♀ G.d./	♂ G.d./	♀ G.d./	♀ S.k./	♂ S.k./	♀ S.k./	♂ S.k./
	♀ S.k.	♂ S.k.	♂ S.k.	♀ G.d.	♂ G.d.	♂ G.d.	♀ G.d.	♂ G.d.	♂ G.d.	♀ G.d.
ht (N)	0.364	0.229	0.362	0.643	0.109	0.354	0.250	0.591	0.535	0.225
l (N)	0.227	0.036	0.138	—	0.036	—	—	0.045	—	—
lk (N)	—	—	0.017	0.036	0.145	0.021	0.075	0.182	0.163	—
ls (N)	—	0.060	0.172	—	—	—	—	0.045	0.023	0.075
lu (N)	0.045	0.048	0.138	0.268	0.073	0.125	—	0.045	0.047	0.075
r (N)	—	—	0.017	—	—	—	—	0.091	—	—
s (N)	0.182	0.157	0.172	0.214	0.091	0.250	0.125	0.364	0.186	0.050
sn (N)	—	—	0.017	—	—	—	—	—	—	—
t (N)	0.045	0.012	0.069	0.018	—	—	—	0.045	—	—
tf (N)	0.045	—	0.086	0.250	—	0.042	—	0.045	0.023	—
tm (N)	0.045	0.072	0.086	0.107	0.091	0.188	0.075	0.091	0.047	0.075
wk (N)	0.045	0.036	0.172	0.304	0.055	0.146	0.025	0.136	0.047	0.050
wl (N)	0.045	0.024	0.052	0.125	0.055	0.104	0.025	—	—	0.025
a (A)	0.091	0.169	0.190	0.161	0.036	0.104	—	0.045	—	0.025
b (A)	—	—	0.069	0.018	—	0.021	—	—	—	—
ca (A)	—	—	0.034	—	—	—	—	—	—	—
hb (A)	—	0.133	0.172	0.071	—	—	—	0.091	0.140	—
m (A)	0.091	0.024	0.052	—	—	—	—	—	—	—
ms (A)	—	0.036	—	0.018	0.073	—	—	—	—	—
ph (A)	—	0.012	0.017	—	—	—	—	—	—	—
ps (A)	—	—	—	0.018	—	—	—	—	—	—
rt (A)	0.091	0.084	0.069	—	—	—	—	0.136	0.047	—
sc (A)	—	—	—	0.071	0.018	0.063	—	—	—	—
sb (A)	—	0.012	—	0.036	—	—	0.025	—	—	—
sd (A)	0.091	0.048	0.103	0.268	0.018	0.125	—	0.045	0.023	—
st (A)	—	—	0.017	—	—	—	—	—	—	—
tt (A)	—	—	0.017	—	—	—	—	—	—	—
tw (A)	—	0.048	—	—	—	—	—	—	—	—
ws (A)	—	—	—	—	—	0.063	—	—	—	—
cr (S)	0.045	0.048	0.069	—	—	—	0.025	0.136	—	—
sp (S)	—	0.012	0.034	0.143	0.055	—	0.025	—	—	—
w (S)	0.091	0.084	0.103	0.018	—	0.104	0.050	—	—	—

push-ups, crouch, raised-tail, sniff, tail-wave, root, mount, licking-substrate, copulation attempt, stiff, and attack.

Withdrawal, sideways-head-bob, and escape were performed exclusively in female-female encounters, and we observed lick, touch, and root only in male-male encounters. Tongue-flick, stand, head-bob, raised-tail, and lick-eye/face occurred exclusively in male *Gonatodes daudini*/female *Sphaerodactylus kirbyi* interactions, and approach and on-wall were exclusive to female *G. daudini*/male *S. kirbyi* interactions. Walk, gular-pumping, and looking-up

were observed at comparable frequencies in all male/female intergeneric interactions, whereas females performed head-turn more frequently than males and males displayed stare and lick-substrate more frequently.

Male *Sphaerodactylus kirbyi* displayed combined aggressive behaviours during interspecific interactions significantly more frequently than male *Gonatodes daudini* ($Z = -1.96$, $P = 0.05$), but females of the two species did not differ in the frequencies of combined aggressive behaviours ($Z = -1.02$, $P = 0.31$). Males and females of both spe-

cies did not differ in the frequency of combined aggressive behaviours (*G. daudini*: $Z = 0.00$, $P > 0.99$; *S. kirbyi*: $Z = -1.04$, $P = 0.30$). Neither males nor females of either species differed in the frequencies of combined submissive behaviours ($Z = -0.60$, $P = 0.55$), nor did males and females within species differ in the frequencies of combined submissive behaviours ($Z = 0.00$, $P > 0.99$).

Neither males nor females of either species exhibited combined neutral behaviours at significantly different rates (all $P \geq 0.14$, except for lick-eye/face, for which the difference approached significance at $P = 0.08$, with male *Sphaerodactylus kirbyi* exhibiting the behaviour more frequently than male *Gonatodes daudini*). Female *G. daudini* exhibited combined neutral behaviours more frequently than males ($Z = -2.26$, $P = 0.02$), but male and female *S. kirbyi* did not differ in the frequency of combined neutral behaviours ($Z = -0.41$, $P = 0.68$).

Discussion

The dearth of significant differences in the frequencies of individual behaviours can be attributed to low sample sizes (largely attributable to having few *Sphaerodactylus kirbyi* available for staged interactions). Also, some of the paucity of significant differences when groups of behaviours (aggressive, submissive, or neutral) were combined might reflect the fact that one sex or one species exhibited higher frequencies of some behaviours and lower frequencies of others, in effect canceling the other's effect. Consequently, many of our conclusions reflect qualitative impressions gained while observing encounters.

Intraspecific interactions of *Sphaerodactylus kirbyi*

Of the three aggressive behaviours exclusive to *Sphaerodactylus kirbyi* male/male interactions, tail-wave was displayed only before contact, suggesting that this behaviour serves as a signal that the approaching individual intends to establish dominance. This differed from REGALADO (1997), who observed raised-tail in *S. elegans* only in subordinate individuals before withdrawal. Sideways-head-bob was performed by the approaching animal when males were in close proximity. The animal being approached displayed mouth-snap, which in all six instances deterred the approaching animal.

Head-bobs were displayed by males usually while in close proximity to a female; other than establishing dominance, head bobs could serve as a sex- and species-recognition behaviour (REGALADO 2003). The animal at which head-bobs were directed usually responded with head-bobs of its own, generally before initiating an approach or after performing an attack. Stand was displayed by the animal that was being approached while the approaching animal, usually a male, did so with its tail raised. Males licked the substrate more frequently than females and usually while in pursuit of the female, possibly indicating the use of chemical cues. Gular-pumping was displayed in similar frequencies by both sexes, usually while both animals were staring or in close proximity. Males usually initiated

touch and females responded in kind, probably also an indication of a sex-recognition mechanism. Behaviours such as withdrawal and crouch were displayed by submissive animals moving away from an approaching animal. This usually precluded acknowledgment of the submissive individual by the approaching lizard. Females in all types of interactions performed crouch more frequently; the opposite of what REGALADO (1997) observed in *Sphaerodactylus elegans*.

Behaviours independent of the other animal (on-wall, turning-head, looking-up, walk) often were accompanied by tongue-flicks by both sexes in similar frequencies. As in MARCUM et al. (2008) for *Sphaerodactylus vincenti*, turning-head was the most repeated behaviour, but we classified this behaviour as neutral because lizards seemed to be scanning their surroundings instead of showing any directed interest in the other animal. Mount was displayed by both sexes in similar frequencies and was almost certainly a way of establishing dominance over the other animal; the animal being mounted usually stayed low and motionless until the mounting animal disengaged and moved away. Because the copulation attempt we observed was not consummated, we were unable to determine whether *S. kirbyi* engaged in "fleeting copulation", as described for *S. elegans* by REGALADO (1997).

Intraspecific interactions of *Gonatodes daudini*

Of the three exclusive behaviours exhibited in male/male *Gonatodes* interactions, mouth-snap was used when the other male came in close contact while performing aggressive behaviours such as stand or showing-colours. Lick was performed by the approaching male, usually around the tail and hind-legs of the other animal and, in most cases, the animal being licked reacted by escaping. This might reflect a dominant/submissive interaction between males. During female/female interactions, we observed four behaviours exclusive to this combination in which head-bobs and sideways-head-bobs were displayed before and after contact and, as with *Sphaerodactylus kirbyi*, they usually elicited a similar response. Probably a way of establishing dominance from a distance and reassuring dominance after contact (usually as touch), head-bobs could also serve as a species- and sex-recognition mechanism, as they do in at least some sphaerodactyls (REGALADO 2003) and anoles (e.g., LOSOS 2009). Females also exhibited push-with-shoulder, which in all cases triggered an escape by the other female. This was sometimes initiated from a distance, with the animal walking-sideways until it came into contact with the other animal, an apparent indicator of dominance.

Other aggressive behaviours were displayed in similar frequencies between males and females in different pairings; such was the case with bite, which was usually triggered by an approach or a copulation attempt. Withdrawal was the most common behaviour after approach and contact, clearly an indicator of submission. Other behaviours not directed toward the other animal were also displayed in similar frequencies. On-wall was almost certainly exhibited when a lizard was concerned solely with escaping from

the cage and appeared to occur independently of the presence of another animal. Gular-pumping might have served different functions, sometimes being directed at the other animal but in some cases performed while looking away from the other individual with no apparent effect.

Females displayed more aggressive behaviours than males, using stand and showing-colours to deter an approaching individual or to show dominance over the other animal. Showing-colours might also be a sex- and species-recognition signal. Only mouth-snap was performed more frequently by male *Gonatodes daudini*, apparently serving to deter another approaching male. Females spent more time performing behaviours not directed at the other animal (head-turns, looking-up, and walking), but also approached the other animal more frequently than males, usually with the other animal staring and not moving. Females stared more often than males, usually while not moving and tongue-flicking until the approaching female or male came into contact or close proximity, which, in turn, usually triggered an escape.

Intergeneric interactions

We observed one type of aggressive behaviour (sideways-head-bob) during intergeneric female/female interactions. This behaviour was exhibited when the other female approached. The other two behaviours exclusive to these interactions (withdrawal and escape) were submissive. All exclusive male/male intergeneric behaviours involved contact (touch and lick) or tasting the environment in association with root. Touch typically preceded lick, which, in turn, was usually followed by withdrawal, suggesting that licking served in species recognition.

Three aggressive behaviours were observed between male *Gonatodes daudini* and female *Sphaerodactylus kirbyi*. Stand was invariably performed by *S. kirbyi* of either sex from a distance of several centimeters, possibly an attempt to emphasise size to deter an advance by the other individual. The approaching animal often raised its tail while walking with its body elevated, probably an aggressive posture. Tongue-flicks, usually by the male *G. daudini*, happened from a distance as well as in close proximity to the female *S. kirbyi*, presumably serving to gather information about the other animal. Head-bobs were employed when contact was imminent and almost always elicited a comparable response by the other animal. This probably confirmed that the other animal was of a different species. As in REGALADO (2003), head-bobs of both species varied in amplitude and duration, but our sample sizes were too small to determine any context for such differences within species. However, head-bobs of *S. kirbyi* were always proportionately higher in amplitude than corresponding bobs by *G. daudini*.

In male *Sphaerodactylus kirbyi*/female *Gonatodes daudini* interactions, the male would almost always initiate the interaction by approaching the female, frequently coming into contact with her, and sometimes exhibiting lick and/or touch. The female usually responded by withdrawal.

With few exceptions, behaviours of *Sphaerodactylus kirbyi* agreed with those described for other sphaerodactyls. Like *S. sabanus* and *S. sputator* (WISSMANN et al. 2005) and

S. vincenti (MARCUM et al. 2008), but unlike *S. elegans* and *S. nicholsi* (REGALADO 1997, 2003), females were as likely to engage in aggressive behaviours as males. Also, generally speaking, the behavioural repertoire of *Gonatodes daudini* was similar to that of *G. vittatus* (DEMETER & MARCELLINI 1981). In all previously described species except *S. elegans* (REGALADO 1997) and in both species included in this study, visual cues (e.g., head-bobs, tail-waving) appeared to be important for both sex- and species-recognition (see discussion in REGALADO 1997), although vomerolfaction (COOPER & BURGHARDT 1990) seems to assume an ever greater importance with proximity. REGALADO (1997) attributed the lack of reliance on visual cues in *S. elegans* to the lack of sexual dichromatism; however, *S. kirbyi* is not dichromatic (Fig. 1) yet appears to employ visual signals.

Observed intergeneric interactions failed to address questions regarding the possibility of behaviours leading to habitat partitioning between the two species. Although preferred habitats appear to differ, the two species live in close proximity, and syntopic associations (e.g., *Sphaerodactylus kirbyi* under large rocks, *Gonatodes daudini* in leaf litter, and both species under termite mounds) have been observed (BENTZ et al. in press). However, in our staged interactions, aggressive behaviours apparently served to determine that the other individual was not a conspecific, at which time active interactions ceased. Consequently, we conclude that, despite some overlap in habitat use, spatial and possibly temporal niches differ enough to moderate any direct competitive (i.e., aggressive) interactions.

Acknowledgements

JOSEPH P. BURGESS brought the presence of *Sphaerodactylus kirbyi* on Union to our attention. JOHN S. PARMERLEE, JR. and ROBERT W. HENDERSON provided helpful comments on early versions of this manuscript. Permits to conduct research on Union Island (# 2010/01) were issued by BRIAN JOHNSON, Director, Department of Forestry, St. Vincent and the Grenadines. Protocols were approved by the Avila University Animal Care and Use Committee (IACUC # 2007-01). Fieldwork was funded by a grant from the National Science Foundation (U.S.A.) to ROBERT POWELL (DBI-0851610).

References

- BENTZ, E. J., M. J. RIVERA RODRÍGUEZ, R. R. JOHN, R. W. HENDERSON & R. POWELL (in press): Population densities, activity, microhabitats, and thermal biology of a unique crevice and litter-dwelling assemblage of reptiles on Union Island, St. Vincent and the Grenadines. – *Herpetological Review*, **42**.
- COOPER, W. E., JR. & G. M. BURGHARDT (1990): Vomerolfaction and vomodor. – *Journal of Chemical Ecology*, **16**: 103–105.
- DEMETER, B. J. & D. L. MARCELLINI. (1981): Courtship and aggressive behaviour of the Streak Lizard (*Gonatodes vittatus*) in captivity. – *Herpetologica*, **37**: 250–256.
- LEUCK, B. E., K. W. HUGHES & H. Y. CHENG (1998): Social displays of experimentally paired dwarf geckos (*Sphaerodactylus clenchi*). – *Journal of Herpetology*, **24**: 416–418.
- LOSOS, J. B. (2009): Lizards in an Evolutionary Tree: Ecology and Adaptive Radiation of Anoles. – Berkeley (University of California Press), xx + 507 pp.

- MARCUM, M. A., M. A. POWELL, A. J. MUENSCH, H. F. ARNOLD & R. POWELL (2008): Social behaviour of the dwarf gecko *Sphaerodactylus vincenti vincenti* on St. Vincent, Lesser Antilles. – *Salamandra*, **44**: 15–22.
- REGALADO, R. (1997): Social behavior of the Ashy Gecko (*Sphaerodactylus elegans* MACLEAY): Repertoire and sex recognition. – *Herpetological Natural History*, **5**: 41–52.
- REGALADO, R. (2003): Social behavior and sex recognition in the Puerto Rican Dwarf Gecko *Sphaerodactylus nicholsi*. – *Caribbean Journal of Science*, **39**: 77–93.
- WISSMANN, S. M., R. L. HENSLEY, R. POWELL & J. S. PARMERLEE, JR. (2005): Social behaviour in the dwarf geckos *Sphaerodactylus sabanus* and *S. sputator* from St. Eustatius, Netherlands Antilles. – *Salamandra*, **41**: 45–50.