Short Communication

Do male barking geckos (*Ptenopus garrulus garrulus*) avoid refuges scented by other males?

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Abstract.—Lizards frequently rely on chemical cues to detect the presence of a conspecific or a predator, or to sample and detect potential prey. Male lizards in particular, may chemically sample potential refuges to avoid rivals. We tested whether male common barking geckos (*Ptenopus g. garrulus*) that normally take refuge in burrows, avoid refuges scented with a rival male. Geckos were equally likely to use an artificial refuge scented by another male compared to a control. We conclude that scent is an unimportant cue for rival male recognition in *P. g. garrulus* based on 1) the result of this experiment; 2) during 510 man hours of field work we did not observe a single gecko tongue-flick; and 3) males respond aggressively to recordings of rival males and this appears to be the primary mechanism maintaining male spatial patterns.

Key words.—Gekkonidae, chemical cues, rival recognition, tongue-flick, scent.

Lizards commonly use chemical cues in a variety of contexts. They are known to detect the scent of prey (Cooper 1995a), predators (Dial *et al*. 1989; Cooper 1990; Downes & Shine 1998; Downes 2002), and conspecifics (Cooper & Vitt 1984a,b; Alberts & Werner 1993; Regalado 2003). The evolution of chemosensory specialisation is likely under a scenario where vision is limited by darkness (but see Roth & Kelber 2004), and most gecko species are nocturnal (Pianka & Vitt 2003). It has also been argued that geckos are olfactory specialists (Mason 1992; Schwenk 1993).

Geckos have been split into two major families: the Eublepharidae and the Gekkonidae (Pianka & Vitt 2003); the latter includes the barking gecko, *P. g. garrulus*. Several studies have demonstrated the role of olfaction in the behaviour of eublepharid geckos. These include conspecific, predator, and prey recognition in *Coleonyx variegatus* (Greenburg 1943; Dial *et al*. 1989; Cooper 1998), predator recognition in *C. brevis* (Dial & Schwenk 1996), and conspecific and prey recognition in *Eublepharis macularius* (Mason 1992; Cooper 1995b). In the Gekkonidae, chemical cues are used for sex recognition in *Hemidactylus flaviviridus* (Mahendra 1953) and *H. mabouia* (Regalado 2003), and predator recognition in *Oedura lesueurii* (Downes & Shine 1998). Furthermore, male *H. mabouia* showed aggressive behaviour in the presence of male rival chemical cues in an experimental laboratory setup and make use of visual, chemical and vocal signals to communicate with conspecifics (Regalado 2003).

In male lizards where contest competition occurs, territories may be maintained using visual signals (Whiting 1999), chemical cues (Lopéz & Martín 2002) and/or vocalisation (TJH unpubl. data). In addition, the costs of fighting (injury, energetic expenditure, and increased risk of predation) are ameliorated through the use of status signals and rival recognition whereby individual recognition allows knowledge of a rival's fighting ability (reviewed in Whiting *et al*. 2003). Such rival recognition may be of a chemical (Lopéz & Martín 2002) or visual (Whiting 1999) nature.

We tested whether male *Ptenopus g. garrulus* are capable of detecting a rival male's scent using refuge selection trials. *Ptenopus g. garrulus* is a small sized (max 60 mm SVL) gecko of the Kalahari and Namib Deserts of southern Africa. They construct burrows up to 380 mm deep with one active entrance and one or more tunnels ending just below the surface (Haacke 1975). Each gecko is usually the sole inhabitant of its burrow, although a burrow may be shared with a juvenile for short periods of time (TJH pers. obs.). The burrow entrance is used as a sit-and-wait foraging lookout from which prey (mainly termites and ants) are ambushed (Hibbitts *et al*. 2005). Males also call from the entrance of their burrow, which signals territory occupancy (TJH, unpubl. data) and may also act as a signal to females. Apart from foraging, males rarely leave their burrows. However, males will leave and enter or construct a new burrow under two scenarios: (1) when males become mature they may disperse to another area (especially when they are within the home range of a larger male); and (2) after breeding, the female remains in the male's burrow and the male moves to a new location nearby (TJH, pers. obs.). The ability to detect chemical signals could aid in selection of a new burrow or burrow location and avoid a costly conflict with a resident male. Our objective was to determine if male *P. g. garrulus* avoided a refuge that had been scented by other males.

Our study took place at the Molopo Nature Reserve research station, Northwest Province, South Africa (25º 50' S, 22º 55' E). We collected 32 adult male *P. g. garrulus*; 12 were used as scent donors and 20 were tested for chemical recognition of rival males. All geckos were housed individually in 340 × 220 ×135 mm plastic tubs. The bottom of each tub was covered with sand and each tub had a 95 × 95 mm ceramic tile as a refuge. The geckos were fed termites weekly and the sand was misted with water every second week. For each experiment two male geckos were used to create a composite scent on a single 95 × 95 mm tile. The scent of the two geckos was extracted by wiping each down with a hexane soaked paper towel. The cloacal region is a source of glandular and faecal material that has been shown to be important chemical cues in some species of lizard (Cooper & Vitt 1984a,b). As a result, we obtained scent from both the cloacal and body regions of geckos. The soaked paper towel was wiped onto a clean tile and the hexane allowed to evaporate, leaving the composite scent of the two geckos. Donor geckos were given at least five days to recover their scent before being used again.

The experiment took place in a 340 × 220 × 135 mm plastic tub. The bottom of the tub was covered with sand and the scented tile was placed at one end of the tub (end selected randomly). A clean tile (control; wiped with water) was placed at the opposite end of the tub. A male gecko was then placed into the centre of the tub and left alone for 24 h. Trials were conducted only when ambient temperature was sufficiently warm to allow gecko activity (night temperature > 15 ºC). The experiment ended during daylight after at least 24 h, ensuring that the gecko would be under a refuge. The location of the gecko was recorded and the gecko was released after being used only once. We examined the sand substrate for any disturbance, to determine if the gecko had been under the other refuge during the trial. Although the geckos did not leave detectable tracks, they would excavate a depression under the tile.

In all experiments ($N = 20$) the gecko used only one of the refuges and was under the refuge at the termination of the experiment. An equal number of geckos selected the control ($N = 10$) and male-scented ($N = 10$) refuges.

Male *P. g. garrulus* showed no evidence of discriminating between the two refuges based on scent, suggesting that scent is unlikely to be important for male rival recognition in this gecko species. An alternative explanation is that geckos simply ran for the first refuge and did not leave because of the stress and perceived predation risk associated with the experimental setup. This scenario could over-ride any normal behaviour associated with recognition of a rival male's scent. However, the close proximity (about 150 mm) of the two refuges suggests that if male chemical cues act as signals of status, then the gecko should move to the neighbouring (control) refuge sometime during the duration of the experiment (24 h). At the start of each trail, we did not observe any obvious signs of stress: no gecko was seen running or acting frantically in the plastic tub. Geckos always responded initially by remaining motionless in the centre of the tub until the lid was put in place.

We found no evidence to suggest that any male abandoned a male-scented refuge.

A final line of evidence further supports our result that *P. g. garrulus* do not use chemical cues to signal male presence: during approximately 510 man hours of field work we never observed *P. g. garrulus* tongue-flick in any context (including courtship, TJH pers. obs.). Tongue-flicking (via vomerolfaction) is the primary means that most lizards use to detect chemical cues (Cooper 1995a; Schwenk 1995). Tongue-flicking has been observed in two species of *Hemidactlyus* geckos during courtship (Mahendra 1953; Regalado 2003) and is frequently used by eublipharid geckos such as *Coleonyx variegatus* (Cooper 1998).

Ptenopus g. garrulus are unusual among lizards in that they use vocal signals and given that males have a yellow throat, they are also likely to use visual signals. Males emit calls from the mouth of their burrows (Haacke 1969) and these calls can be heard from well over 200 m by the human ear. One possible function of the call is to signal body size of the territory holder in lieu of the potentially risky activity of patrolling the territory. Other male geckos will avoid areas already occupied by a calling male to avoid a costly conflict (TJH, unpubl. data). Furthermore, during playback experiments resident males will rapidly approach a speaker broadcasting the call of a rival male (TJH unpubl. data). Therefore, the long-range signal of the call may preclude the need for a short-range chemical cue. Another plausible explanation for the lack of scent discrimination in *P. g. garrulus* is the environment in which they live. The loose sandy soils on the surface are blown by frequent winds, presumably removing any scent left around the mouth of another male's burrow. When investigating a new burrow, an intruder would have to enter the burrow to detect the scent of a resident, which would increase the chance of a conflict. Therefore, it may be that in this system, prevailing environmental conditions preclude the effective use of scent as a social cue.

We therefore conclude that *P. g. garrulus* does not use chemical cues to select refuges. Our refuge selection results, observations of calling behaviour, environmental conditions that make chemical communication difficult, and the absence of tongue-flicking behaviour all suggest that male *P. g. garrulus* do not use scent discrimination to detect rivals.

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