

Anti-predator tail displays by three semi-fossorial skinks *Chalcides* spp. across the Mediterranean Basin

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ABSTRACT - We report seven opportunistic observations of conspicuous tail-display behaviours in three semi-fossorial skink species (*Chalcides ocellatus*, *Chalcides bedriagai* and *Chalcides montanus*) from Greece, Portugal and Morocco. There were three categories of tail display - tail raised, curling with basal wagging and vigorous horizontal wiggling with tip vibration. These occurred most often when escape was constrained or during brief handling. We suggest that these displays are consistent with an anti-predator, tail-redirecting function.

INTRODUCTION

Defensive mechanisms order to maximise animal survival have been well documented, including in different stages of the predatory sequence (Huang & Caro, 2023). Tail display is one of the most recognisable mechanisms and is closely connected to tail autotomy in lizards (Arnold, 1984; Greene, 1988; Bateman & Fleming, 2009; Senter, 2024). Within the diverse family of skinks (Scincidae), tail displays have been documented in several genera, including *Chalcides*, *Plestiodon*, *Sphenomorphus* and *Trachylepis* (Cooper & Vitt, 1985; Langkilde et al., 2003; Sánchez-Hernández et al., 2012; Galoyan & Geissler, 2013; Gasparotto et al., 2021).

Anti-predator tail display in skinks may function to attract the predator's attention to the tail (Hasson et al., 1989); an attack targeted at this part of the body leads to autotomy, facilitating escape. Tail display could further signal to a predator that it has been detected by the prey (Hasson, 1991). This signaling function has also been documented in social and agonistic interactions between individuals of the same species (Langkilde et al., 2003; Sánchez-Hernández et al., 2012; Gasparotto et al., 2021). However, the variation observed in tail displays complicates their characterisation as does the imprecise language used to describe them. Consequently, the definitions of displays may not be clear which can lead to overlap with other similar behaviours and functions (Huang & Caro, 2023). While skinks use their tail in different ways (Langkilde et al., 2003), the characterisation of different defensive tail displays seems important.

In this note, we describe some interesting behaviours included with tail displays which may play an anti-predator role performed by three different semi-fossorial *Chalcides*

skinks: the ocellated skink *Chalcides ocellatus* (Forskål, 1775), Bedriaga's skink *Chalcides bedriagai* (Boscá, 1880) and the Atlas Mountain skink *Chalcides montanus* Werner, 1931. Such behaviours have not previously been documented for these species.

MATERIALS & METHODS

The observations have been collected opportunistically during fieldwork between March 2024 and June 2025 across sites in Greece, Portugal and Morocco (Fig. 1; Table 1) and refer to adult individuals. Behavioural notes were recorded in situ and specimens were photographed and/or videoed.

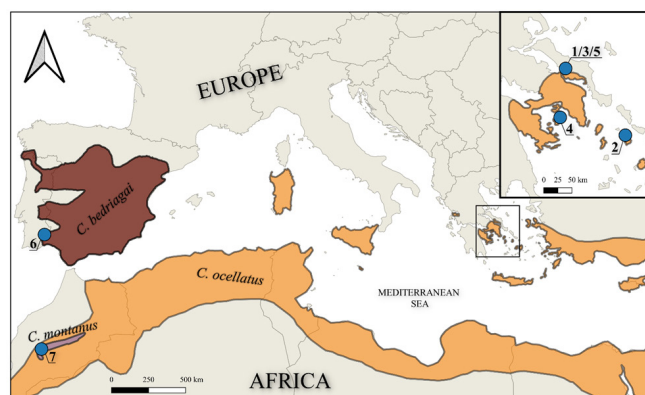


Figure 1. Approximate distribution maps of the three examined skink species: Ocellated skink *Chalcides ocellatus* (Forskål, 1775), Bedriaga's skink *Chalcides bedriagai* (Boscá, 1880) and Atlas Mountain skink *Chalcides montanus*, Werner, 1931. Blue dots indicate the behavioural observations, and numbers correspond to the text and Table 1

Specifically, we recorded date, locality, altitude, context (handling, escape, injured) and tail condition (original, regenerated, autotomised). Tail-display behaviour was coded post hoc from field notes, photographs and video into qualitative categories for better conceptualisation (Huang & Caro, 2023).

As the records were not collected under a standardised experimental protocol, measures such as exact handling duration or detailed camera metadata were not systematically recorded for every observation. We emphasise that our dataset is opportunistic and limited in sample size; therefore, statistical inference is not attempted here, and interpretations are framed as hypotheses to be tested experimentally.

OBSERVATIONS

The localities at which observations were made are shown in Figure 1 with relevant metadata and a categorisation of the behavioural displays presented in Table 1.

Chalcides ocellatus

Observation 1 (Fig. 2A) was made on central Euboea Island, Greece. During handling, the individual raised its tail slowly, keeping it vertical and stayed immobilised on the first author's hand while it kept its head low, the forelimbs relaxed and with slow blinking eyes. Hindlimbs were extended and firmly planted, lifting the posterior part of the body slightly off the ground.

Observation 2 (Fig. 2B & BHS video, 2026a) was made on Syros Island, Greece. During escape, the skink was unable to dig a hole or run in the direction of the observer, so it raised its tail, curling it and wagging slowly. The rest of the body was immobile with the hindlimbs extended, but the animal looked alert with head and forelimbs on standby.

Observation 3 (Fig. 2C) was made on central Euboea Island, Greece. Similar to observation 1, the individual was immobile after human handling, even when it was placed back on a rock, keeping its tail straight like a spike, with no curling, but a bit lower at this time. Head low, eyes open, hindlimbs extended.

Observation 4 (Fig. 2D) was made on Aegina Island, Greece. The skink was unable to escape, similar to observation 2, so it raised its tail, curling it without any tail movement, while remaining immobile. The head was kept low, and the hindlimbs were extended, but the posterior part of the body wasn't lifted. The tip of the tail was regenerated.

Observation 5 (Fig. 2E) was made on central Euboea Island, Greece and was crucial for understanding the functional significance of tail display. The skink had escaped from a domestic cat and as a result was injured with an autotomised tail. During handling, although there was no tail, the hindlimbs were deployed in a similar manner to earlier observations, extending and lifting the posterior body, while the head was kept low and the eyes closed. The skink was immobile but alive.

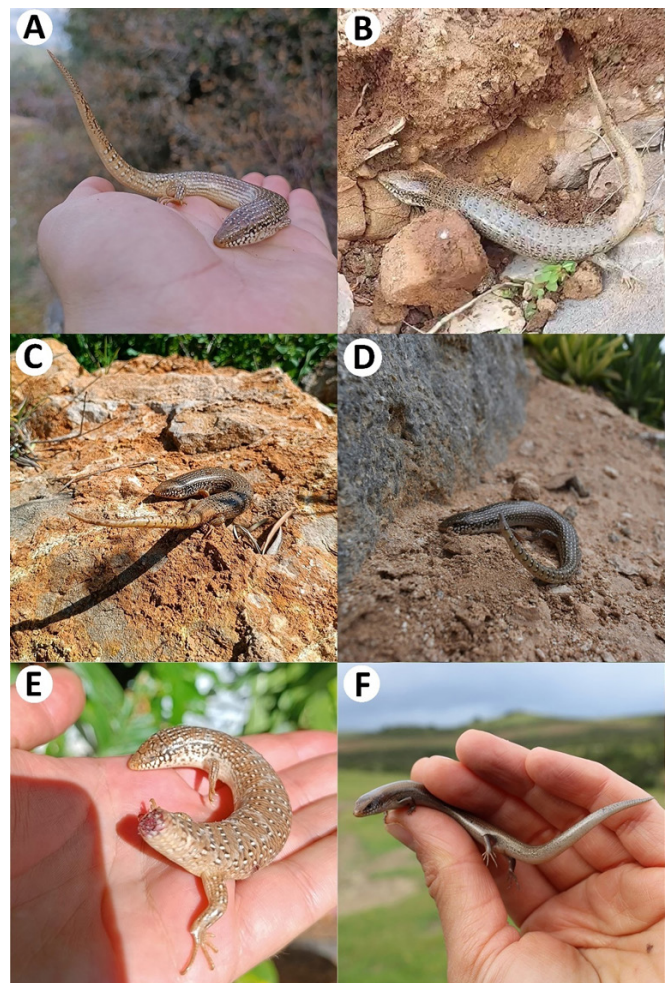


Figure 2. Tail displays given by *Chalcides* skinks - **A.** Ocellated skink tail raising without lateral movement, **B.** Ocellated skink tail curling and wagging, **C.** Ocellated skink tail raising without lateral movement, **D.** Ocellated skink tail curling without lateral movement (tail tip seems regenerated), **E.** Autotomised ocellated skink with extended hindlimbs and lifting the posterior body, **F.** Bedriaga's skink tail raising without lateral movement

Chalcides bedriagai

Observation 6 (Fig. 2F) was made in Guadiana Valley Natural Park, Portugal. While it is a different species, the individual displayed its tail in a similar manner to the first observation of the ocellated skink, raising its tail vertically during handling, while the head was oriented in the direction of the observer.

Chalcides montanus

Observation 7 was made in the Atlas Mountains, Morocco. This concerns the Atlas Mountain skink, a species with little known biology (Schleich et al., 1996; del Mármol et al., 2019), and differed markedly from all other records. During handling, the individual was wiggling its tail with moderate to intense, repeated motions. These movements included vibration of the tail tip and horizontal waving of the tail (BHS video, 2026b). The rest of the body remained immobilised, with the head held low and the forelimbs relaxed against the surface, although the animal attempted to escape when released. The eyes were open and alert throughout the display.

Table 1. Metadata for the observations on *Chalcides* spp. tail displays and display categorisation

Obs. No.	Species	Date	Locality	Altitude (m a.s.l.)	Context	Tail state	Tail display categories (A/B/C)
1	<i>Chalcides ocellatus</i>	4 Mar 2024	Central Euboea, Greece (38.5755° N, 23.6548° E)	26	Handling	Original	A (raised straight)
2	<i>Chalcides ocellatus</i>	9 Feb 2025	Syros, Greece (37.3981°N, 24.8678°E)	48	Escape (could not dig/ unable to run)	Original	B (curling + wagging)
3	<i>Chalcides ocellatus</i>	10 Mar 2025	Central Euboea, Greece (38.5754°N, 23.6548°E)	26	After handling, immobilised on a rock	Original	A (straight, spike-like)
4	<i>Chalcides ocellatus</i>	22 Mar 2025	Aegina, Greece (37.7736°N, 23.5078°E)	2	Escape/prevented from escaping	Tip regenerated	B (curled, no movement)
5	<i>Chalcides ocellatus</i>	1 May 2025	Central Euboea, Greece (38.5787°N, 23.6403°E)	22	Rescued after a cat attack; handling	Tail autotomised	No tail posture
6	<i>Chalcides bedriagai</i>	2 Apr 2025	Guadiana Valley NP, Portugal (37.6414°N, 7.6607°W)	75	Handling	Original	A (raised straight)
7	<i>Chalcides montanus</i>	16 Jun 2025	Atlas Mountains, Morocco (31.2097°N, 7.8516°W)	2586	Handling	Original	C (vigorous tail wiggling; tip vibration & horizontal waving)

DISCUSSION

We suggest that the tail display behaviour recorded in all three observed skink species, *C. ocellatus*, *C. bedriagai* and *C. montanus*, serves an anti-predator role. The individuals presented the tail either after an extended period of handling or when escape was prevented (hard artificial terrain and absence of shelter). The observed tail displays would lead a potential predator to strike the tail, a non-vital body part, increasing the probability of the skink's escape, despite the loss of the tail (Miranda et al., 2022). However, the main anti-predator behaviours of these semi-fossorial species are escape towards vegetation and stones or diving into the sand (Schleich et al., 1996; Attum et al., 2007) and during handling, they spin and push as if attempting to burrow into the fist, or even bite (Schneider, 1981). One explanation for the relative rarity of reports of tail displays, particularly in the ocellated skink, is the limited number of observations of this species, although it is possible that this behaviour is only displayed under specific circumstances and so reducing the likelihood of it being reported.

The tail displays we observed can be placed in three categories (Table 1): A) the tail raised straight and stiff above the substrate without lateral movement, B) the tail curled and wagging from its base, and C) the tail wiggling (horizontal waving). In some observations, the skink emphasised its tail display by lowering the head, relaxing forelimbs and closing its eyes. The first category seems quite similar to the tail display of juvenile collared lizards *Crotaphytus collaris* (York et al., 2016), the second looks similar to an agonistic behaviour of 'tail undulation' of a related species, the West Canary skink *Chalcides viridanus* (Sánchez-Hernández et al., 2012) while the third looks similar to the five-lined skink *Plestiodon fasciatus* and broadhead skink *Plestiodon laticeps* (Cooper & Vitt, 1985). Regarding the Atlas Mountain skink juveniles we suggest that the reddish tail colouration in combination with the tail wiggling may enhance the

anti-predator function similar to the blue-tailed juveniles of *Plestiodon skinks* (Cooper & Vitt, 1985).

In the ocellated skink, tail position appeared to vary according to context: during handling, the tail was typically raised straight like a spike (category A); during escape, it was often curled and may be wagged (category B). This pattern may suggest a different display mode depending on threat proximity and type. A possible explanation is that the category A tail display is triggered when the skink is caught, serving to misdirect the predators' attack toward the tail, whereas the category B may act as warning signal to the predator. In the two other skink species, all displays were observed during handling. Body immobilisation was also a feature of all our observation, which is a well-documented anti-predator behaviour in lizards (Martín et al., 2009; Mo, 2024).

It is of interest to note that the ocellated skink which had suffered tail autotomy adopted the same posture with hindlimb extension and posterior body elevation as the other skinks. This observation indicates that the benefit of this posture may be independent of the tail. Caudal autotomy and tail display seem to be evolutionary ancestral behaviours and conserved in the family Scincidae preceding the development of colourful tails (Murali et al., 2018). Despite *Chalcides* species having become adapted to a fossorial lifestyle near dense vegetation (Caputo et al., 1995) and generally not having bright and colourful tails, it is possible that the tail display behaviour has been maintained in these taxa. Another possibility, is that the maintenance of a colourful tail in juveniles, but not in adults, in the case of *C. montanus*, may be linked to differing pressures among age groups. Juveniles may experience greater predation pressure (Hawlena et al., 2006; Guidi et al., 2021), which could make tail displays advantageous despite the costs associated with autotomy that can significantly affect the survival of autotomised individuals (Formanowicz et al., 1990; Cooper & Smith, 2009).

Future behavioural experiments should investigate the contextual factors that influence the observed variation in tail display in *Chalcides* skinks, including the influence of age class, sex, physiological condition and past experiences with predators.

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