REPTILES & AMPHIBIANS

# A Megarian Banded Centipede (*Scolopendra cingulata*) Preying on a Juvenile Ocellated Skink (*Chalcides ocellatus*) in Cyprus

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Worldwide, predacious invertebrates play important roles in shaping populations of small vertebrates and can indirectly affect other wildlife as well (McCormick and Polis 1982; Nordberg et al. 2018; von May et al. 2019; Valdez 2020; Halpin et al. 2021). Several studies indicate that arthropods prey on vertebrates far more often than previously assumed (e.g., McCormick and Polis 1982; von May et al. 2019; Valdez 2020; Emery et al. 2021; Nyffeler and Gibbons 2022). Consequently, a better understanding of the natural history and feeding ecology of large predatory arthropods, as well as recognition of their predator-prey interactions with vertebrates, is critical for understanding how arthropods can shape vertebrate populations and communities (Nordberg et al. 2018; Valdez 2020). Centipedes in the family Scolopendridae, generalist predators and among the largest terrestrial venomous arthropods, prey on a wide range of invertebrates and even overpower and consume small vertebrates such as amphibians, reptiles, seabird chicks, and small mammals (McCormick and Polis 1982; Molinari et al. 2005; Lewis 2009; Goessling et al. 2012; Nordberg et al. 2018; Valdez 2020; Halpin et al. 2021). Most cases of predation by giant centipedes on vertebrates have been observed in the tropics but few reports are known for Europe (e.g., Zimic and Jelic 2014). Scolopendromorph centipedes possess potent neurotoxins, which they inject with their powerful forcipules (Dugon and Arthur 2012), using it for predation as well as defense.

The Megarian Banded Centipede (*Scolopendra cingulata*) (Fig. 1), Europe's most common and largest (maximum body length > 150 mm) species of scolopendromorph centipede, has a distribution ranging from the Mediterranean to the Black Sea and into Russia (Simaiakis et al. 2011, 2012). Consuming a wide range of arthropods and even small vertebrates, this nocturnal hunter is a top terrestrial invertebrate predator (e.g., Deimezis-Tsikoutas et al. 2020).

Most extant reptiles are carnivorous, and numerous species of lizards, snakes and turtles include arthropods in their diet (e.g., Georges 1982; Hardy and Crnkovic 2006; Mizsei et al. 2019). The Ocellated Skink (*Chalcides ocellatus*) (Fig. 2) ranges from North Africa (including the Sahara Desert) and the southern Mediterranean to the Arabian Peninsula and into Pakistan. In Cyprus, it reaches a total length of 155 mm,

**Figure 1.** An adult Megarian Banded Centipede (*Scolopendra cingulata*) (12.0 cm body length fully stretched; 4.3 g body mass) from Skoulli Village, Cyprus. Photograph by D. Jestrzemski.





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**Figure 2.** An adult Ocellated Skink (*Chalcides ocellatus*) (~15 cm SVL) from Geri Town, Cyprus. Photograph by George Constantinou.

with a maximum reported snout-vent length of 87.3 mm, and is commonly found in sandy areas and grassy lowlands with bushes and scattered stones, as well as in anthropogenically disturbed areas such as in rubbish sites (Osenegg 1989; Baier et al. 2013). Ocellated Skinks are nocturnal and primarily feed on insects (Carretero et al. 2010; Baier et al. 2013).

## Case Study

We herein report for the first time the predation of *Scolopendra cingulata* on *Chalcides ocellatus* on 27 October 2017 at ~1500 h in scrubland habitat (phrygana) near Moni Village, Limassol District, Cyprus. When flipping a rock (diameter ~ 40 cm), GP observed a large Megarian Banded Centipede (estimated length at least 17 cm, including the hind legs) that had grasped a juvenile Ocellated Skink with its legs (Fig. 3). The skink was substantially smaller than the centipede. Neither predator nor prey was moving. The centipede had sunk its forcipules into the prey's body and blood was visible around the puncture wound. After about two minutes, GP left the scene. As the centipede had made no attempts to escape or relinquish its prey, it likely continued feeding on the skink.

**Figure 3.** A large adult Megarian Banded Centipede (*Scolopendra cingulata*) preying on a juvenile Ocellated Skink (*Chalcides ocellatus*) near Moni Village, Limassol, Cyprus. Note the centipede's legs grasping the lizard's body. Photograph by G. Pishilis.

## Discussion

*Reptilian predation by* Scolopendra cingulata.—Predation of reptiles by Megarian Banded Centipedes is rarely documented. To the best of our knowledge, this is only the third published report of saurophagy by *S. cingulata*. In the two other instances, *S. cingulata* was observed feeding on a Sharp-snouted Rock Lizard (*Dalmatolacerta oxycephala*) in Croatia (Korčula Island) (Zimić and Jelić 2014) and on an Aegean Wall Lizard (*Podarcis erhardii*) in Greece (Andros Island) (Deimezis-Tsikoutas et al. 2020). In both cases, predation was considered more likely than scavenging, as the tail and extremities of one lizard were still moving weakly (Zimić and Jelić 2014), and the scales of the other lizard were glossy like those of a live animal, and its general condition still relatively good (Deimezis-Tsikoutas et al. 2020).

Notably, all three observations of saurophagy by *S. cingulata* occurred on islands. On the one hand, islands might intensify trophic interactions between small reptiles and scolopendromorph centipedes due to their physical constraints, limited availability of prey, and possible food shortages. Such conditions presumably require centipedes and small reptiles to share the same microhabitats (e.g., rocky crevices, concrete or rock slabs, woody debris) and the predators to tackle unusually large or dangerous prey, which increases their risk (Patharkar et al. 2022). Under these conditions, *S. cingulata* might more frequently prey on lizards. On the other hand, these interactions certainly also occur on the mainland, where the same microhabitats are found. Furthermore, very large *S. cingulata*, which are more likely to prey on reptiles than smaller centipedes, are not limited to islands (Simaiakis et al. 2011). For example, in mainland Greece, *S. cingulata* can attain a body length of 15 cm and a body mass of 10 g (Fig. 4). Thus, very large Megarian Banded Centipedes can attain the same weight as neonatal Cypriot Blunt-nosed Vipers (*Macrovipera lebetinus lebetinus*), Cyprus's largest and heaviest snake species (Jestrzemski and Kuzyakova 2018). Hence, in light of their impressive maximum size and relatively potent venom, we suspect that Megarian Banded Centipedes include a wide range of small Mediterranean lizards and snakes in their diet.

Although juvenile *C. ocellatus* are more likely to become prey of *S. cingulata* than the larger adults, an ontogenetic

**Figure 4.** An adult Megarian Banded Centipede (*Scolopendra cingulata*) of 15.0 cm body length (fully stretched) and 10.0 g body mass from Thrace, Greece, illustrating the large size to which these arthropodan predators can grow. The grid size is 1 cm. Photograph by D. Jestrzemski.

dietary shift (or cross-predation) can occur, with adult *C. ocellatus* feeding on *S. cingulata* (e.g., McCormick and Polis 1982). A comparable example is a large adult Aegean Wall Lizard (*Podarcis erhardii*) consuming a Megarian Banded Centipede in Greece (Andros Island) (Patharkar et al. 2022).

Lizard tolerance for centipede venom likely increases with body size, whereas the consumption of venomous prey (e.g., scolopendromorph centipedes) might have evolved as an anti-predator response, with nutrient gain a side benefit for lizards. Lizards living in sympatry with giant centipedes might have also developed a higher resistance against centipede venom (Patharkar et al. 2022).

Another predation event recorded on Golem Grad Island, Macedonia, involved a *S. cingulata* (body mass 4.8 grams) that had been devoured by a juvenile Nose-Horned Viper (*Vipera ammodytes*; body mass 4.2 grams) but had partly eaten its way out of the snake's body and thus killed its predator before succumbing (Arsovski et al. 2014). As *S. cingulata* is common prey of *V. ammodytes* (Clark 1967; Laing 2020) and other reptiles such as the Cypriot Whipsnake (*Hierophis cypriensis*) (Baier et al. 2013), situations might occur when centipedes kill (or even devour) reptilian predators in defense.

*The influence of protective microhabitats and human-made structures.*—Protective microhabitats are important, as they facilitate interactions between small reptiles and arthropod predators (Pike et al. 2010; Nordberg et al. 2018). Such structures are critical refuges for Ocellated Skinks and giant centipedes, both of which are secluded and hidden during the day (Klingel 1960; Baier et al. 2013). As centipedes lack the waxy cuticle of insects and arachnids, they lose water more rapidly and are particularly dependent on moist microclimates and protection from sunlight (Barnes 1982). Hence, *S. cingulata* and *C. ocellatus* might encounter each other in protective microhabitat relatively frequently, suggesting that predatory interactions between these species are likely more common than generally thought. However, lizards can reduce the risk of centipede predation by avoiding habitats shared with the latter. Pike et al. (2010) found that centipedes (*Cormocephalus* sp.) and geckos (*Oedura lesueurii*) used rocks with similar structural features (size and thickness), but despite that overlap of suitable microhabitats rarely shared rocks in the field. In fact, the authors observed an ontogenetic shift in habitat selection by geckos in response to the presence of centipedes, with juvenile geckos preferring wide crevices without centipedes, whereas adults chose narrow crevices even if these contained centipedes. Yet, geckos of all life stages left crevices when centipedes were added, showing both size- and context-dependent antipredator behavior. *Chalcides ocellatus* also might avoid centipede predation by similar, possibly size-dependent shifts in anti-predator behavior.

Human-made structures entrapping small wildlife with or without purpose (e.g., animal enclosures, buildings) also can facilitate encounters between small herpetofauna and predaceous arthropods, thus increasing the predation risk for the former (e.g., Carpenter and Yoshida 1966; Lewis et al. 2010; Pomeroy et al. 2021). Moura et al. (2015) and Silva Vieira et al. (2021) reported two instances of giant centipedes preying on lizards in pitfall traps in the Brazilian Caatinga (Table 1). In the first case, a Spix's Whiptail (*Ameivula ocellifera*) (SVL 69.5 mm) was attacked and killed by a *Scolopendra* sp., whereas in the second encounter, a Naked-Toed Gecko (*Gymnodactylus geckoides*) (SVL 43 mm) was overpowered by a giant centipede (*S. viridicornis*) (156 mm total length).

Numerous other records document giant centipedes preying on reptiles and amphibians in tropical countries, where the body sizes of a number of scolopendromorph species exceed that of *S. cingulata* (e.g., Molinari et al. 2005). For example, tropical giant centipedes (*Scolopendra* spp.) have been observed overpowering snakes several times larger than themselves, including McClung's Philippine False Coral Snake (*Hemibungarus mcclungi*) (Acuña et al. 2021), Baker's Cat-eyed Snake (*Leptodeira bakeri*) (Goessling et al. 2012; Van Buurt and Dilrosun 2017), and albeit unsuccessfully, attacking Malayan Kraits (*Bungarus candidus*) (Radcliffe et al. 2020).

*Island studies of vertebrate predation by* Scolopendra *spp.*—The ecological impact of giant centipede populations can be especially consequential on islands (Emery et al. 2021). For instance, the Phillip Island Centipede (*Cormocephalus*

**Table 1:** Literature records of centipedes (Arthropoda: Chilopoda) preying on lizards (Reptilia: Squamata).

| **Centipede species** | **Lizard species** | **Lizard family** | **Country and situation** | **Reference** |
|---|---|---|---|---|
| *Cormocephalus* sp. | Velvet Gecko (*Oedura lesueurii*) | Diplodactylidae | Morton National Park, southeastern New South Wales, Australia. | Pike et al. 2010 |
| *Cormocephalus* sp. | Copper-tailed Skink (*Ctenotus taeniolatus*) | Scincidae | Morton National Park, southeastern New South Wales, Australia. | Pike et al. 2010 |
| *Heterostoma* sp. (cf. *Ethmostigmus* sp.) | Gecko (*Diplodactylus* sp.) | Diplodactylidae | Australia, about six miles from the town of Wilcannia on the Darling River, underneath a dead log, 18 September 1879. | Whittell 1883 |
| *S. cingulata* | Sharp-snouted Rock Lizard (*Dalmatolacerta oxycephala*) | Lacertidae | Medvinjak on the island of Korčula (Croatia), 7 July 2014, diurnally. | Zimić and Jelić 2014 |
| *S. cingulata* | Aegean Wall Lizard (*Podarcis erhardii*) | Lacertidae | Andros Island, Greece, 6 June 2019, around noon. | Deimezis-Tsikoutas et al. 2020 |
| ***S. cingulata*** | **Ocellated Skink (*Chalcides ocellatus*)** | **Scincidae** | **Cyprus, Limassol, Moni, 27 October 2017, around 1500 h afternoon.** | **This study** |
| *S. dehaani* | Bowring's Supple Skink (*Lygosoma bowringii*) | Scincidae | Thailand, Nakhon Ratchasima, Suranaree University of Technology (SUT) campus, diurnal predation, 4 November 2018, 1621 h. | Hodges and Goodyear 2021 |
| *S. gigantea* | Wiegmann's Striped Gecko (*Gonatodes vittatus*) | Sphaerodactylidae | Trinidad and Tobago, Chacachacare Island, in captivity. | Charles and Smith 2009 |
| *S. morsitans* | Eyrean Earless Dragon (*Tympanocryptis tetraporophora*) | Agamidae | Australia, Central Queensland, 29 December 2023, 2320 h. | McFadden and McFadden 2025 |
| *S. heros* | Common Chuckwalla (*Sauromalus ater*) | Iguanidae | Tinajas Altas Mountains, Arizona, USA, 9 September 2022, 1840 h. | Koleska et al. 2023 |
| *S. subspinipes* | Asian House Gecko (*Hemidactylus frenatus*) | Gekkonidae | Australia, Christmas Island. | Emery et al. 2021 |
| *S. subspinipes* | Blue-tailed Skink (*Cryptoblepharus egeriae*) | Scincidae | Australia, Christmas Island. | Emery et al. 2021 |
| *S. subspinipes* | House Gecko (*Hemidactylus mercatorius)*) | Gekkonidae | Ambila-Lemaitso, Madagascar, 3 January 2016, 2257 h. | Prötzel et al. 2023 |
| *S. valida* | Atlantic Lizard (*Gallotia atlantica*) | Lacertidae | Spain, Lanzarote (30 August 1985, 6 May 2005). | Hamilton et al. 2010 |
| *S. viridornis* | Naked-toed Gecko (*Gymnodactylus geckoides*) | Phyllodactylidae | Fazenda Almas Private Natural Reserve in the Cariri western region, municipality of São José dos Cordeiros, Paraíba State, Northeastern Brazil, inside a pit-fall trap, 10 May 2013, 0800 h. | Vieira et al. 2021 |
| *Scolopendra* sp. | Spix's Whiptail (*Ameivulla ocellifera*) | Teiidae | Caatinga, at the Monumento Natural Grota do Angico, municipality of Poço Redondo, state of Sergipe, Brazil, inside a pitfall trap, 21 February 2013, in the morning. | Moura et al. 2015 |
| Unknown species of giant centipede (Scolopendridae) | Australian Native House Gecko (*Gehyra dubia*) | Gekkonidae | Australia, North Queensland, 23 August 2015, 2343 h. | Nordberg et al. 2018; E. Nordberg, pers. comm. |

*coynei*) has evolved as a terrestrial top predator on the Norfolk Islands (Australia), with vertebrates making up nearly half of its diet (48%) on Phillip Island. The vertebrate content consisted of squamates (30.5%), seabird nestlings (*Pterodroma nigripennis*) (7.9%), and scavenged fish remains regurgitated by seabirds (9.6%), with annual nestling predation rates of up to 19.6% (3,724 individuals). This example emphasizes the potential of arthropod predators in altering the vertebrate reproductive output and modifying trophic structures and nutrient flow in island ecosystems (Halpin et al. 2021). When scolopendromorph centipedes are introduced on islands, they can also pose a threat to the survival of native reptilian species. Emery et al. (2021) found that the invasive centipede *S. subspinipes* acted as an opportunistic predator and intraguild competitor of the Blue-Tailed Skink (*Cryptoblepharus egeriae*) on Christmas Island (Australia). The authors also confirmed that, in addition to Blue-Tailed Skinks, *S. subspinipes* consumed Common Wolfsnakes (*Lycodon capucinus*) and the Common House Gecko (*Hemidactylus frenatus*). In the experiments, high densities of *S. subspinipes* reduced the survival of *C. egeriae* on the island by 44%. The authors further observed a significant reduction in body condition of skinks co-housed with *S. subspinipes*, as well as predator avoidance behaviors, which are energetically and physiologically costly, and negatively affect the survival of prey populations (Emery et al. 2021).

*Arthropod predation on vertebrates: Relative frequency and scientific research.*—Although centipede predation on vertebrates likely occurs more frequently than previously assumed, such encounters are rarely observed. In 500 hours of visual field surveys, Nordberg et al. (2018) recorded only a single case of centipede predation on vertebrates, namely a scolopendromorph (*Scolopendra* sp.) feeding on a native Australian House Gecko (*Gehyra dubia*). Their total of five cases of arthropods preying on vertebrates translated into only one recorded arthropod attack per 100 survey hours. However, invertebrate predators were responsible for 23.3% (wet season) and 6.8% (dry season) of all attacks on lizard models deployed for quantifying attack frequencies (Nordberg et al. 2018).

Despite numerous online and newspaper records of arthropods preying on vertebrates, these events are only occasionally documented in the scientific literature, with most published articles describing individual observations and appearing as natural history notes. The relative rarity of such articles and their scattered distribution give an impression of rarity of arthropod predation on vertebrates, which hinders the identification of patterns and the potential impact of these trophic relationships (Valdez 2020). Also, few studies have systematically investigated the frequency of arthropod predation on vertebrates or its ecological impacts on the latter (e.g., Pike et al. 2010; Nordberg et al. 2018; Emery et al. 2021).

## Conclusions

We conclude that arthropod predation on vertebrates, as well as the natural history and ecology of predatory arthropod groups such as centipedes and spiders should be studied more frequently and with greater intensity by performing, for example, controlled experiments with manipulated predator and prey densities in mesocosms (Pike et al. 2010) or with models used to quantify attack frequencies (Nordberg et al. 2018). Also, new technologies such as stable isotope analysis or DNA extraction techniques can help to identify prey in fecal samples of predatory invertebrates, thus allowing for more precise dietary analyses and possibly revealing a greater frequency of vertebrate consumption by invertebrates than currently thought (Nordberg et al. 2018). Novel camera traps designed for sampling small vertebrates and large invertebrates also could be used to record trophic interactions between these groups (Hobbs and Brehme 2017). Finally, the anecdotal nature of numerous observations of invertebrate predation on vertebrates further underlines the value of citizen science in contributing natural history data to the current body of knowledge (e.g., Acuña et al. 2021).

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