Herpetology Notes, volume 14: 273-277 (2021) (published online on 01 February 2021)

Aquatic habits of some scincid and lacertid lizards in Italy

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Among European lizards, there are no strictly aquatic or semi-aquatic species (Corti et al., 2011). The only ones that regularly show familiarity with aquatic environments are *Zootoca vivipara* (Jacquin, 1787) and especially *Z. carniolica* (Mayer et al., 2000). Species of the genus *Zootoca* can generally be found in wetlands and peat bogs (Bruno, 1986; Corti and Lo Cascio, 1999; Lapini, 2007; Bombi, 2011; Speybroeck, 2016; Di Nicola et al., 2019), swimming through the habitat from one floating site to another for feeding, or for escape (Bruno, 1986; Glandt, 2001; Speybroeck et al., 2016). These lizards are apparently even capable of diving into a body of water to reach the bottom in order to flee from predators (Bruno, 1986).

Nonetheless, aquatic habits are considered infrequent in other members of the family Lacertidae, including the genera *Lacerta*, *Podarcis*, and *Timon* (Bringsøe, 2005), while relevant sightings are lacking altogether for European Scincidae. As for the genus *Lacerta* (*L. agilis*, *L. bilineata*, *L. schreiberi*, *L. strigata*, *L. trilineata*, *L. viridis*), it is possible to mention records regarding unusual aquatic habits due to movement (Di Cerbo and Di Tizio, 2008), escape (Bringsøe, 1986; Di Cerbo and Di Tizio, 2008), or thermoregulation (Webb, 1980; Bringsøe, 2005). Notably, good swimming skills of *L. bilineata*, both on the surface and underwater, have been observed while evading predators (Di Cerbo and Di Tizio, 2008). Another valuable example is represented by three gravid *L. viridis* found resting in the water with only the head above the surface (northeastern Greece, June 1979), a behaviour that was interpreted as thermoregulation (Webb, 1980). We here report several remarkable observations of different behaviours in aquatic environments in non-accidental circumstances for three Italian lizard species (*Chalcides chalcides*, *Lacerta bilineata*, *Podarcis muralis*).

***Chalcides chalcides* (Linnaeus, 1758)**
Italian Three-toed Skink

First event. On 1 July 2020 at 12:11 h (sunny weather; T_{max} = 32°C; T_{avg} = 25°C) near Poggioferro, Grosseto Province, Italy (42.6962°N, 11.3693°E, elevation 494 m), one of the authors (AM) observed an Italian three-toed skink floating in a near-vertical position in a swimming pool, with only its head above the water surface (Fig. 1A). During the first attempt to rescue the animal with a pool net, it immediately fled by diving and swimming across the pool to reach a safer spot. After that, the skink was observed for several minutes: it assumed a vertical position whenever it was not swimming (even underwater, diving time of about one minute), it did not try to feed on nearby insects, it did not appear to be afraid of three people in the swimming pool. Later, the animal rested at the shallow edge of the pool (Fig. 1B) and, after half an hour, it returned to the water. During the following days, the author did not see the skink again.

Second event. On 12 June 2009 at 15:35 h (slightly cloudy weather; T_{max} = 29°C; T_{avg} = 25°C) near Montechino, Piacenza Province (44.8043°N, 9.6806°E, elevation 381 m), Italy, AA and SM observed an Italian three-toed skink resting while partially submerged (rear body part only) in water pooled at the edge of a stream (Fig. 2A).

Third event. On 21 June 2017 at 16:48 h (slightly cloudy weather; T_{max} = 33°C; T_{avg} = 29°C) near Lugagnano, Piacenza Province, Italy (44.8211°N, 9.7483°E, elevation 272 m), MRDN and SM observed an Italian three-toed skink crossing a stream riffle, with short stops in shallow water or on surfacing stones. When the animal reached the centre of the adjacent pool it stayed on the algal mass emerging from the shallow

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Figure 1. *Chalcides chalcides* observed on 1 July 2020 in a swimming pool, (A) floating in a vertical position and (B) resting at the pool's edge.

water for about 3 min (Fig. 2B). It subsequently moved away, and hid in the riparian vegetation.

Fourth event. On 4 July 2016 at 2.30 pm (slightly cloudy weather; T_{max} = 28 °C; T_{avg} = 25 °C) near Lugagnano, Piacenza Province, Italy (44.8139°N, 9.7434°E, elevation 288 m), SM observed an Italian three-toed skink standing still and almost completely submerged (head only above the water surface) in shallow stream water. After several minutes, it came out of the water and headed for the bushes on the shore.

***Lacerta bilineata* Daudin, 1802**
Western Green Lizard

On 12 June 2009 at 11:45 h (slightly cloudy weather; T_{max} = 29°C; T_{avg} = 25°C) near Lugagnano, Piacenza Province, Italy (44.8242°N, 9.8114°E; elevation 209 m), AA and SM observed an adult male western green lizard resting while almost completely submerged (head only above the water surface) in shallow stream water among algal clusters (Fig. 3).

***Podarcis muralis* (Laurenti, 1768)**
Common Wall Lizard

On 11 June 2013 at 12.30 am (sunny weather; T_{max} = 22 °C; T_{avg} = 18 °C) near Ferriere, Piacenza Province, Italy (44.6007°N, 9.5437°E, elevation 1424 m), AA observed an unusual escape behaviour of a common wall lizard. Once alarmed, the animal jumped into the pooled water of a nearby stream and started swimming under water, heading for the bottom to hide among rocks (Fig. 4A). The dive lasted about 2.5 min, after which it returned to the surface and rested on the edge of the stream (Fig. 4B).

Discussion

Our observations represent new records of significant aquatic behaviours in *Lacerta bilineata* and *Podarcis muralis*, and first ones for *Chalcides chalcides*. Indeed, there are no previous records to the ones we describe for *C. chalcides*. Surprisingly, the species shows good

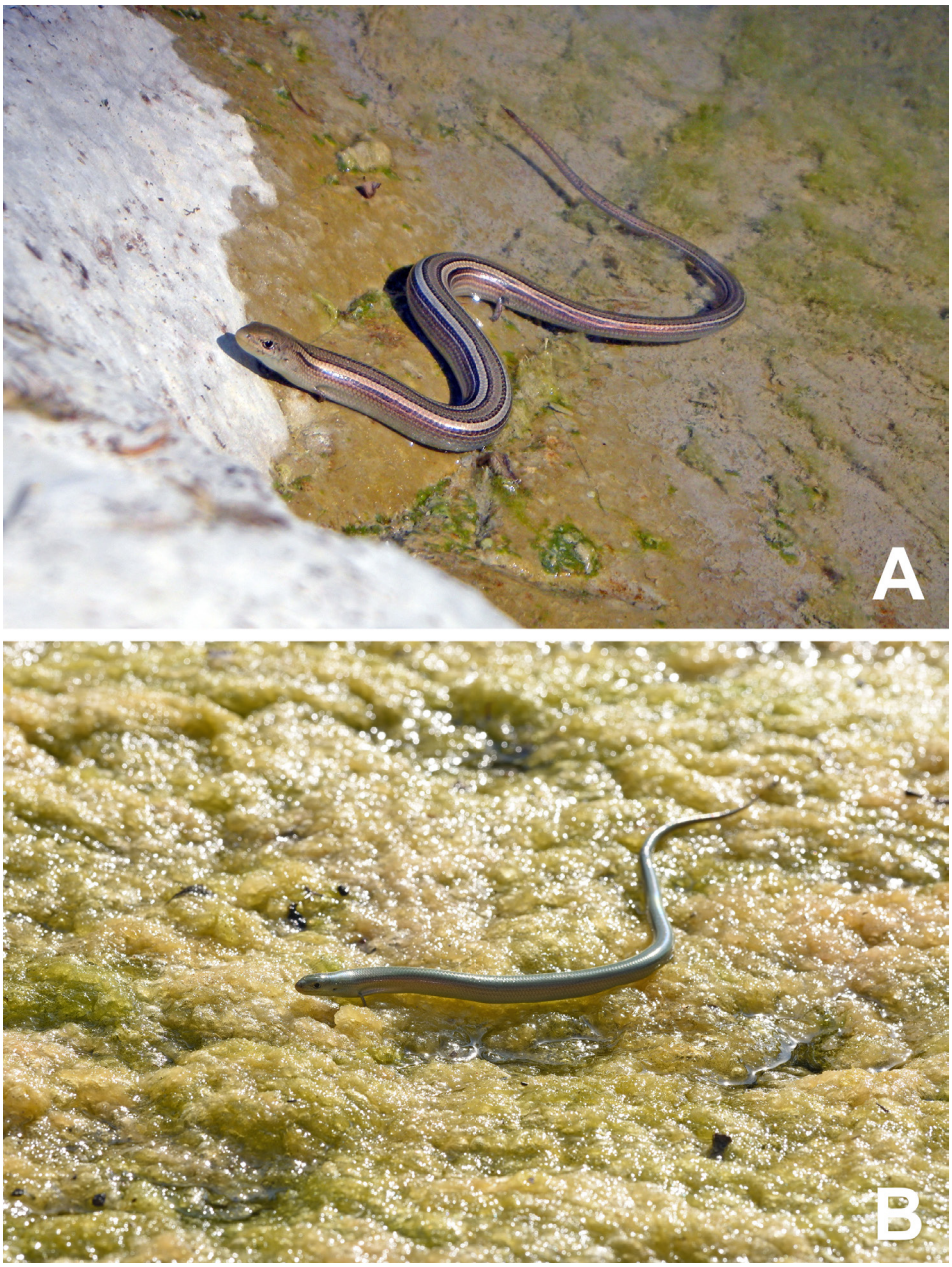

Figure 2. (A) *Chalcides chalcides* observed on 12 June 2009 partially submerged in stream water. (B) A second individual observed on 21 June 2017 on the algal mass emerging from shallow water.

swimming skills, as reported in the description of the first event. Even though the whole situation could be explained by an accidental fall into the swimming pool, we think we can exclude this scenario because the edges of the pool were neither steep nor slippery, and allowed the skink to get out of the water easily. In fact, the animal looked breathless but not in danger, and it voluntarily repeated its unusual behaviour by returning into the water a second time.

Although this peculiar observation is difficult to explain, thermoregulation could be the purpose of at least the other three sightings of *C. chalcides* and one

Figure 3. *Lacerta bilineata* observed on 12 June 2009 standing still and almost completely submerged in shallow stream water.

of the western green lizard: these were all recorded on very hot days (with T_{max} near or above 30°C and $T_{avg} \geq$ 25°C). Each animal did not seem in a rush to leave the water, suggesting a voluntary behaviour. In particular, for *L. bilineata*, similar observations were made for gravid females (Webb, 1980), while our case represents the first observation for an adult male.

Finally, as regards to the *P. muralis*, previous records of individuals swimming across stream water due to normal movement or escape reasons are available (Bringsøe, 2005; Bovero et al., 2013). Nevertheless, the event described in this work is peculiar because the lizard voluntarily chose to hide underwater instead of taking cover in one of the numerous hideouts on the shore. After a dive of about 2.5 min, it cautiously looked for threats in the surroundings before leaving the water.

Even though occasional, the present observations shed light on the potential use of the aquatic environment for thermoregulation and escape strategies in Italian lizard species. Future experimental studies could point out in which conditions these behaviours are adopted for thermoregulation and if escaping into the water may be a local adaptation.

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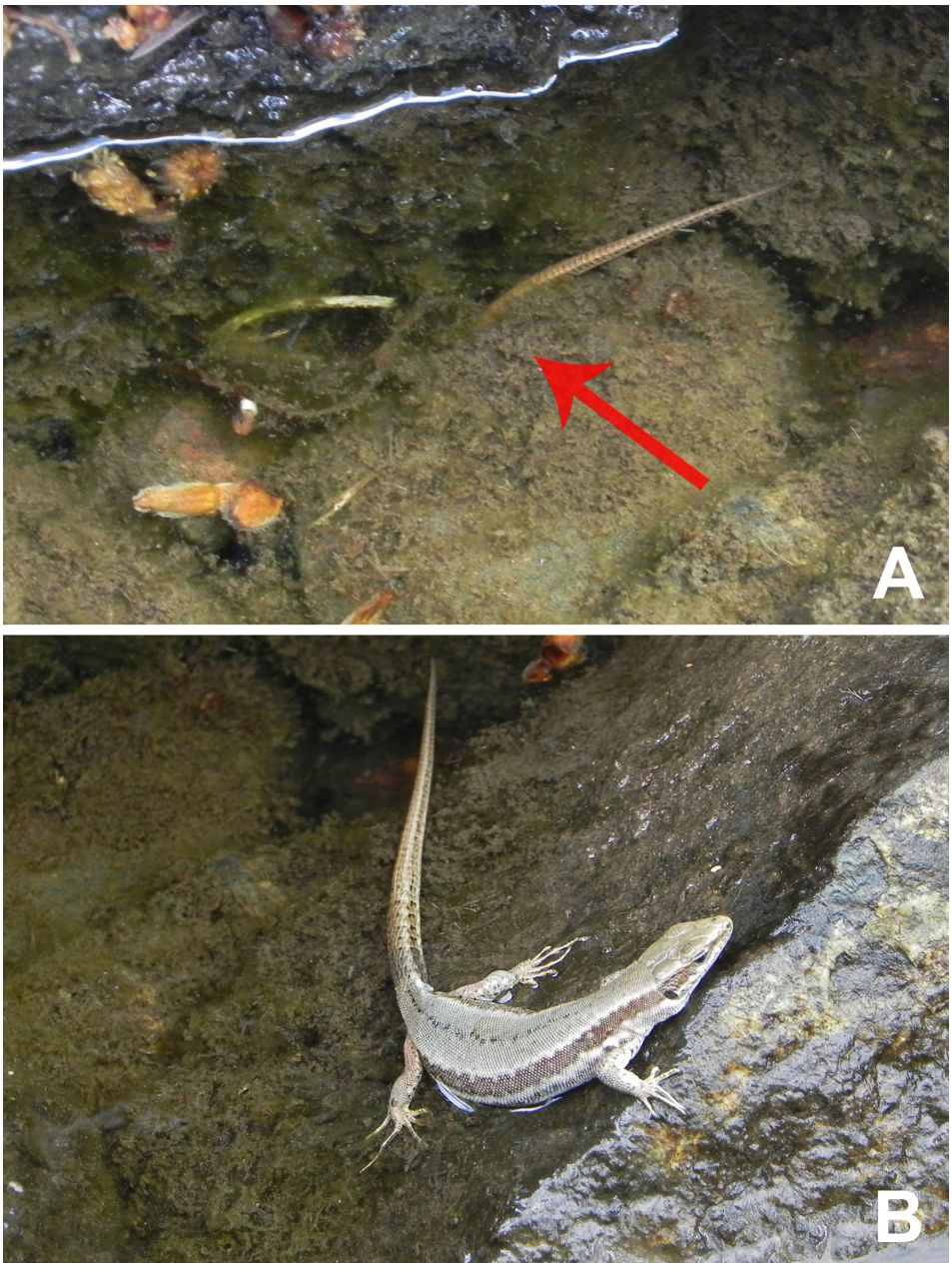

Figure 4. *Podarcis muralis* observed on 11 June 2013 in a pool of stream water. (A) The lizard is hiding underwater after an escape response (the tail is visible). (B) After a dive of about 2.5 min, it surfaced and rested on the shore.

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Accepted by Petra Frýdlová