REPTILES & AMPHIBIANS

Metabolic Rate and Evaporative Water Loss During a Shedding Event in the Mediterranean House Gecko *Hemidactylus turcicus*

Reut Vardi[1*], Shahar Dubiner[1], Roy Ben Bezalel[1], Shai Meiri[1,2], Eran Levin[1]

[1]School of Zoology, Faculty of Life Sciences, Tel Aviv University, Tel Aviv 6997801, Israel
[2]The Steinhardt Museum of Natural History, Tel Aviv University, Tel Aviv 6997801, Israel
*Corresponding author email: reutvardi@gmail.com

The process of ecdysis (sloughing or skin shedding) occurs periodically in all squamates. While necessary to prevent cutaneous evaporative water loss, enable growth, and remove parasites, ecdysis is a physiologically demanding process and can be very costly (Rutland et al. 2019). Different phases of the shedding cycle have been shown to be associated with increased evaporative water loss in both snake and lizard species. For example, Dupoué et al. (2015) showed that gravid and pre-shedding asp vipers (*Vipera aspis*) have significantly higher evaporative water loss compared with digesting and resting individuals (under no apparent physiological constraints). Oxygen consumption rates of pre-shedding individuals (with blue belly and opaque eyes) were higher compared to resting individuals, but low compared to digesting ones. In Tokay Geckos (*Gecko gecko*), evaporative water loss was shown to increase prior to shedding, peak at the shedding event itself, and decrease immediately post-shedding (Zucker and Maderson 1980; Lillywhite and Maderson 1982).

While well documented in *G. gecko*, metabolic rate and evaporative water loss during shedding are less explored in other lizard species. Claussen (1967) showed in one Green Anole (*Anolis carolinensis*) that, during shedding, cutaneous evaporation was high, and overall evaporative water loss was almost twice as high as that of non-shedding individuals. Neilson (2002) showed that an individual New Zealand Chevron Skink (*Oligosoma homalonotum*) lost 10-fold more water immediately after-shedding than the species average. Pintor et al. (2016) also noted that ecdysis greatly increased water loss in the Red-throated Rainbow Skink (*Carlia rubrigularis*) though they did not provide quantitative data.

We add to the evidence of the costs of shedding by presenting documentation of metabolic rates (MR) and Total Evaporative Water Loss (TEWL) of a Mediterranean House Gecko, *Hemidactylus turcicus*, during ecdysis. A 3.3-g male, was measured for five hours as part of a comparison of reptiles from urban and natural habitats (Vardi et al. 2023). Approximately three hours after the beginning of the experiment, the gecko started moving restlessly in its vessel, increasing its MR and TEWL. Fifteen minutes later shedding was documented (see supplementary video). Four weeks later, we measured the same individual again under the same conditions for 24 hours as a control. We deprived it of food for five days before each measurement, then weighed it, and placed it in a dark, isolated metabolic chamber (50 ml) connected to a constant flow of CO_2-free dry air at a flow rate of 100 ml/min (FB8-flow bar, Sable Systems, USA) . The chamber was placed inside an incubator (Panasonic, Japan) at 30°C and monitored by infrared camera. Air exiting the metabolic cell flowed through a LICOR LI-7000 CO_2/H_2O analyzer (LICOR, Lincoln, NE, USA), then passed through an Ascarite-Mg(ClO4)$_2$ column (i.e., CO_2 and H_2O scrubbers) into an Oxzilla O_2 analyzer (Sable Systems, USA). An empty 50 ml chamber, with a constant flow of air at 100 ml/min, was used as a reference baseline and measured every 120 minutes for 10 minutes. For recording the data and analysis, we used Sable Systems Expedata version 1.9.20 and the equations of Lighton (2008).

Table 1. Metabolic rate (carbon dioxide production) and evaporative water loss of a single Mediterranean House Gecko (*Hemidactylus turcicus*) prior to, during, and after shedding, in comparison with a control measurement four weeks post shedding.

	Measurement time	CO2 (ml/ /g*hour)	H2O (µL/g*hour)
Pre-shedding	12:27–13:30	0.08	2.02
Shedding	14:36–15:39	0.28	5.92
Post-shedding	15:51–16:36	0.09	3.26
Control	15:20–16:22	0.07	0.94

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During the shedding event, including the 15 minutes of increased movement prior to visual shedding, the metabolic rate of the gecko, measured by carbon dioxide production, increased by almost four-fold compared to the control measurement. Our results also show that the increased water loss rate starts several hours prior to the actual shedding with more than a two-fold increase in TEWL compared with the control measurement (Table 1). The rate of water loss peaked during the active shedding of the skin, increasing by more than six-fold compared to the control. Immediately after shedding, the gecko's water loss rate decreased but was still almost 3.5 times higher than during the control experiment. Throughout the process, the gecko consumed parts of its shed skin (keratophagy; see supplementary video), a typical behavior in reptiles, especially in geckos (Mitchell et al. 2006).

The different increase in water loss we report, compared to other species recorded (Claussen 1967; Neilson 2002) can be attributed to either methodical differences among studies or to species-specific differences in sensitivity, epidermic lipid content, and local adaptations to different conditions. Le Galliard et al. (2021) assembled a global database of evaporative water loss rates in 301 squamate species demonstrating the great interspecific variation in evaporative water loss due to species traits and external factors such as habitat aridity. While water loss is increased for several hours prior and post shedding itself, metabolic rates seem to only increase during the shedding. This could be related to the increased movement noticed to initiate and complete the shedding (see supplementary video). Overall, the ecdysis process seems to incur physiological costs on individuals, which may explain why many reptile species seek shelter for the duration of shedding.

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