

Record sizes for the Turkish house gecko, *Hemidactylus turcicus*, from Aegean islands, Greece

YUVAL ITESCU^{1*}, RACHEL SCHWARZ¹, MICHAEL MOSES¹, PANAYIOTIS PAFILIS²
& SHAI MEIRI¹

¹Department of Zoology, Tel Aviv University, Tel Aviv 6997801, Israel

²Section of Zoology and Marine Biology, Department of Biology, National and Kapodistrian University of Athens, Panepistimioupolis, Ilissia, Athens 157-84, Greece

*Corresponding author Email: yuvitescu@gmail.com

ABSTRACT - Insular animals are thought to evolve extreme sizes compared to the mainland. The reported maximum body size of the Turkish house gecko, *Hemidactylus turcicus*, does not go beyond 61 mm in snout-vent length, 120 mm in total length and 3.6 g in mass, across its distribution. Here we report much higher size estimates for this species on the Aegean islands of Kassos, Sifnos and Anafi. The commonly perceived drivers of insular gigantism vary across these islands. Therefore, the reasons for the extreme size on these islands, while on other Aegean islands live “normal-sized” geckos, are unclear.

INTRODUCTION

The Turkish house gecko, *Hemidactylus turcicus*, is a nocturnal and insectivorous gecko (Durrell, 1956; Baha El Din, 2006; Bar & Haimovitch, 2012; authors' personal observations). It is a common edificarian house gecko that frequents rocks, boulders and house walls (the Hebrew origin of Proverbs 30:28 is more specific than common English translation in stating that unlike “a lizard”, a gecko “is caught by hand, yet inhabits the king's palaces”). It is naturally distributed in Southern Europe, North Africa, the Middle East (Sindaco & Jeremcenko, 2008), Pakistan and India (Sharma, 2005; Khan, 2006). It is widely introduced in the New World, from Panama to the USA (Uetz, 2016). *H. turcicus* is a relatively small member of its genus (Feldman et al., 2016). The vast literature pertaining to its body size suggests it grows to no more than 61mm in SVL (maximum recorded for males: 60.2 mm, for females: 59.7 mm, Delaugerre, 1984). Our own measurements of 563 live individuals and museum specimens (Table 1; adults and juveniles of both sexes) suggest an overall size range of 17- 60.1 mm SVL. Mass data are less common for *H. turcicus*, as they are for lizards in general (Meiri, 2010). Literature data (Huey et al., 1989; Garland, 1994; Irschick et al., 1996; Van Damme & Vanhooydonck, 2001) suggest a maximum of 3.6 g. Our measurements (Table 1) suggest an overall mass range of 0.1- 6.5 g).

METHODS

During field work from May 2013 to May 2016 we searched for geckos on several Aegean islands (Fig. 1(a)), by looking under and into possible covers and surveying building, natural and dry-stone walls, both at day and at night. Snout-vent lengths (SVL) and tail lengths of animals were measured using a digital caliper to the 0.01 mm precision. Animals were also weighed to the 0.1 gram precision, and their sex was determined visually.

RESULTS

We found several specimens with SVL, total length and mass that were much larger than previously reported. On 27 May 2014, on Anafi Island, we found a very large female on a house wall (36°20'47.4"N 25°46'27.8"E) foraging for beetles under a street lamp around midnight. This female (60.1 mm SVL; Fig. 1(b)) was gravid with two eggs and weighed 7.9 g which is by far the heaviest specimen ever reported for this species (see above).

We found still longer (but lighter) lizards on Kassos Island, during 6-8 May 2016. Five specimens (three adults and two sub-adults) were found in a single location on this island, inactive under various objects in the western outskirts of the port Fri (35°24'59.4"N 26°55'13.4"E) at midday. While specimens from the nearby islands of

Table 1. Body size measurements of *H. turcicus* from Greece and Israel.

Source	Geographic origin	n	Size index	Size range	Size mean	Comments
Museum	Israel	140	SVL (mm)	17.0-60.0	39.7±9.9	Steinhardt Museum of Natural History, Tel Aviv University
		138			1.6±1.2	
Wild caught		78			43.1±8.6	
	Aegean Islands, Greece	77	SVL (mm)	29.4-58.1	2.2±1.1	42 islands; Zoologische Staatssammlung München; Zoologische Forschungsmuseum Alexander Koenig in Bonn; Natural History Museum of Crete
Museum		128			47.1±5.5	
Wild caught		217			47±6.4	
			Mass (g)	0.5-6.5	3±1.1	22 islands, authors' measurements



Figure 1. **A.** Islands with giant geckos: Sifnos, Anafi and Kassos; **B.** The heaviest individual ever reported (Anafi Island); **C.** The longest individual ever reported (Kassos Island) on a 5.5 inch phone.

Karpathos and Saria (first *H. turcicus* record from the later island) are of “normal” size, three of the Kassos ones were veritable giants: the largest specimen (Fig. 1(c); TAU #17870), a gravid female with two eggs, measured 64.7 mm (tail length 63.3 mm, mass=6.1 g). It is, to our knowledge, the longest specimen ever recorded of the species. The other specimens (including two adults measuring 58.4 and 58 mm SVL, 4.4 and 3.6 g, respectively) were released soon after capture. The mean SVL of adult Kassos Island *H. turcicus* (60.4 mm) is thus similar to the maximum SVL previously reported.

Potentially, an even larger gecko was found on Sifnos Island, Cyclades Archipelago, Greece, by Cattaneo (1984). This author reported, as part of a table of *H. turcicus* measurements an animal with a SVL of 65 mm (tail length 40 mm, no weight reported). Cattaneo (1984) rounded SVLs to the nearest 1 mm, thus this animal could have been any length from 64.5 to 65.4 mm. It may also be that this measurement represents a typo, because Cattaneo (1984) does not mention anything unusual about this gecko, and its tail is short. We do, however, have reasons to think the figure may be genuine: three weeks after we visited Kassos (on 23 May 2016) one of us (RS) found a very large female (SVL=63.3 mm, regenerated tail length=46.8 mm, mass=5.9 g) on Sifnos (36°58'38.6"N 24°44'25.8"E), supporting the possibility that individuals of this species could be very large there.

DISCUSSION

The reasons for the large sizes of the geckos from Kassos, Sifnos and Anafi are unclear. Insular lizards are often larger

than their mainland conspecifics or close relatives (Case, 1978; Pregill, 1986; Meiri, 2007; Raia et al., 2010; Meiri et al., 2011; Senczuk et al., 2014; Slavenko et al., 2016; see also Arnold, 2000). Some conditions are quite different across these three islands but are not different in general from other Greek islands we visited. While house geckos are relatively rare on Kassos and Sifnos, they are abundant on Anafi (Itescu et al., unpublished). The only other gecko, and potential competitor of the house gecko, Kotschy's gecko (*Mediodactylus kotschy*) occurs on all three islands (Anafi, Sifnos and Kassos), and on virtually all other Aegean Sea islands inhabited by *H. turcicus*. Thus character displacement is an unlikely cause of insular gigantism in *H. turcicus*. *Mediodactylus kotschy* individuals, however, are not particularly large on any of these islands (and in fact are relatively small on Kassos, Itescu et al., 2016), thus these islands do not seem particularly favourable for the evolution of large size of geckos in general. The conditions often associated with the evolution of insular gigantism (Hasegawa, 1994; Meiri, 2007) vary across the three islands: Sifnos and Kassos are inhabited by snakes that are important gecko predators, whereas Anafi is snake-free (as its Greek name – ἀνευ ὀφείως – ‘snake free’, implies). All three islands harbour other gecko predators such as rats and domestic cats. Release from competition is also an unlikely cause, as the herpetofaunal composition on these three islands is similar to that of many Greek islands (Valakos et al., 2008) where geckos are of average size (Itescu et al., 2016). Neither island enjoys significant amounts of marine subsidies (i.e., food brought in by nesting sea birds), a factor associated with reptile gigantism in many places (Bonnet et al., 2002; Hasegawa, 2003; Keogh et al., 2005), including the Greek Islands (Pafilis et al., 2009).

We are not sure if *H. turcicus* is really native on these islands. On Kassos, for example, some resident lizards may have been introduced recently, based on conversations with locals, who started observing these species only in 2011 (Itescu et al., unpublished). Gigantism in reptiles may well be the result of founder effects, with colonisers being larger than average (Arnold, 2000; see also Cernansky et al., 2015), although in this case, the islands with giant individuals are quite distant from each other, and there are several “normal-sized” population on islands between them (e.g., Sikinos, Folegandros, Karpathos). Thus, evolution is a more likely explanation. Evolution can be extremely fast in island lizards (e.g., Campbell & Echternacht, 2003; Stuart et al., 2014), and so even if the geckos are not native on these islands, they may well have evolved there. We are nonetheless unable at the moment to explain what selective forces drive the evolution of gigantism in this particular population.

ACKNOWLEDGEMENTS

Specimens were caught under permission from the Greek Ministry of Environment, Energy, and Climate Change (Permit 20305/824). The study was funded by an Israel Science Foundation (ISF) grant #1005/12. We are indebted to Erez Maza for helping with the logistics involved in the field work.

REFERENCES

- Arnold, E.N. (2000). Using fossils and phylogenies to understand evolution of reptile communities on islands. In *Isolated vertebrate communities in the tropics*, pp. 309-323. Rheinwald, G. (Ed). Bonn: Bonner Zoologische Monographien 46, Zoologisches Forschungsinstitut und Museum A. Koenig, Bonn.
- Baha El Din, S.M. (2006). *A Guide to the Reptiles and Amphibians of Egypt*. Cairo: American University in Cairo Press. 320 pp.
- Bar, A. & Haimovitch, G. (2012). *A Field guide to Reptiles and Amphibians of Israel*. Herzlyia: Privately published. 246 pp.
- Bonnet, X., Pearson, D., Ladyman, M., Lourdais, O. & Bradshaw, D. (2002). 'Heaven' for serpents? A mark-recapture study of tiger snakes (*Notechis scutatus*) on Carnac Island, Western Australia. *Austral Ecology* 27: 442-450.
- Campbell, T.S. & Echternacht, A.C. (2003). Introduced species as moving targets: changes in body sizes of introduced lizards following experimental introductions and historical invasions. *Biological Invasions* 5: 193-212.
- Case, T.J. (1978). A general explanation for insular body size trends in terrestrial vertebrates. *Ecology* 59: 1-18.
- Cattaneo, A. (1984). Reperti erpetologici nelle Cicladi occidentali: *Testudo marginata* a Milos, *Hemidactylus turcicus* ed *Elaphe situla* a Sifnos (Reptilia). *Natura* (Milan) 75: 75-78.
- Cernansky, A., Klembara, J. & Smith, K.T. (2015). Fossil lizard from central Europe resolves the origin of large body size and herbivory in giant Canary Island lacertids. *Zoological Journal of the Linnean Society* 176: 861-877.
- Delaugerre, M. (1984). Sur l'ecologie thermique des geckos *Phyllodactylus europaeus*, *Hemidactylus turcicus* et *Tarentola mauritanica*: rythmes d'activite, temperature et activite, repartition altitudinale. *Travaux scientifiques du parc naturel regional de Corse* 3: 96-121.
- Durrell, G.M. (1956). *My family and other Animals*. London: Rupert Hart-Davis. 288 pp.
- Garland, T. (1994). Phylogenetic analyses of lizard endurance capacity in relation to body size and body temperature. In *Lizard Ecology: Historical and Experimental Perspectives*, pp. 237-259. Vitt, L.J. & Pianka, E.R. (Eds.). Princeton: Princeton University Press.
- Hasegawa, M. (1994). Insular radiation in life history of the lizard *Eumeces okadae* in the Izu Islands, Japan. *Copeia* 1994: 732-747.
- Hasegawa, M. (2003). Ecological diversification of insular terrestrial reptiles: A review of the studies on the lizard and snakes of the Izu Islands. *Global Environmental Research* 7: 59-67.
- Huey, R.B., Niewiarowski, P.H., Kaufmann, J. & Herron, J.C. (1989). Thermal biology of nocturnal ectotherms: is sprint performance of geckos maximal at low body temperatures? *Physiological Zoology* 62: 488-504.
- Irschick, D.J., Austin, C.C., Petren, K., Fisher, R.N., Losos, J.B. & Ellers, O. (1996). A comparative analysis of clinging ability among pad-bearing lizards. *Biological Journal of the Linnean Society* 59: 21-35.
- Itescu, Y., Schwarz, R., Meiri, S. and Pafilis, P. (2016). Intra-specific competition, not predation, drives lizard tail loss on islands. *Journal of Animal Ecology*, doi: 10.1111/1365-2656.12591.
- Keogh, J.S., Scott, I.A. W. & Hayes, C. (2005). Rapid and repeated origin of insular gigantism and dwarfism in Australian tiger snakes. *Evolution* 59: 226-233.
- Khan, M.S. (2006). *The amphibians and reptiles of Pakistan*. Malabar: Krieger Publishing Company. 328 pp.
- Meiri, S. (2007). Size evolution in island lizards. *Global Ecology and Biogeography* 16: 702-708.
- Meiri, S. (2010). Length-weight allometries in lizards. *Journal of Zoology* 281: 218-226.
- Meiri, S., Raia, P. & Phillimore, A.B. (2011). Slaying dragons: limited evidence for unusual body size evolution on islands. *Journal of Biogeography* 38: 89-100.
- Pafilis, P., Meiri, S., Fofopopoulos, J. & Valakos, E. (2009). Intraspecific competition and high food availability are associated with insular gigantism in a lizard. *Naturwissenschaften* 96: 1107-1113.
- Pregill, G.K. (1986). Body size of insular lizards: a pattern of Holocene dwarfism. *Evolution* 40: 997-1008.
- Raia, P., Carotenuto, F. & Meiri, S. (2010). One size does not fit all: No evidence for an optimal body size on islands. *Global Ecology and Biogeography* 19: 475-484.
- Senczuk, G., Garcia, A., Colangelo, P., Annesi, F. & Castiglia, R. (2014). Morphometric and genetic divergence in island and mainland populations of *Anolis nebulosus* (Squamata: Polychrotidae) from Jalisco (Mexico): an instance of insular gigantism. *Italian Journal of Zoology* 81: 204-214.
- Sharma, R.C. (2005). The fauna of India and the adjacent countries: Reptilia: Volume 2: Sauria. 2nd edition. Fauna of India and the adjacent countries. Kolkata: *Zoological Survey of India*. xxv+430 pp.
- Sindaco, R. & Jeremcenko, V.K. (2008). The reptiles of the Western Palearctic. 1. *Annotated checklist and distributional atlas of the turtles, crocodiles, amphisbaenians and lizards of Europe, North Africa, Middle East and Central Asia*. Latina: Edizioni Belvedere. 579 pp.
- Slavenko, A., Tallowin, O.J.S., Itescu, Y., Raia, P. & Meiri, S. (2016). Late Quaternary reptile extinctions: size matters, insularity dominates. *Global Ecology and Biogeography* 25: 1308-1320.
- Stuart, Y.E., Campbell, T.S., Hohenlohe, P.A., Reynolds, R.G., Revell, L.J. & Losos, J.B. (2014). Rapid evolution of a native species following invasion by a congener. *Science* 346: 463-465.
- Valakos, E.D., Pafilis, P., Sotiropoulos, K., Lymberakis, P., Maragou, P. & Fofopopoulos, J. (2008). *The amphibians and reptiles of Greece*. Frankfurt Am Main: Edition Chimaira. 463 pp.
- Van Damme, R. & Vanhooydonck, B. (2001). Origins of interspecific variation in lizard sprint capacity. *Functional Ecology* 15: 186-202.

Accepted: 29 October 2016