

# Notes on the Role of *Varanus griseus* as a Likely Top Diurnal Predator

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**Abstract - In the southern coastal plain of Israel, adult *Varanus griseus* have been inferred to be the top diurnal predators and ecological equivalent of the Egyptian mongoose (*Herpestes ichneumon*). These assessments have both supportive and unsupportive argumentations, all of which are discussed.**

## Introduction

Monitor lizards are often referred to as the ecological equivalents of mammalian carnivores (e.g., Pough, 1973; Wood *et al.*, 1977a, Pianka & Sweet, 2016). In this context, small-medium sized varanids (total length up to 150 cm) might be considered as the ecological equivalents of small predatory mammals such as viverrids (Pianka & Sweet, 2016), and *Varanus komodoensis* – as the ecological equivalent of a leopard, tiger or lion (Auffenberg, 1981). In my study of the desert monitor (*V. griseus*; Stanner, 1983), *V. griseus* was considered to be the ecological equivalent of the Egyptian mongoose (*Herpestes ichneumon*; see below).

The ecological equivalence of monitor lizards to mammalian carnivores relies on several morphological, physiological and behavioral characteristics typical of monitor lizards:

- 1) Large body size.
- 2) Considerable strength, agility and aggressiveness.
- 3) The ability of several species such as *V. komodoensis* and *V. salvator* to rip large prey apart with their jaws and forefeet (e.g., Auffenberg, 1981; Stanner, 2010).
- 4) A well-developed cardio-pulmonary system (e.g., White, 1968; Kirshfeld, 1970; Hanemaaijer *et al.*, 2019); aerobic metabolic capabilities superior to those of most other reptiles (e.g., Wood *et al.*, 1978); efficient blood physiology (Millard & Johnson, 1974; Wood

*et al.*, 1977a,b, 1978; Hanemaaijer *et al.*, 2019), and comparatively high levels of myoglobin in the skeletal muscles (Bennet, 1973).

These features enable monitor lizards to sustain high levels of activity for prolonged periods, as well as to hunt and subjugate comparatively large and strong prey.

## Observations

The ecological equivalence of *V. griseus* to the Egyptian mongoose was inferred during my study of *V. griseus* in Israel between 1979 and 1981 (Stanner, 1983). My field work was conducted in the inland sand dunes between the cities of Holon and Rishon Lezion in the southern coastal plain of Israel. The sand dunes of the coastal plain of Israel are a comparatively young formation (ca., 6000 years old) that was formed by alluvial sand from the Nile River washed ashore by currents in the Mediterranean Sea (Eig, 1939; Nir, 1973). In terms of soil, flora and fauna, the coastal plain of Israel, as well as the adjacent (to the south) northwestern Negev (Israel) and northern Sinai (Egypt) might be considered as an extension of the Sahara Desert (e.g., Yom-Tov, 1988; Yom-Tov & Mendelsohn, 1988). The faunal composition in my study area consisted of a mixture of both Mediterranean and Saharo-Arabian species. In the coastal plain of Israel the ratio between the numbers of the Mediterranean and Saharo-Arabian species changes along a north-south gradient – in the northern parts the Mediterranean species outnumber the Saharo-Arabian species, and vice versa - in the

southern parts. The largest of the Saharo-Arabian reptile is *V. griseus*. At present, large stretches of my former study area are covered by concrete and have been turned into residential areas. The remainder is crisscrossed by tracks from off-road recreational vehicles, littered with building debris and affected by other environmentally-unfriendly activities, and it is highly doubtful that desert monitors still exist there. More details on the study area can be found elsewhere (e.g., Stanner & Mendelssohn, 1987).

*Herpestes ichneumon* is both diurnal and nocturnal (Shalmon, 1993). *Herpestes ichneumon* is sympatric with *V. griseus* in the southern coastal plain of Israel, but not syntopic with it. The two species do not share the same sand-dunes habitats in the southern coastal plain of Israel, and mongooses were completely absent from my study area. In summary, the ecological equivalence of *V. griseus* to *H. ichneumon* can be depicted as follows: mongooses were not present in the study area, both species are diurnal (though, *H. ichneumon* is also nocturnal), and both species prey on the same type of prey, including large venomous snakes (Stanner & Mendelssohn, 1986/1987).

The red fox (*Vulpes vulpes*) was the only mammalian carnivore present in my study area. Red foxes are mainly nocturnal, though activity during dawn and dusk is also common (Shalmon, 1993); hence, their daily activity patterns do not overlap those of *V. griseus*, which is completely diurnal and not active during dawn or dusk (Stanner & Mendelssohn, 1991). In this study, as well as in other studies, there were no indications that red foxes prey on adult desert monitors. Once I observed a *V. griseus* entering the burrow of a red fox but that might have been an escape behavior (Immelmann & Beer, 1992) triggered by the observer. Furthermore, on several occasions I saw *V. griseus* tracks leading into and out of burrows of red fox burrows, which may indicate that the two species have no predator-prey relationships.

In my study area, as well as in the study area of Vernet (1977) in the Grand Erg Occidental in Algeria, *V. griseus* was inferred to be the top predator, but contrary to this study, Vernet (1977) makes no distinctions between diurnal and nocturnal predators. The terms “top diurnal predators” vs. “top nocturnal predators” are occasionally encountered in the ornithological literature, especially in connection with “diurnal raptors” vs. “nocturnal raptors” (e.g., Glue, 2004). It should be emphasized that the status of *V. griseus* as a top diurnal predator refers only to adult monitors. Juveniles occupy a lower level in the food web and might be preyed upon by many species of vertebrates, including larger conspecifics

(Vernet, 1977). In this context, *V. griseus* has several defensive capabilities that may deter potential predators, as follows:

- 1) *Varanus griseus* is strong, aggressive and has a powerful bite, and can hold on forcibly and fiercely with its jaws, as well as inflict painful tail whips.
- 2) Its comparatively long neck enables *V. griseus* to swing its head sideways in a wide angle thus enhancing its biting capabilities.
- 3) The teeth of *V. griseus* are bilaterally compressed at the distal aspects and serrated along the posterior edges (Fig. 1). Less distinct serrations may also occur along the anterior edges (Fig. 2). Thus the teeth may also have cutting capabilities - thereby exacerbating the damage of the bite and may cause bleeding.
- 4) The saliva of *V. griseus* was found to have venomous properties (Sopiev *et al.*, 1987; Ballard & Antonio, 2001; Zima, 2019). Longitudinal grooves along proximal aspects of the teeth (Fig. 3) may facilitate the flow of venomous saliva into the bitten animal (cf., Fry *et al.*, 2009).

In spite of the aforementioned, the status of adult *V. griseus* as a top diurnal predator might be thwarted by certain factors, mainly anthropogenic factors, including

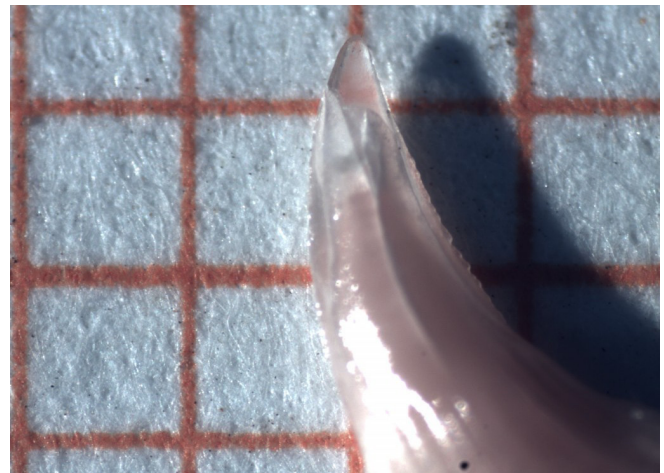


Fig. 1. Stereo-microscopic photograph of *Varanus griseus* tooth extracted from the left maxilla, showing bilateral compression at the distal aspect of the tooth and serration along the posterior edge. In background - 1 mm squared paper. Specimen: R.16780, Steinhardt Museum of Natural History, Tel Aviv University (STMH); 25+34 cm (Snout Vent Length + Tail Length). Photographed by **Michael Stanner**.

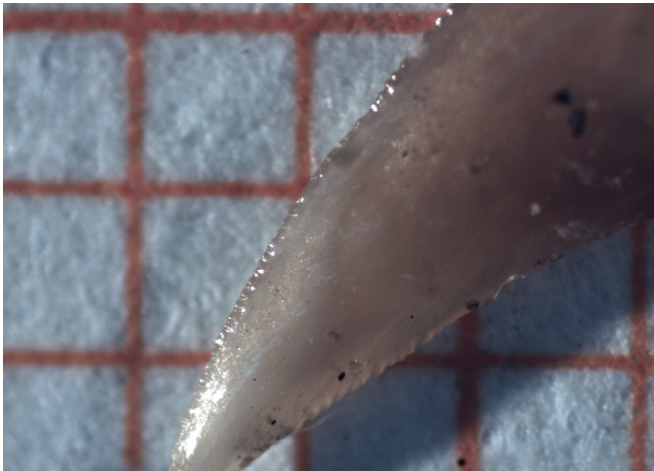


Fig. 2. Less-distinct serration along the anterior edge of the tooth. Tooth extracted from the left mandible. Specimen: R.13044 (STMH); 43+55 cm. Other details and abbreviations as in Fig. 1. Photographed by **Michael Stanner**.

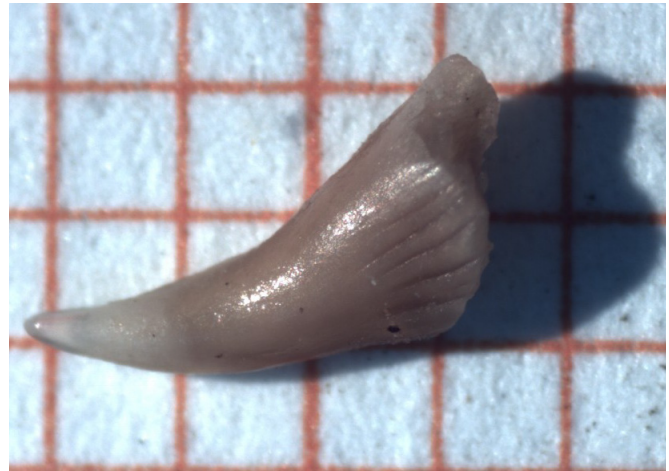


Fig. 3. Maxillary tooth showing longitudinal grooves at the proximal aspect of the tooth. Same specimen as in Fig. 2. Other details as in Fig. 1. Photographed by **Michael Stanner**.

the first two in the following list:

1) Road kills, as well as deliberate killings by humans (Stanner, 1983). Moreover, in many places throughout their range *V. griseus* were hunted extensively for their meat, traditional medicine, and especially – their skins which were targeted in large numbers for the international skin trade. Since 1975 *V. griseus* has been included in CITES Appendix I. Thereafter, since the beginning of the 1980s, a decrease in *V. griseus* skins was reported. (Vernet, 1977; review, Stanner, 2004), and in CITES meeting in 1989 a proposal was submitted to move *V. griseus* from Appendix I to Appendix II, which was not accepted.

2) Intrusion of the sand dunes (southern coastal plain of Israel) by domestic and feral dogs that occasionally kill adult desert monitors (Stanner, 1983; Perry & Dmi'el, 1995).

3) Birds of prey. Tentatively, large raptors might be capable of hunting adult desert monitors. Short-toed eagles (*Circaetus gallicus*), buzzards (*Buteo* sp.) and harriers (*Circus* sp.) were the only large raptors that were seen in my study area. It is doubtful that even *C. gallicus*, the largest of the three, is capable of hunting adult desert monitors. There are no reports of direct observations of raptors preying on adult desert monitors, though the following three circumstantial evidences may indicate that raptors do prey on adult desert monitors:

a) Tsellarius & Cherlin (1991) report that in the western Kyzikum Desert in Uzbekistan more than half of the Caspian desert monitors (*V. griseus caspius*) had scars and fresh wounds on their dorsa, which they attributed to attacks by raptors of the genera *Aquila* and *Buteo* that were prevalent in their study area. However, it is apparent that those presumable predation attempts were eventually unsuccessful. Besides, the scars and wounds might have been caused by aggressive intra-specific interactions (Vernet, 1977; Tsellarius & Tsellarius, 1997), as well as by the monitors wriggling through tight crevices (Stanner, 2007; D. Bennett, pers. comm.).



Fig. 4. *Varanus griseus* head found under the nest of a golden eagle (*Aquila chrysaetos*). Eilat Mountains, southern Israel. Photographed by **Yossi Leshem**.



b) The head of a desert monitor was found under the nest of a golden eagle (*Aquila chrysaetos*; Fig. 4) in the Eilat Mountains, southern Israel, but the monitor could have been scavenged. Golden eagles are formidable predators, but are known to scavenge as well (Inbar, 1977).

c) During an exploration study of the eastern Thar Desert in Jodhpur District of Rajasthan, India, Kumwat *et al.* (2018) observed a Bonelli's eagle (*Aquila fasciata*) feeding on a carcass of a desert monitor on a rock cliff (ca. 15 m high) near the eagle's nest, but the authors attribute this feeding to scavenging rather than predation. Moreover, the desert monitor that was observed by Kumawat *et al.* (2018) belonged to the southern and easternmost subspecies (*V. griseus koniecznyi*), which is the smallest subspecies of *V. griseus*.

4) Albeit not documented yet, occasional predation of adult desert monitors by (mainly nocturnal) large carnivores cannot be ruled out (see below).

a) Rismiller *et al.* (2010) report that females *V. rosenbergi* on Kangaroo Island, South Australia are preyed upon by feral cats. The body size of *V. rosenbergi* is somewhat similar to that of *V. griseus*, but cats (*Felis catus*) are a comparatively recent invasive species to Australia. Hence, endemic Australian fauna (including varanids) are probably more susceptible to predation by cats than elsewhere (Woinarski *et al.*, 2019).

## Conclusions

The assessment that *V. griseus* is a top predator is incomprehensive. Here, the assessment is downgraded by 2-3 limitations: 1) It applies only to adult monitors; 2) It concerns only diurnal predators, and maybe 3) only terrestrial predators (vs., aerial-avian predators). Within the framework of these limitations the status of *V. griseus* as a top predator seems to be plausible. However, lack of knowledge from many areas within the distribution of *V. griseus* may downgrade this assessment even more, or even invalidate it locally, *i.e.*, it may not necessarily be valid throughout its entire distribution area. The main reservations to this assessment are associated with anthropogenic factors. Other reservations are either speculative or based on equivocal circumstantial evidence. As far as community ecology in *V. griseus* habitats in the Saharo-Arabian zoogeographic sub-region is concerned, the status of adult *V. griseus* as the top diurnal predator seems to be the firmest. Natural

(non-anthropogenic) predation on adult *V. griseus* in such communities (if at all) might be attributed only to non-endemic predators (such as large raptors) whose distribution areas are wider and may encompass several zoogeographic regions. Furthermore, inferred from my study area in the southern coastal plain of Israel, future studies of community ecology in various places within the distribution area of *V. griseus* ought to focus more on syntopic species (rather than sympatric species) because diurnal carnivores (especially non-endemic ones) are likely to avoid the extreme conditions that prevail in the hot, dry and unstable sand-dunes that are favored by *V. griseus*, especially in places where these habitats may spread over wide stretches of land such as in north Africa.

**Acknowledgments** - Yoram Yom-Tov reviewed the article and provided valuable comments; Matthias Achenbach helped with German language literature; Nir Stern and Kesem Kazes (of the Steinhardt Museum of Natural History of the Tel Aviv University, SMNH) helped to extract and photograph *V. griseus* teeth; Michael Ram provided dental equipment; the SMNH provided the *V. griseus* specimens and allowed me to use the SMNH facilities and photographic equipment. Their kind help is gratefully acknowledged.

## References

- Auffenberg, W. 1981. Behavioral Ecology of the Komodo Monitor. University of Florida Press, Gainesville. 406 pp.
- Ballard, V. & F.B. Antonio. 2001. *Varanus griseus* (desert monitor) Toxicity. Herpetological Review 32(4): 261.
- Bennet, A.F. 1973. Blood physiology and oxygen transport during activity in two lizards, *Varanus gouldii* and *Sauromalus hispidus*. Comparative Biochemistry and Physiology 46A: 673–690.
- Eig, A. 1939. The variation of the light soils belt of the coastal plain of Palestine. Palestinian Journal of Botany, Jerusalem 1: 255–258.
- Fry, B.G., S. Wroe, W. Teeuwisse, M.J.P. van Osche, K. Moreno, J. Ingle, C. McHenry, T. Ferrara, P. Glausen, H. Scheib, K.L. Winter, L. Greisman, K. Roelants, L. van der Weerd, C.J. Clemente, E. Giannakis, W.C. Hodgson, S. Luz, P. Martelli, K. Krishnasamy, E. Kochva, H.F. Kwok, D. Scanlon, J. Karas, D.M. Citron, E.J.C. Goldstein, J.E. Mcnaughtan & J.A. Norman. 2009. A central role for venom in predation by *Varanus*

- komodoensis* (Komodo Dragon) and the extinct giant *Varanus (Megalania) priscus*. Proceedings of the National Academy of Sciences 106(22): 8969–8974.
- Glue, D. 2004. Blackcap and rosefinch – garden stars. Bird Populations 8: 184–187.
- Hanemaaijer, J., M. Gregorovicova, J.M. Nielsen, A.F.M. Moorman, T. Wang, R.N. Planken, V.M. Christoffels, D. Sedmera & B. Jensen. 2019. Identification of the building blocks of ventricular septation in monitor lizards (Varanidae). Development 146(14): dev177121.
- Immelmann, K. & C. Beer. 1992. A Dictionary of Ethology. Harvard University Press, Cambridge. 352 pp.
- Inbar, R. 1977. Birds of Israel. Achiasaf Publishing House, LTD, Tel Aviv. [In Hebrew]
- Kirschfeld, V. 1970. Eine Bauplananalyse der Waranlunge. Zoologische Beiträge 16: 401–440.
- Kumawat, R., R.P. Saran & A. Purohit. 2018. Bonelli's eagle: Records of predation on *Varanus griseus* and *Ptyonoprogne concolor* by *Aquila fasciata* in Agolai, Jodhpur, India. Bird-o-soar #17. Zoo's Print 33(5): 17–20.
- Millard, R.W. & D. Johnson. 1974. Ventricular outflow dynamics in the lizard *Varanus niloticus*: Responses to hypoxia, hypercarbia and diving. Journal of Experimental Biology 60: 871–880.
- Nir, Y. 1973. Geological history of the recent and sub-recent sediments of the Israel Mediterranean shelf and slope. Unpub. Report. Geological Survey of Israel, Jerusalem.
- Perry, G. and R. Dmi'el. 1995. Urbanization and sand dunes in Israel: Direct and indirect effects. Israel Journal of Zoology 41: 33–41.
- Pianka, E.R. & S.S. Sweet. 2016. Field observations by two American varanophiles. Pp. 1–68. In: Cota, M. (ed.), Proceedings of the 2015 Interdisciplinary World Conference on Monitor Lizards. Institute for Research and Development, Suan Sunandha Rajabhat University, Bangkok.
- Pough, F.H. 1973. Lizards energetic and diet. Ecology 54: 837–844.
- Rismiller, P.G. M.W. McKelvey & B. Green. 2010. Breeding phenology and behavior of Rosenberg's goanna (*Varanus rosenbergi*) on Kangaroo Island, South Australia. Journal of Herpetology 44: 399–408.
- Shalmon, B. 1993. A Field Guide to the Land Mammals of Israel, their Tracks and Signs. Keter Publishing House, Jerusalem. [In Hebrew]
- Sopiev, O., V.M. Makeyev, S.V. Krudrjstev & A.N. Makarov. 1987. A case of intoxication from a bite of *Varanus griseus*. Izvestiia Akademii Nauk Serii Biologicheskaja 87:78.
- Stanner, M. 1983. The etho-ecology of the desert monitor (*Varanus griseus*) in the sand dunes south of Holon, Israel. M.Sc. Thesis. Tel Aviv University. [In Hebrew]
- Stanner, 2004. *Varanus griseus*. Pp. 104–132. In: Pianka, E. R. & D.R. King (eds.), Varanoid Lizards of the World. Indiana University Press, Bloomington.
- Stanner, M. 2007. The burrows, burrows' use and burrowing strategies of the desert monitor (*Varanus griseus*) in the coastal plain of Israel. Pp. 364–377. In: Horn, H.-G., W. Böhme & U. Krebs (eds.), Advances in Monitor Research III, Mertensiella 16. Deutsche Gesellschaft für Herpetologie und Terrarienkunde, e.V., Rheinbach.
- Stanner, M. 2010. Mammal-like feeding behavior of *Varanus salvator* and its conservational implications. Biawak 4: 128–131.
- Stanner, M. & H. Mendelsohn. 1986/1987. The diet of *Varanus griseus* in the southern coastal plain of Israel (Reptilia: Sauria). Israel Journal of Zoology 34: 67–75.
- Stanner, M. & H. Mendelsohn. 1987. Sex ratio, population density, and home range of the desert monitor (*Varanus griseus*) in the southern coastal plain of Israel. Amphibia-Reptilia 8: 153–164.
- Stanner, M. & H. Mendelsohn. 1991. Activity patterns of the desert monitor (*Varanus griseus*) in the southern coastal plain of Israel. Pp. 253–262. In: Böhme, W. & H.-G. Horn (eds.), Advances in Monitor Research, Mertensiella 2. Deutsche Gesellschaft für Herpetologie und Terrarienkunde, e.V., Rheinbach.
- Tsellarius, A.Ju. & V.A. Cherlin. 1991. Individual identification and new method of marking of *Varanus griseus* (Reptilia, Varanidae) in field conditions. Herpetological Researches Leningrad 1: 104–118.
- Tsellarius, A.Y. & E.Y. Tsellarius. 1997. Behavior of *Varanus griseus* during encounters with conspecifics. Asiatic Herpetological Research 7: 108–130.
- Vernet, R. 1977. Recherches sur l'ecologie de *Varanus griseus* Daudin (Reptilia, Sauria, Varanidae) dans les écosystèmes sableaux du Sahara nord-occidental (Algerie). Ph.D. These de l'Université Pierre et Marie Curie, Paris.

- White, F.N. 1968. Functional anatomy of the heart of reptiles. *American Zoologist* 8: 211–219.
- Woinarski, C.Z., S.M. Legge & C.R. Dickman. 2019. *Cats in Australia: Companion and Killer*. CSIRO Publishing, Clayton. 332 pp.
- Wood, S.C., M. Glass & K. Johansen. 1977a. Effects of temperature on respiration and acid base balance in a monitor lizard. *Journal of Comparative Physiology* 116: 287–296.
- Wood, S.C., K. Johansen & R.N. Gatz. 1977b. Pulmonary blood flow ventilation/perfusion ratio and oxygen transport in a varanid lizard. *American Journal of Physiology* 233: R89–R93.
- Wood, S.C., K. Johansen, L. Morgens, M. Glass & G.M.O. Maloiy. 1978. Aerobic metabolism of the lizard *Varanus exanthematicus*: Effects of activity, temperature and size. *Journal of Comparative Physiology* 127: 331–336.
- Yom-Tov, Y. 1988. The zoogeography of the birds and mammals of Israel. Pp. 389–409. *In*: Yom-Tov, Y. & E. Tchernov (eds.), *The Zoogeography of Israel: The Distribution and Abundance at a Zoogeographical Crossroad*. Dr W. Junk Publishers, Dordrecht.
- Yom-Tov, Y. & H. Mendelssohn. 1988. Changes in the distribution and abundance of vertebrates in Israel during the 20th century. Pp. 513–547. *In*: Yom-Tov, Y. & E. Tchernov (eds.), *The Zoogeography of Israel: The Distribution and Abundance at a Zoogeographical Crossroad*. Dr W. Junk Publishers, Dordrecht.
- Zima, Y.A. 2019. On the toxicity of the bite of the Caspian gray monitor lizard (*Varanus griseus caspius*). *Biawak* 13(2): 115–118.