

Melanism in monitor lizards (Squamata: Varanidae), with a first case in the Nile Monitor, *Varanus (Polydaedalus) niloticus* (Squamata: Varanidae)

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Melanistic lizard populations are most frequently observed on islands, as shown already by the early compilation of numerous examples by Werner (1893) or Mertens (1934). Lacertid lizards are especially well studied in this respect, where obligatory melanism is present in many insular populations of the Mediterranean genus *Podarcis* Wagler, 1830. Obligatory, in spite of facultative, means binding, i.e. valid or true for all individuals of a particular population. Various hypotheses, predominantly climatological ones (Trullas et al., 2007), have been drawn as to the causality of melanism in these insular and often microinsular lizard populations which are often regarded as distinct – either specific or subspecific – taxa (e.g., Mertens, 1924, 1934, 1952, 1963; Kramer, 1949; Eisentraut, 1950, 1954; Böhme, 1986; Tosini et al., 1991; Cirer, 2021). But also in several mainland lacertids, melanistic individuals can facultatively, i.e. valid for only single individuals of a population, occur and have – rarely – been found in *Darevskia praticola* (Eversmann, 1834), *Lacerta agilis* Linnaeus, 1758, *L. viridis* (Laurenti, 1768), *Podarcis hispanicus* (Steindachner, 1870), *P. muralis* (Laurenti, 1768), *P. siculus* (Rafinesque, 1810), *P. virescens* Geniez et al., 2014, *Timon pater* (Lataste, 1880) and *Zootoca vivipara* (Lichtenstein, 1823) (Böhme, 1984; Sound, 1994; Fulgione et al., 2004; San José et al., 2008; García-Muñoz et al., 2011; Domeneghetti et al., 2016; Recknagel et al., 2018; Atance and Fuentes, 2020; Doronin and Doronina, 2020). In the latter species, it was possible to obtain an entirely melanistic breeding stock from one single black individual, by back-crossing

it repeatedly with its offspring (Langerwerf, 1981).

Melanism is also known from island as well as mainland populations from other scincomorph lizard families, e.g. teiids (*Cnemidophorus* Wagler, 1830: Eisentraut, 1933), and scincids (*Emoia* Gray, 1845: Brown, 1991; Adler et al., 1995). In cordylids, there is an entirely black population of species rank (*Cordylus niger* Cuvier, 1829) near Cape Town, South Africa (Janse van Rensburg et al., 2009). Another example is the occurrence of melanism in various iguanian lizards of the family Liolaemidae, e.g. the presence of both entirely and irregularly melanistic specimens in the *Phymaturus patagonicus* group Koslowsky, 1898 (Lobo and Nenda, 2015; Scolaro et al., 2016; Azócar et al., 2020).

In the anguimorph lizard families melanism is less common, except in the slow worm *Anguis fragilis* Linnaeus, 1758 (Gleed-Owen, 2012; Graitson et al., 2015), the sheltopusik *Pseudopus apodus* (Pallas, 1775) (Jablonski and Avraham, 2018) and some varanids where melanistic specimens are known, on a facultative or obligatory basis. It is the aim of the present note to describe the first case of a melanistic individual in the Nile monitor lizard, *Varanus niloticus* (Linné, 1766) and to briefly review all known cases, to the best of our knowledge, of melanism in varanids (see Table 1).

On 3 November 2010 one of us (VR) was able to take a small number of photographs of a large, broad-headed (presumably male) specimen of the Nile monitor (*V. niloticus*) in the Kasanka National Park in Zambia which immediately afterwards disappeared in the bush. This small park of 390 km² is located in the north of the Central Province close to the Congolese border. It is dominated by woodland, but has an unusual number of pans, dambos and floodplains (Leonard, 2005). Kasanka National Park, though threatened by illegal encroachment and deforestation, is famous for the largest mammal migration of 10 million straw-coloured fruit bats, *Eidolon helvum* (Kerr, 1792), every year between

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Table 1. Overview of all known cases of melanism occurring in monitor lizards (Varanidae).

Species	Geographic origin	Obligatory or facultative melanism	Remarks	Bibliographic reference
<i>Euprepiosaurus</i>				
<i>V. (E.) obor</i>	Sanana Island, Moluccas, Indonesia	obligatory		Weijola and Sweet, 2010
<i>Hapturosaurus</i>				
<i>V. (H.) beccarii</i>	Aru Islands, Indonesia	obligatory		Doria, 1874
<i>V. (H.) bogerti</i>	D'Entrecasteaux and Trobriand Archipelagos, Papua New Guinea	obligatory		Mertens, 1950
<i>V. (H.) telensestes</i>	Rossel Islands, Papua New Guinea	obligatory	only known from the type specimen; doubtful taxonomic status	Sprackland, 1991
<i>Odatria</i>				
<i>V. (O.) tristis</i>	Australia	obligatory		Mertens, 1942
<i>Philippinosaurus</i>				
<i>V. (P.) mabitang</i>	Panay, Philippines	obligatory		Gaulke & Curio, 2001
<i>Polydaedalus</i>				
<i>V. (P.) niloticus</i>	Kasanka National Park, Zambia	facultative		This study
<i>Soterosaurus</i>				
<i>V. (S.) nuchalis</i>	Philippines	facultative		Koch et al., 2007
<i>V. (S.) rudicollis</i>	Borneo	facultative	melanistic specimen described as <i>V. scutigerulus</i>	Mertens (1959)
<i>V. (S.) salvator bivittatus</i>	Ujung Kulon National Park, Java and Sumatra, Indonesia	facultative		M. Auliya, pers. communication; Ziegler and Vences, 2020
<i>V. (S.) salvator macromaculatus</i>	Isthmus of Kra, southern Thailand	facultative	melanistic population from southern Thailand formerly described as a separate taxon (<i>Varanus s. komaini</i>)	Nutphand, 1981, 1987; Pianka et al., 2004
<i>V. (S.) salvator</i> ssp.	Atauro Island off the Northern coast of East Timor	facultative/obligatory?		H. Kaiser, pers. communication
<i>V. (S.) togianus</i>	Togian archipelago, and mainland Sulawesi, Indonesia	obligatory		Koch et al., 2007
<i>Varanus</i>				
<i>V. (V.) rosenbergi</i>	Australia	obligatory		Mertens, 1942; Storr et al., 1983

October and December (Kasanka Trust, 2021) and is also home of important but threatened populations of ungulates (see Rduch and Jentke, 2021) as well as of a rich bird life (Leonard, 2005). The eponymous Kasanka River runs from south to north through the middle of the park forming a floodplain with diverse channels.

It is in the northern part of this floodplain where the observation of this melanistic Nile monitor was made, more precisely at 12.5411°S, 30.2222°E. The melanistic individual from Zambia (Fig. 1) has a dark, patternless body colouration with a few light markings on the sides of the head and on the upper hindlimbs.



Figure 1. A large melanistic (presumably male) Nile monitor (*Varanus niloticus*) fleeing. Kasanka National Park, Zambia, 3 November 2010. Photograph by Vera Rduch.

The rather massive head of the observed, uncollected specimen resembles the condition regarded as typical for *V. ornatus* (Daudin, 1803), the rain forest sibling taxon of *V. niloticus* which was raised to specific rank by Böhme and Ziegler (1997). However, not only the rank of this taxon, but also its taxonomic validity was challenged by Dowell et al. (2016) who found the phylogeographic pattern of this species complex more diversified than suggested by the separation into just two allopecies. The taxonomic resolution of the Nile monitor complex, however, is still a task for future research, to finally also assess the allocation of the Zambian population within the *V. niloticus* complex (see Dowell et al., 2016). Although melanism in monitor lizards occurs through several clades of this family, currently still arranged in eleven subgenera of a single genus *Varanus* Merrem, 1820, our record of a melanistic African monitor lizard of the subgenus *Polydaedalus* Wagler, 1830 is new and special.

Populations of only black *Varanus* specimens have been described as distinct species in some tree monitor lizards (subgenus *Hapturosaurus* Bucklitsch et al.,

2016) from several Indonesian islands: *Varanus* (*H.*) *beccarii* (Doria, 1874) from the Aru Islands, and *V.* (*H.*) *bogerti* Mertens, 1950 (as well as *V. telenesetes* Sprackland, 1991, with a doubtful taxonomic status; sometimes regarded as conspecific with *V. bogerti*) from islands of the Louisiade archipelago, both off the eastern coast of New Guinea. Another distinct fully melanistic species was discovered within the subgenus *Philippinosaurus* Mertens, 1959, viz. the frugivorous *Varanus* (*P.*) *mabitang* Gaulke & Curio, 2001, endemic to the Philippine island of Panay (Gaulke and Curio, 2001).

The next clade of (formally) subgeneric rank where melanistic populations occur, is the water monitor or *V. salvator* (Laurenti, 1768) group (subgenus *Sotosaurus* Ziegler & Böhme, 1997). Here, *Varanus togianus* Peters, 1872, described as a mostly melanistic (with lighter underparts) island population of the Togian archipelago, northern Sulawesi Indonesia (Mertens, 1942; Pianka et al., 2004), turned out to occur also on mainland Sulawesi itself, in sympatry with another taxon of the *V. salvator* group, viz. *V. s. celebensis*

(Schlegel, 1844), demonstrating its full species status, apart from its morphological differences (Koch et al., 2007). On other Indonesian islands, e.g. Java, melanistic water monitors (here *V. salvator bivittatus* (Kuhl, 1829)) were observed only in single cases, such as one of a fully black specimen in the Ujung Kulon National Park (M. Auliya, pers. communication) or two melanistic individuals allegedly originating from Sumatra (Ziegler and Vences, 2020). A very dark colour pattern is also common in one member of the Philippine section of the *V. salvator* group, viz. *V. nuchalis* (Koch et al., 2007). However, on a populational scale, totally black individuals have also been found, in part even as morphologically and geographically consistent, uniform populations. Although this was reported from southern Thailand (Pianka et al., 2004) for a single specimen only (under the name *V. s. salvator*), Nutphand (1987) had already based a subspecies description (*Varanus salvator komaini*) on these lizards from this particular region, close to the Isthmus of Kra, having reported earlier on a series of no less than 29 entirely black specimens (Nutphand, 1981). His taxon was later synonymised by Koch et al. (2007) with the widely distributed mainland form of this complex, viz. *V. salvator macromaculatus* Deraniyagala, 1944, since, apart from the colouration, no distinguishing characters of Nutphand's nomen could be found. The *V. salvator* complex may contain another insular form with a tendency to melanism where the individuals have scattered, small whitish spots, on Atauro Island off the northern coast of East Timor (H. Kaiser, pers. communication). The nomen *V. scutigerulus* Barbour, 1932, formerly assigned as a subspecies to *V. salvator* by Mertens (1942), is, according to Mertens (1959), however based on a melanistic specimen of *V. rudicollis* (Gray, 1845), an Asian species with unclear phylogenetic relationships within *Varanus*.

A melanistic species of the *V. indicus* (Daudin, 1802) group (subgenus *Euprepiosaurus* Fitzinger, 1843), *V. obor* Weijola & Sweet, 2010, considered to be a colour pattern counterpart of the melanistic *V. togianus* of the *V. salvator* complex, occurs only on Sanana Island in the northwestern Moluccas (Weijola and Sweet, 2010).

Specimens of monitor lizards of the *Varanus gouldii* Gray, 1838 group, from Australia although with unknown locality, representatives of the *Pantherosaurus* Fitzinger, 1843 clade within the subgenus *Varanus*, with a similar colour pattern, were mentioned and figured by Mertens (1942). These were darkish or black lizards sprinkled with white, minute light dots, later described as *V. g. rosenbergi* Mertens, 1957. Subsequently they

were also recorded from mainland Australia and elevated to species rank by Storr (1980) although they have, however, a much lighter ground colour with a distinct pattern of black oblique stripes (see figures in e.g. Storr et al., 1983).

Also, the subgenus *Odatria* Gray, 1838 contains one species where specimens occur (mostly adult males) with a very dark to blackish colouration, viz. *Varanus (Odatria) tristis* (Schlegel, 1838) (see Mertens, 1942).

All these examples are from South-East Asia, Melanesia and Australia (see Table 1), while from the species of the varanid subgenera living in South and Southwest Asia as well as in North Africa, viz. *Empagusia* Gray, 1838, *Psammosaurus*, Fitzinger, 1826 and *Polydaedalus*, no records of melanism have been recorded so far. Therefore, our record here of a melanistic specimen of *V. niloticus* from the Zambian Kasanka National Park is the first documented instance of melanism in a monitor lizard of the *Polydaedalus* clade of *Varanus* and the first from the African continent for the family Varanidae.

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References

- Adler, G.H., Austin, C.C., Dudley, R. (1995): Dispersal and speciation of skinks among archipelagos in the tropical Pacific Ocean. *Evolutionary Ecology* 9: 529–541.
- Atance, J.A., Fuentes, M.M. (2020): Nuevos casos de anomalías pigmentarias para cinco especies de anfibios y reptiles en Guadalajara y Soria, España. *Boletín de la Asociación Herpetológica Española* 31(2): 39–45.
- Azócar, D.L.M., Nayan, A.A., Perotti, M.G., Cruz, F.B. (2020): How and when melanic coloration is an advantage for lizards: the case of three closely-related species of *Liolaemus*. *Zoology* 141: 125774.
- Böhm, W. (Ed., 1984): *Handbuch der Reptilien und Amphibien Europas*. – Band 2/I, Echsen (Sauria) II (Lacertidae II.: *Lacerta*) – Wiesbaden (AULA-Verlag), 415 pp.
- Böhm, W. (ed., 1986): *Handbuch der Reptilien und Amphibien Europas*. – Band 2/II, Echsen (Sauria) III (Lacertidae III.: *Podarcis*). Wiesbaden, Germany, AULA-Verlag.
- Böhm, W., Ziegler, T. (1997): A taxonomic review of the *Varanus (Polydaedalus) niloticus* (Linnaeus, 1766) species complex. *Herpetological Journal* 7: 155–162.
- Brown, W.C. (1991): Lizards of the genus *Emoia* (Scincidae) with observations on their evolution and biogeography. *Memoirs of the California Academy of Sciences* 15: 1–94.
- Cirer, A.M. (2021): *Sargantanas negros* a Ilocos inesperts. *Eivissa* 69 (340-347): 4–11.

- Domeneghetti, D., Mondini, S., Bruni, G. (2016): Melanism and pseudo-melanism in the Wall Lizard, *Podarcis muralis* Laurenti, 1768 (Reptilia: Lacertidae) in central Italy. *Herpetology Notes* **9**: 307–309.
- Doronin, I.V., Doronina, M.A. (2020): On Melanism in the Meadow Lizard, *Darevskia praticola* (Eversmann, 1834) (Lacertidae, Reptilia). *Current Studies in Herpetology* **20**(3–4): 148–151.
- Dowell, S.A., Portik, D.M., de Buffrénil, V., Ineich, I., Greenbaum, E., Kolokotronis, S.-O., Hekkala, E.R. (2016): Molecular data from contemporary and historical collections reveal a complex story of cryptic diversification in the *Varanus* (*Polydaedalus*) *niloticus* Species Group. *Molecular Phylogenetics and Evolution* **94**: 591–604.
- Eisentraut, M. (1933): Inselmelanismus in der Gattung *Cnemidophorus*. *Zoologischer Anzeiger* **101**: 228–232.
- Eisentraut, M. (1950 „1949“): Die Eidechsen der spanischen Mittelmeerinseln und ihre Rassenaufspaltung im Lichte der Evolution. Mitteilungen aus dem Zoologischen Museum zu Berlin **26**: 1–225.
- Eisentraut, M. (1954): Der Inselmelanismus bei Eidechsen und seine Entstehung im Streit der Meinungen. *Zoologischer Anzeiger* **152**: 317–321.
- Fulgione, D., Milone, M., Rippa, D., Capriglione, T., Guarino, F.M., Odierna, G. (2004): Genetic analysis in a mainland melanic lizard (*Podarcis sicula*) population from Cilento and Vallo di Diano national park (Campania, Italy). *Italian Journal of Zoology* **71**: 25–28.
- García-Muñoz, E., Gomes, V., Carretero, M.A. (2011): Un caso de melanismo en *Podarcis hispanica* (sensu lato). *Boletín de la Asociación Herpetológica Española* **22**: 84–86.
- Gaulke, M., Curio, E. (2001): A new monitor lizard from Panay Island, Philippines (Reptilia, Sauria, Varanidae). *Spixiana* **24**(3): 275–286.
- Gleed-Owen, C. (2012): *Anguis fragilis* (slow-worm): Melanism. *Herpetological Bulletin* **120**: 34–35.
- Graitson, E., Lebrun, K., Teynié, A. (2015): Des cas de mélanisme chez l'orvet fragile *Anguis fragilis* Linnaeus, 1758 en Belgique et en France “ Bulletin de la Société Herpétologique de France **154**: 67–69.
- Jablonski, D., Avraham, N. (2018): Markedly dark coloration in a Pallas' glass lizard, *Pseudopus apodus*. *Spixiana* **41**(1): 155–156.
- Janse van Rensburg, D.A., Mouton, P.L.F., van Niekerk, A. (2009): Why cordylid lizards are black on the southwestern tip of Africa. *Journal of Zoology* **278**: 333–341.
- Kasanka Trust (2021): Available at <https://kasanka.com/>. Accessed on 04 November 2021.
- Koch, A., Auliya, M., Schmitz, A., Kuch, U., Böhme, W. (2007): Morphological studies on the systematics of South East Asian water monitors (*Varanus salvator* complex): nominotypic populations and taxonomic overview. *Mertensiella* **16**: 109–180.
- Kramer, G. (1949): Über Inselmelanismus bei Eidechsen. *Zeitschrift für Abstammungslehre* **83**: 157–164.
- Langerwerf, B. (1981): Nigrinos bei der Nachzucht von *Lacerta lepida pater*. *Herpetofauna* **3**(12): 21–22.
- Leonard, P. (2005): Important bird areas in Zambia. The *Zambian Ornithological Society*, Lusaka.
- Lobo, F., Nenda, S.J. (2015): Discovery of two new species of *Phymaturus* (Iguania: Liolaemidae) from Patagonia, Argentina, and occurrence of melanism in the *patagonicus* group. *Cuadernos de herpetología* **29**(1): 5–25.
- Mertens, R. (1924): Ein Beitrag zur Kenntnis der melanotischen Inseleidechsen des Mittelmeeres. *Pallasia* **2**: 40–52.
- Mertens, R. (1934): Inselreptilien, ihre Ausbreitung, Variation und Artbildung. *Zoologica, Originalabhandlungen aus dem Gesamtgebiet der Zoologie* **84**: 1–209.
- Mertens, R. (1942): Die Familie der Warane (Varanidae). Erster und dritter Teil. Abhandlungen der senckenbergischen naturforschenden Gesellschaft, **462**: 1–116; **466**: 235–391.
- Mertens, R. (1952): Schwarzblaue Inseleidechsen und die neueren Ansichten über ihr Farbkleid. *Natur und Volk* **82**: 386–394.
- Mertens, R. (1957): Ein neuer melanistischer Waran aus dem südlichen Australien. *Zoologischer Anzeiger* **159**(1/2): 17–20.
- Mertens, R. (1959): Liste der Warane Asiens und der indoastralischen Inselwelt, mit systematischen Bemerkungen. *Senckenbergiana biologica* **40**(5/6): 221–240.
- Mertens, R. (1963): Wie entstand das dunkle Farbkleid der Inseleidechsen? *Umschau* **6**: 180–192.
- Nutphand, W. (1981): *Varanus*, new species. *Proceedings of the 2nd Wildlife of Thailand Seminar* **1**: 4–7.
- Nutphand, W. (1987): Monitors of Thailand. *Journal of the Thai Zoological Center* **2**(15): 51.
- Pianka, E.R., King, D.R., King, R.A. (Eds., 2004): *Varanoid lizards of the world*. Bloomington/IN, USA, Indiana University Press.
- Rduch, V., Jentke, T. (2021): Alarming decline of bovids in Kasanka National Park, Zambia: a case study of the Puku antelope (*Kobus vardonii*). *African Journal of Ecology* **59**: 387–398.
- Recknagel, H., Layton, M., Carey, R., Leitão, H., Sutherland, M., Elmer, K.R. (2018): Melanism in common lizards (Squamata: Lacertidae: *Zootoca vivipara*): new evidence for a rare but widespread ancestral polymorphism. *Herpetology Notes* **11**: 607–612.
- San-Jose, L.M., Gonzalez-Jimenez, V., Fitze, S. (2008): Frequency and phenotypic differences of a melanistic and normally coloured common lizard, *Lacerta* (*Zootoca*) *vivipara* of the Southern Pyrenees (Spain). *Herpetological Review* **39**(4): 422–425.
- Scolaro, J.A., Corbalán, V.E., Tappari, O.F., Streitenberger, L.O. (2016): Lizards at the end of the world: a new melanic species of *Phymaturus* of the *patagonicus* clade from rocky outcrops in the northwestern steppe of Chubut province, Patagonia Argentina (Reptilia: Iguania: Liolaemidae). *Boletín del Museo Nacional de Historia Natural, Chile* **65**: 137–152.
- Sound, P. (1994): Fund eines vollmelanistischen Exemplares der Mauereidechse (*Podarcis muralis*) im Mittelrheintal. *Salamandra* **30**(3): 221–222.
- Storr, G.M. (1980): The monitor lizards (genus *Varanus* Merrem, 1820) of Western Australia. *Records of the Western Australian Museum* **8**: 273–293.
- Storr, G.M., Smith, L.A., Johnstone, R.E. (1983): Lizards of Western Australia II. Dragons and monitors. Perth, Australia, Western Australian Museum.
- Tosini, G., Lanza, B., Bacci, M. (1991): On the thermoregulatory significance of microinsular melanism in the lizard of genus *Podarcis*. In: *Symposium of the Evolution of Terrestrial Vertebrates*, p. 613–629. Ghiara, G., et al., Eds., Modena, Italy, Mucchi Editore.

- Trullas, S.C., van Wyk, J.H., Spotila, J.R. (2007): Thermal melanism in ectotherms. *Journal of Thermal Biology* **32**(5): 235–245.
- Werner, F. (1893): Albinismus und Melanismus bei Reptilien und Amphibien. *Verhandlungen der Zoologisch-Botanischen Gesellschaft in Wien* **43**: 4–6.
- Weijola, V.S.A., Sweet, S.S. (2010): A new melanistic species of monitor lizard (Reptilia: Squamata: Varanidae) from Sanana Island, Indonesia. *Zootaxa* **2434**(1): 17–32.
- Ziegler, T., Vences, M. (2020): Molecular identification of water monitors (*Varanus salvator* complex) from confiscations and the pet trade, including phylogenetic placement of *V. s. ziegleri* – a molecular reference for species conservation enforcement and conservation breeding. *Der Zoologische Garten* **88**: 31–50.