

New records of *Echis leucogaster* in Morocco

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The white-bellied carpet (or saw-scaled) viper *Echis leucogaster* ROMAN, 1972 is considered one of the rarest snakes in Morocco (Spawls and Branch, 1995; Bons and Geniez, 1996; Schleich et al., 1996). Recent genetic studies have subdivided the genus *Echis* into four main clades consisting of the *E. ocellatus*, *E. coloratus*, *E. pyramidum* and *E. carinatus* groups (Arnold et al., 2009; Pook et al., 2009). Within the *E. pyramidum* clade, *E. leucogaster* inhabits the western Sahel region, with possibly isolated populations in the Algerian Hoggar (or Ahaggar) massif, in southern Morocco and in Tunisia (Pook et al., 2009; Geniez, 2015). Due to low genetic variability, it has been proposed that *E. leucogaster* should be regarded as a subspecies of *E. pyramidum* (Arnold et al., 2009; Sindaco et al., 2013; Geniez 2015).

Until less than two decades ago, *E. leucogaster* was known in Morocco from only a single locality near Aouinet Torkoz (presently Aouinet Lahna), where it was discovered in 1963 (Bons and Dakka, 1963). However, starting from 1999 observations were made at other locations, resulting in a fragmented distribution with three major known populations: in Aouinet Lahna, which has been confirmed by several observations over the years (Herrmann et al., 2000; Aymerich et al., 2004; personal observations by M. Berroneau, T. Charlton, S. Clerc, D. Herrero, B. Rebollo, M. Sassoè, G.J. Verspui and M. Wilson); another one in a region located between Agdz and Bou Azzer and extending south to Allougoum,

which comprises the northernmost record of the species in Morocco (Maran and Geniez, 1999; Aymerich et al., 2004; Escoriza et al., 2009; Pook et al., 2009); and in the Zemmour region near Amgala, which is known from only one dead individual and may be contiguous with populations in northern Mauritania (Aymerich

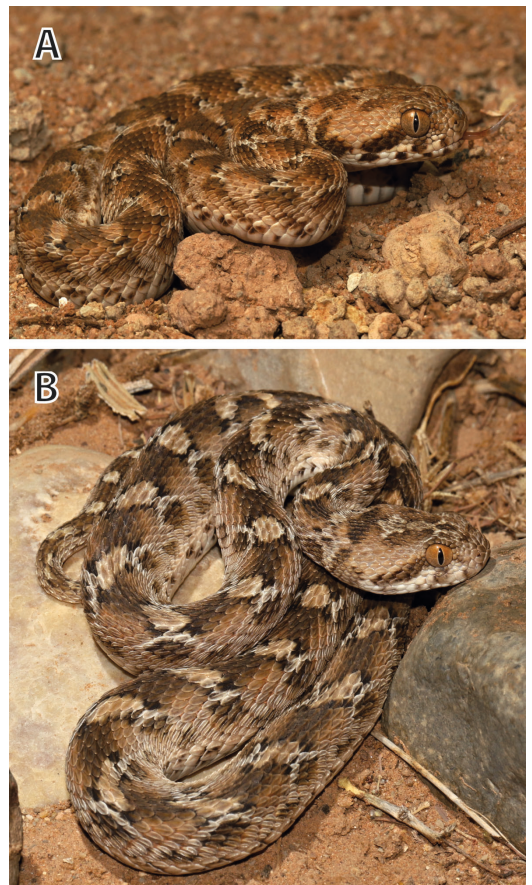


Figure 1. Photographs of the two *Echis* individuals found near Assa. (A) juvenile. (B) male.

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et al., 2004). More recently, a juvenile *E. leucogaster* has been found near Tata, suggesting that there could be a continuous distribution between the population of Aouinet Lahna and that of Agdz along the Drâa valley (Martinez del Marmol and Rebollo Fernandez, 2012).

In support of this idea, we report here two novel observations of the species near the town of Assa. A juvenile specimen (approximately 20 cm in length) of *E. leucogaster* was located at the southern exit of Assa (28.58°N 9.41°W) on May 5, 2017 (Fig. 1A). The snake was found active at night in a dry river bed with sparse vegetation forming potential shelter (Fig. 2). Another individual, a male of approximately 45 cm in total length, was spotted in the same area inside a small bush on the night of September 28, 2017 (Fig. 1B). The habitat in which the vipers were found is bordered by plantations, which corresponds with previous records of this species (see Martinez del Marmol and Rebollo Fernandez, 2012). Other reptiles and amphibians observed in the

surroundings include *Chalcides ocellatus*, *Ptyodactylus oudrii*, *Stenodactylus mauritanicus*, *Tarentola boehmei*, and *Pelophylax saharicus* and *Sclerophrys mauritanica* in a nearby water pond.

This novel locality of *E. leucogaster* is located 40 km east of the well-known population of Aouinet Lahna. The species has been recorded further down the Drâa valley, south of Tigit (Aymerich et al., 2004), suggesting that its distribution embraces the lower course of the Drâa river. This region is found within an area of high occurrence probability as predicted by niche modelling analysis (Escoriza et al., 2009; Brito et al., 2011). North of Assa, the closest locality in which the species has been recorded is Tata at 200 km (Martinez del Marmol and Rebollo Fernandez, 2012), which is halfway from the populations situated west of Agdz (Fig. 2). Further exploration is needed to understand whether the lack of data in intermediate areas between these localities is due to poor sampling or rather reflects a fragmentary

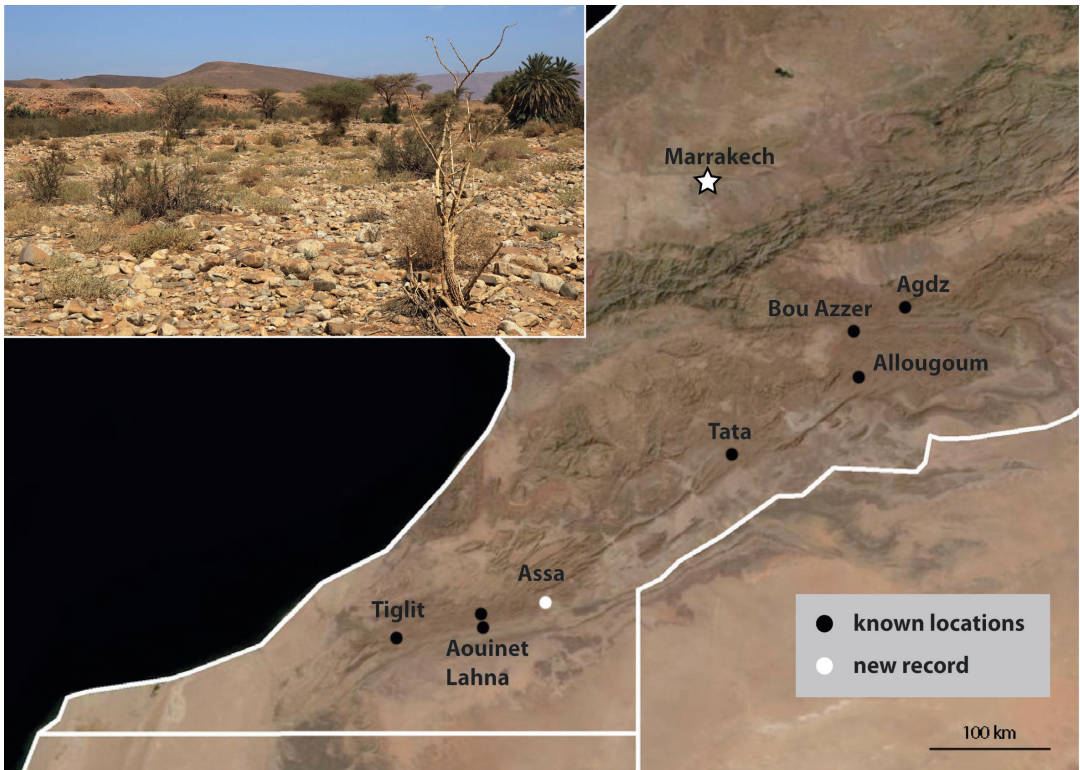


Figure 2. Summary of the known distribution of *Echis leucogaster* in Morocco. Black dots indicate known localities, based on published reports (see text). The site of the new observations near Assa is marked with a white dot. The inset shows the habitat where the two individuals were found.

distribution of the species in isolated populations. Similarly, it will be interesting to establish whether the Moroccan populations of *E. leucogaster* are connected to those of the Sahel or whether they should be regarded as relict populations. Genetic analyses have indicated that Moroccan *Echis* are very closely related to those found in southern Mauritania, suggesting that these populations either have a continuous distribution or have been separated in recent times (Escoriza et al., 2009). A better knowledge of the distribution of *E. leucogaster* in Morocco is required for predicting factors that may negatively impact the survival of its populations under scenarios of climatic and environmental changes (Brito et al., 2011).

One factor that may influence the distribution of *E. leucogaster* in Morocco is the interaction with other viperids (see for example Herrmann et al., 2000). The southwestern part of Morocco in which *Echis* has been found is an environmental transition zone with potential sympatry of five distinct species of vipers (Brito et al., 2011). Indeed, *Cerastes cerastes* has been found (e.g. two adult individuals observed by M. Sassoe in May 2017) at sites near Aouinet Lahna where *Echis* has also been recorded. Moreover, coexistence between *C. cerastes* and *Daboia mauritanica* has been reported in the vicinity of Aouinet Lahna (Martínez-Freiria et al., 2016), suggesting that three species of vipers with distinct biogeographical affinities occur in sympatry in the same region. Fieldwork is needed to determine how these species partition habitat resources in this contact zone.

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References

- Arnold, N., Robinson, M., Carranza, S. (2009): A preliminary analysis of phylogenetic relationships and biogeography of the dangerously venomous Carpet Vipers, *Echis* (*Squamata*, *Serpentes*, *Viperidae*) based on mitochondrial DNA sequences. *Amphibia-Reptilia* **30**: 273–282.
- Aymerich, M., Borof-Aymerich, E., Geniez, P. (2004): Neufunde der seltenen Weißbäuchigen Sandrasselotter *Echis leucogaster* Roman, 1972 in Marokko (*Serpentes*: *Viperidae*). *Herpetozoa* **16**: 157–162.
- Bons, J., Dakka, M. (1963): Capture au Maroc de la vipère des Pyramides *Echis carinatus* (Schneider, 1801). C. R. Société des Sciences Naturelles et Physiques du Maroc, Rabat **29**: 55–57.
- Bons, J., Geniez, P. (1996): Amphibiens et reptiles du Maroc (Sahara Occidental compris). Atlas Biogéographique. Barcelona, Asociación Herpetológica Española.
- Brito, J.C., Fahd, S., Geniez, P., Martínez-Freiria, F., Pleguezuelos, J.M., Trape, J.-F. (2011): Biogeography and conservation of viperids from North-West Africa: An application of ecological niche-based models and GIS. *Journal of Arid Environments* **75**: 1029e1037.
- Escoriza, D., Metallinou, M., Donaire-Barroso, D., Amat, F., Carranza, S. (2009): Biogeography of the White-Bellied Carpet Viper *Echis leucogaster* Roman, 1972 in Morocco, a study combining mitochondrial DNA data and ecological niche modeling. *Butlletí de la Societat Catalana d'Herpetologia* **18**: 55–68.
- Geniez, P. (2015): Serpents d'Europe, d'Afrique du Nord et du Moyen-Orient. Paris, Delachaux et Niestlé.
- Herrmann, H.-W., Herrmann, P.A., Geniez, P.H. (2000): Zur Verbreitung von *Echis leucogaster* Roman, 1972 in Marokko. *Salamandra* **36**: 203–207.
- Maran, J., Geniez, P.H. (1999): Nouvelles observations sur l'herpétofaune du Maroc, 7. Redécouverte de l'Echide à ventre blanc, *Echis leucogaster* ROMAN, 1972 (*Reptilia*, *Serpentes*, *Viperidae*) au Maroc. *Bulletin de la Société Herpétologique de France*, Paris **90**: 63–64.
- Martínez del Marmol Marin, G., Rebollo Fernandez, B. (2012): An important new record of *Echis leucogaster* Roman, 1972 from Morocco. *Herpetology Notes* **5**: 229–231.
- Martínez-Freiria, F., Stols, V.F., García-Cardenete, L. (2016): Human-mediated syntopy between *Cerastes cerastes* and *Daboia mauritanica* in the lower Drâa Valley, Morocco. *Boletín de la Asociación Herpetológica Española* **27**: 2.
- Pook, C.E., Joger, U., Stümpel, N., Wüster, W. (2009): When continents collide: phylogeny, historical biogeography and systematics of the medically important viper genus *Echis* (*Squamata*: *Serpentes*: *Viperidae*). *Molecular Phylogenetics and Evolution* **53**: 792–807.
- Schleich, H.H., Kastle, W., Kabisch, K. (1996): Amphibians and reptiles of North Africa. Koenigstein, Koelts Scientific Publishers.
- Sindaco, R., Venchi, A., Grieco, C. (2013): The Reptiles of the Western Palearctic. Vol 2: Annotated checklist and distribution atlas of the snakes of Europe, North Africa, Middle East and Central Asia. Latina, Edizioni Belvedere.
- Spawls, S., Branch, B. (1995): The dangerous snakes of Africa. London, Blanford.