Zoodiversity, **55**(5):381–386, 2021
DOI 10.15407/zoo2021.05.381

UDC 598.112.11:504.064.3(1-18:497.2)

CITIZEN SCIENCE ASSISTED MONITORING PROVIDES NEW DATA CONCERNING THE DISTRIBUTION OF THE BULGARIAN BENT-TOED GECKO, *MEDIODACTYLUS DANILEWSKII* STRAUCH (GEKKONIDAE, SQUAMATA), IN NORTH-EAST BULGARIA

T. Koynova[1*], P. Marinova[1], N. Nikolov[2], M. Kaschieva[1], C. Chernikov[3], V. Velkova[4], N. Natchev[1,5]

[1]*Department Biology, Faculty of Natural Sciences, Shumen University, Universitetska 115, 9700 Shumen, Bulgaria*
[2]*Didactics of Sports, Faculty of Pedagogics, Shumen University, Universitetska 115, 9700 Shumen, Bulgaria*
[3]*Zoo Razgrad, Severen blv., 7200 Razgrad, Bulgaria*
[4]*Faculty of Pharmacy, Medical University Varna, Tz. Osvoboditel 84, 9000 Varna, Bulgaria*
[5]*Department of Integrative Zoology, Vienna University, Althanstrasse 14, Wien 1090, Vienna Austria*
**Corresponding author*
E-mail: t.koynova@shu.bg

T. Koynova (https://orcid.org/0000-0001-9044-6708)

Citizen Science Assisted Monitoring Provides New Data Concerning the Distribution of the Bulgarian Bent-toed Gecko, *Mediodactylus danilewskii* (Gekkonidae, Squamata), in North-East Bulgaria. Koynova, T., Marinova, P., Nikolov, N., Kaschieva, M., Chernikov, C., Velkova, V., Natchev, N. — The Bulgarian Bent-toed Gecko *(Mediodactylus danilewskii* Strauch, 1887) is one of the two species of geckos inhabiting the territory of Bulgaria. In the recent years, new information on its distribution was published and big amount of data were collected. We organized an information platform for sharing data on the biology and live-range of *M. danilewskii* in inland North-East Bulgaria. This gecko is a highly synanthropic species which is often observed by citizens. Here we report on four new observation spots and also confirm the presence of the species from recently published localities. All data were recorded by volunteers, hence we discuss on the methods for documentation of the specimens and the critical role of the citizen science to assess the range of distribution of the species.
Key words: volunteers, observation, documentation, population, new locality, gecko.

Introduction

The genus *Mediodactylus* Szczerbak and Golubev, 1977 is widespread from the Mediterranean region to Central Asia (Ananjeva et al., 2006) and includes five species — *M. kotschyi; M. orientalis; M. danilewskii; M. bartoni and M. oertzeni* (Kotsakiozi et al., 2018). The gecko *Mediodactylus danilewskii* is a small lizard with total length of 11 cm (see Stojanov et al., 2011). The species is highly synanthropic and inhabits almost exclusively human settlements in Bulgaria (Beshkov & Nanev, 2002). These geckoes are thigmothermic, have a rather cryptic behavior and are active predominantly during the night (Stojanov et al., 2011). These characteristics make them a challenging object for monitoring. Often the professional scientists are limited in time and resources, so the methods of the "citizen science" can be applied for the purposes of time-consuming monitoring missions (Theobald et al., 2015; Kobori et al., 2016). Some forms of "citizen science" may represent a volunteer-based

monitoring and possess the potential to solve problems concerning personnel limitations (McClure et al., 2020). The volunteers may support the researchers using methodologies developed by professional scientists (Trumbull et al., 2000; Silvertown, 2009). With proper training, citizens are able to provide accurate and reliable information (Darwall & Dulvy, 1996; Newman et al., 2003). In addition, the modern technologies allow those citizens in access to advanced data collection and reporting tools, thus reducing data submission errors and efforts (Starr et al., 2014).

In the recent years, interest in citizen science projects is growing globally (Bonney et al., 2014; Peters et al., 2015; Hecker et al., 2018). In the ecological monitoring, the citizen science has a long and positive history and nowadays become more and more popular. The new information technologies allow for growing number of volunteers to contribute in gaining more information concerning the general biology of a variety of species (Bonney et al., 2014; Kobori et al., 2016). Actually, the monitoring of biodiversity is one of the scientific fields, in which the citizen naturalists readily cooperate with the professional specialists (see Miller-Rushing et al., 2020). To date there are a lot of citizen science projects that involve collection of data on herpetofauna distribution (Cosentino et al., 2014; Petrovan & Schmidt, 2016; Deutsch et al., 2017, Rowley et al., 2019). Learning is a very useful benefit of volunteering and it is often a motivation to support such activities (Ryan et al., 2001; Bruyere & Rappe, 2007; Stepenuck & Green, 2015). Furthermore, public engagement with the environment can lead to behavioural change within the human society (McKinley et al., 2017).

The main goal of the present study was to involve volunteers in the investigation of the Bulgarian Bent-toed Gecko populations in inland North-East Bulgaria. We used the help of citizen science as an effective complement to field surveys to collect data and to document the expansive distribution of *M. danilewskii* in the region.

Material and methods

In inland North-Eastern Bulgaria (except two populations near the Danube River), the Bulgarian Bent-toed Gecko was observed for the first time in 2015 by a local hobby naturalist from Shumen town. We started immediately an organized observation of the population and established a data sharing platform at the website of the Biology Department (FNS, Shumen University) for collecting new information concerning the distribution of the species. Since 2015 we organized a group of volunteers from different settlements in northeastern Bulgaria and since 2016, we also monitored some social platforms for information sharing.

For correct identification we had prepared a photographic guide for *M. danilewskii* (see fig. 1). As a model organism we used one of the specimens detected in the town of Razgrad. For detailed photographic documentation we use a Canon EOS 60D with a macro lens Canon EF 100mm f/2.8 Macro USM (Canon Inc., Ota City, Tokyo, Japan) and a Sony RX 10 III (Sony Electronics Corporation, Minato, Tokyo, Japan). The most important morphological characteristics of the species were provided by Stojanov et al. (2011): small and oval dorsal tubercles; 5 to 8 W-formed dark dorsal stripes (normally 6); 4 to 9 preanal pores (normally 7); 1–3 prismatic postanal tubercles; the cranial tubercles are positioned above the ear opening.

Results and discussion

On the base of our previous researcher on *M. danilewskii* in North-Eastern Bulgaria (Koynova et al., 2017) and the observations we currently made, we estimate that citizen involvement could be a very useful tool to complement the picture of the distribution of the species in this part of the country. Since 2015 we started to monitor the presence of the species in the region and thanks to the efforts of all involved specialists and volunteers, we were able to gather valuable data. We confirmed the distribution and the presence of permanent living population in Shumen town (see Koynova et al., 2020; Koynova & Natchev, 2020).

Geckos are among the species that are most often translocated and are able to establish extralimital populations (Kraus, 2009). Our observations confirm this information and indicate on the expansive distribution of *M. danilewskii* in northeastern Bulgaria. In the present study we provide data on new registrations in sites with previously reported presence and represent data on four completely new sites of distribution – Razgrad, Dobrich, Ivanski, Osmar (fig. 2). For the population in Razgrad we report presence confirmation from 2016, 2017, 2019 and 2020 from four different localities. For Dobrich were reported multiple observations on subadult and adult specimens from two spots in the town. New data were provided for Ivanski and Osmar villages (Shumen District). One recently documented specimen confirmed the presence of the species in Novi Pazar town (see also Koynova

et al., 2020). We collected also data from six new localities of the species in Shumen town (additional to the data provided by Koynova et al., 2017; Koynova et al., 2020; Koynova & Natchev, 2020). All new reported observations are associated to low profile buildings of 1 to 3 floors with exception of the geckos from Dobrich, where they were recorded on a 5 floored building (table 1).

We were able to confirm the presence of *M. danilewskii* on the newly recorded spots by the help of photographic materials, which were supplemented to the observation reports of the volunteers. In general, these lizards are very hard for photo documentation, because they are tiny and mostly night active. Normally, they behave rather shy and it is difficult to be approached. A good and detailed photo shot normally demands proper illumination, the use of expensive bright-aperture telescopic lenses, camera body with a large sensor and the use of a tripod (see fig. 1).

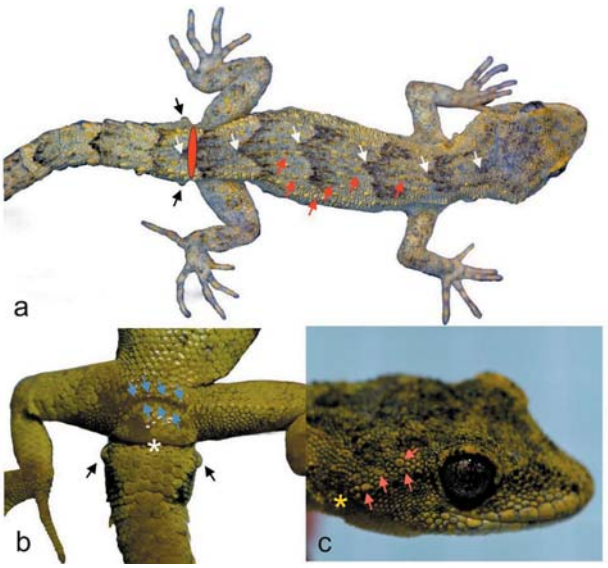

Fig. 1. Morphological indicators for photograph-based identification of the Bulgarian Bent-toed Gecko (*M. danilewskii*): a — dorsal view of an adult specimen: white arrows indicate the six W-formed dorsal stripes, red arrows indicate the small and round dorsal tubercles, black arrows indicate the two prismatic postanal tubercles, red ellipse indicates the position of the cloacal opening on the ventral site of the body; b — ventral view of the cloacal region of the lizard: pale-blue arrows indicate the position of the seven preanal pores, the white asterisk indicates the cloacal opening, black arrows indicate the two prismatic postanal tubercles; c — close up picture of the head in right dorso-lateral plane: pale-rose arrows indicate the position of the cranial tubercle above the ear opening (indicated by an yellow asterisk); Picture performed by the use of Canon EOS 60D with micro lens EF 100 mm/2.8, illumination LedLenser T16 by 6000-8000K.

The documentation of details at the level of single scales is possible only by the use of macro-photography and in most cases demands the capture and immobilization of the specimen (fig. 1). However, a high-resolution picture from dorsal view can contribute for the successful species indication

Table 1. Coordinates of the newly recorded specimens of *M. danilewskii* in North East Bulgaria

Place	Coordinates (Datum, WGS 84)	Name
Dobrich	43.55232° N, 27.82891° E; 255 m a .s. l.	Nelly Raycheva
	43.57746° N, 27.82803° E; 197 m a. s. l.	Nelly Raycheva
Razgrad	43.52482° N, 26.52362° E; 206 m a. s. l.	Chavdar Chernikov
	43.52661° N, 26.52124° E; 203 m a. s. l.	Chavdar Chernikov
	43.52841° N, 26.52308° E; 202 m a. s. l.	Chavdar Chernikov
	43.51955° N, 26.52808° E; 249 m a. s. l.	Djanan Isufova
Ivanski	43.14486° N, 27.03489° E; 105 m a. s. l.	Pavlina Marinova
Osmar	43.21711° N, 26.85822° E; 174 m a. s. l.	Nikolay Nikolov
Shumen	43.27721° N, 26.91167° E; 265 m a. s. l.	Aydin Hatibov
	43.27408° N, 26.90809° E; 272 m a. s. l.	Svilena Ivanova
	43.23921° N, 26.93214° E; 184 m a. s. l.	Stoyan Stoyanov
	43.26403° N, 26.94092° E; 205 m a. s. l.	Todorka Todorova
	43.26869° N, 26.92109° E; 259 m a. s. l.	Nikolay Nikolov
	43.28228° N, 26.89981° E; 314 m a. s. l.	Ralitsa Balkanska
Novi Pazar	43.34139° N, 27.16639° E; 152 m a. s. l.	Sevinch Basri

Fig. 2. Schematic map of the confirmed and new sites of distribution of the Bulgarian Bent-toed Gecko in North-East Bulgaria. Black spots represent the confirmed locations and the grey spots represent the newly recorded localities. The scale bar represents 10 km.

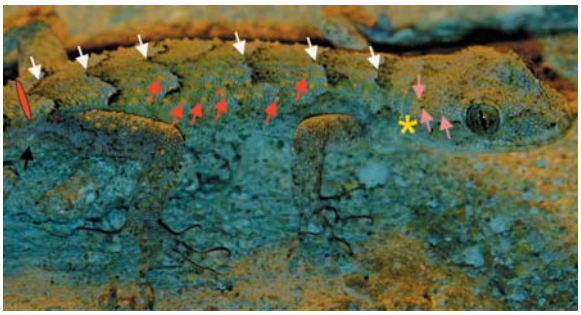

Fig. 3. Morphological indicators for photograph based identification of the Bulgarian Bent-toed Gecko (*M. danilewskii*): white arrows indicate the six W-formed dorsal stripes; red arrows indicate the small and round dorsal tubercles; the black arrow indicates the right prismatic post-anal tubercles; the red ellipse indicates the position of the cloacal opening; pale rose arrows indicate the position of the cranial tubercle above the ear opening (indicated by an yellow asterisk); Picture performed by the use Sony RX 10 III, illumination LedLenser T16 by 600–8000K.

of the geckos. Only the registration of the preanal pores demands a picture in ventral view. Actually, the location of the cloacal opening can be estimated from a dorsal image and such a picture would allow for the precise count of the dorsal W-formed stripes between the occipital region and the origin of the tale. By the use of proper illumination, the position of the cranial tubercles and the characteristics of the dorsal tubercles can be recognized on a high-resolution picture from dorsal view (figs 1 and 3). The increased intensity of the light and the stabilization of a small-sensor camera (e. g., a bridge camera or a smart phone camera) may improve dramatically the quality of the picture as a document confirming the presence of the Bulgarian Bent-toed Gecko (see fig. 3).

Conclusions

The crucial role of the volunteers in collecting data on the occurrence of the Bulgarian Bent-toed Gecko in inland North-East Bulgaria is demonstrated by the fact, that all documentations of the presence of the species were performed by citizens. The involvement of hobby environmentalist in non-avian monitoring programs is a relatively new procedure for Bulgaria. Especially for near future in studies of synanthropic species or species with wide distribution (some amphibian, reptiles, and mammals), we expect intensive development of citizen science platforms in Bulgaria. Several initiatives like the ongoing monitoring of *M. danilewskii* provided already valuable results and represent a solid base for the further involvement of citizen science volunteers in different ecological investigations.

This work was partly supported by the Research Fund of the Konstantin Preslavsky University of Shumen (Grant No. RD-08-67/25.01.2021) and Bulgarian Ministry of Education and Science under the National Program for Research "Young Scientists and Postdoctoral Students". We are thankful to all volunteers for their work.

References

Ananjeva, N. B., Orlov, N. L., Khalikov, R. G., Darevsky, I. S., Ryabov S. A., Barabanov, A. 2006. *An atlas of the reptiles of Northern Eurasia: Taxonomic diversity, distribution, conservation status*. Pensoft Publishers, Sofia, 1–245.

Beshkov, V., Nanev, K. 2002. *The amphibians and reptiles in Bulgaria*. Pensoft, Sofia–Moscow, 1–120 [In Bulgarian].

Bonney, R., Shirk, J. L., Phillips, T. B., Wiggins, A., Ballard, H. L., Miller-Rushing, A. J., Parrish, J. K. 2014. Next steps for citizen science. *Science*, **343**, 1436–1437. doi: 10.1126/science.1251554

Bruyere, B., Rappe, S. 2007. Identifying the motivations of environmental volunteers. *Journal of Environmental Planning and Management*, **50** (4), 503–516. https://doi.org/10.1080/09640560701402034

Cosentino, B. J., Marsh, D. M., Jones, K.S., Apodaca, J. J., Bates, C., Beach, J. 2014. Citizen science reveals widespread negative effects of roads on amphibian distributions. *Biological Conservation*, **180**, 31–38. https://doi.org/10.1016/j.biocon.2014.09.027

Darwall, W. R., Dulvy, N. K. 1996. An evaluation of the suitability of non-specialist volunteer researchers for coral reef fish surveys. Mafia Island, Tanzania — a case study. *Biological Conservation*, **78**, 223–231. https://doi.org/10.1016/0006-3207(95)00147-6

Deutsch, C., Bilenca, D., Agostini, G. 2017. In Search of the Horned Frog (*Ceratophrys ornata*) in Argentina: Complementing Field Surveys with Citizen Science. *Herpetological Conservation and Biology*, **12**(3), 664–672. http://www.herpconbio.org/Volume_12/Issue_3/Deutsch_etal_2017.pdf

Hecker, S., Haklay, M., Bowser, A., Makuch, Z., Vogel, J., Bonn, A. 2018. *Citizen Science: Innovation in Open Science, Society and Policy*. UCL Press, London, 1–542.

Kobori, H., Dickinson, J. L., Washitani, I., Sakurai, R., Amano, T., Komatsu, N., Kitamura, W., Takagawa, S., Koyama, K., Ogawara, T., Miller-Rushing, A. J. 2016. Citizen science: a new approach to advance ecology, education, and conservation. *Ecological Research*, **31**, 1–19. doi: 10.1007/s11284-015-1314-y

Kotsakiozi, P., Jablonski, D., Ilgaz, C., Kumlutaş, Y., Avcı, A., Meiri, S., Itescu, Y., Kukushkin, O., Gvoždík, V., Scillitani, G., Roussos, S. A., Jandzik, D., Kasapidis, P., Lymberakis, P., Poulakakis, N. 2018. Multilocus phylogeny and coalescent species delimitation in Kotschy's gecko, *Mediodactylus kotschyi*: hidden diversity and cryptic species. *Molecular Phylogenetics and Evolution*, **125**, 177–187. https://doi.org/10.1016/j.ympev.2018.03.022

Koynova, T., Tzankov, N., Popgeorgiev, G., Naumov, B., Natchev, N. 2017. A new distribution record of the Kotschy's Gecko (*Mediodactylus kotschyi*) from inland north-eastern Bulgaria. *Herpetology notes,* **10**, 1–2. https://www.biotaxa.org/hn/article/view/23029/25867

Koynova, T., Doichev, D., Natchev, N. 2020. New data on the distribution of the Bulgarian Bent-toed Gecko (*Mediodactylus danilewskii* Strauch, 1887) in Shumen town (NE Bulgaria). *Biharean Biologist*, **14** (2), 122–124. http://biozoojournals.ro/bihbiol/cont/v14n2/bb_e202302_Koynova.pdf

Koynova, T., Natchev, N. 2020. *MEDIODACTYLUS DANILEWSKII* (Mediterranean Thin-toed Gecko). DIET. *Herpetological Review*, **51** (4), 51.

Kraus, F. 2009. *Alien reptiles and amphibians: a scientific compendium and analysis*. Springer, Netherlands, 1–569.

McClure, E. C., Sievers, M., Brown, C. J., Buelow, C. A., Ditria, E. M., Hayes, M. A., Pearson, R. M., Tulloch, V. J. D., Unsworth, R. K. F., Connolly, R. M. 2020. Artificial Intelligence Meets Citizen Science to Supercharge Ecological Monitoring. *Patterns (New York)*, **1** (7), 100109. https://doi.org/10.1016/j.patter.2020.100109

McKinley, D. C., Miller-Rushing, A. J., Ballard, H. L., Bonney, R., Brown, H., Cook-Patton, S. C., Evans, D. M., French, R. A., Parrish, J. K., Phillips, T. B., Ryan, S. F., Shanley, L. A., Shirk, J. L., Stepenuck, K. F., Weltzin, J. F., Wiggins, A., Boyle, O. D., Briggs, R. D., Chapin, S. F., Hewitt, D. A., Preuss, P. W., Soukup, M. A. 2017. Citizen science can improve conservation science, natural resource management, and environmental protection. *Biological Conservation*, **208**, 15–28. https://doi.org/10.1016/j.biocon.2016.05.015

Miller-Rushing, A., Primack, R., Bonney, R., Albee, E. 2020. The history of citizen science in Ecology and Conservation. *In*: Lepczyk, C., Boyle, O., Vargo, T., eds. *Handbook of Citizen Science in Ecology and Conservation*. University of California Press, 17–23.

Newman, C., Buesching, C. D., Macdonald, D. W. 2003. Validating mammal monitoring methods and assessing the performance of volunteers in wildlife conservation — "Sed quis custodiet ipsos custodies?". *Biological Conservation*, **113**, 189–197. https://doi.org/10.1016/S0006-3207(02)00374-9

Peters, M., Eames, C., Hamilton, D. 2015. The use and value of citizen science data in New Zealand. *Journal of the Royal Society of New Zealand*, **45**(3), 151–160. https://doi.org/10.1080/03036758.2015.1051549

Petrovan, S. O., Schmidt, B. R. 2016. Volunteer conservation action data reveals large-scale and long-term negative population trends of a widespread amphibian, the Common Toad (*Bufo bufo*). *PLoS ONE*, 11:e0161943. https://doi.org/10.1371/journal.pone.0161943

Rowley, J., Callaghan, C., Cutajar, T., Portway, C., Potter, K., Mahony, S., Trembath, D., Flemons, P., Woods, A. 2019. FrogID: Citizen Scientists Provide Validated Biodiversity Data on Frogs of Australia. *Herpetological Conservation and Biology* **14** (1), 155–170. http://www.herpconbio.org/Volume_14/Issue_1/Rowley_etal_2019.pdf

Ryan, R. L., Kaplan, R., Grese, R. E. 2001. Predicting Volunteer Commitment in Environmental Stewardship Programmes. *Journal of Environmental Planning and Management*, **44** (5), 629–648. https://doi.org/10.1080/09640560120079948

Silvertown, J. 2009. A new dawn for citizen science. *Trends in Ecology & Evolution*, **24**, 467–471. https://doi.org/10.1016/j.tree.2009.03.017

Starr, J., Schweik, C. M., Bush, N., Fletcher, L., Finn, J., Fish, J., Bargeron, C. T. 2014. Lights, camera…Citizen science: Assessing the effectiveness of smartphone-based video training in invasive plant identification. *PLoS ONE*, 9:e111433. https://doi.org/10.1371/journal.pone.0111433

Stepenuck, K. F., Green, L. T. 2015. Individual- and community-level impacts of volunteer environmental monitoring: A synthesis of peer-reviewed literature. *Ecology and Society*, **20** (3), 19. https://www.jstor.org/stable/26270236

Stojanov, A., Tzankov, N., Naumov, B. 2011. *Die Amphibien und Reptilien Bulgariens*. Edition Chimaira, Germany, 1–582 [In German].

Theobald, E. J., Ettinger, A. K., Burgess, H. K., DeBey, L. B., Schmidt, N. R., Froehlich, H. E., Wagner, C., HilleRisLambers, J., Tewksbury, J., Harsch, M. A., Parrish, J. K. 2015. Global change and local solutions: tapping the unrealized potential of citizen science for biodiversity research. *Biological Conservation*, **181**, 236–244. https://doi.org/10.1016/j.biocon.2014.10.021

Trumbull, D. J., Bonney, R., Bascom, D., Cabral, A. 2000. Thinking scientifically during participation in a citizen-science project. *Science Education*, **84**, 265–275. https://doi.org/10.1002/(SICI)1098-237X(200003)84:2%3C265::AID-SCE7%3E3.0.CO; 2-5

Received 13 June 2021
Accepted 1 September 2021