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TRENDS IN THE TRANSITION OF ALIEN HERPETOFAUNA SPECIES TO THE STATUS OF INVASIVE IN THE KRASNODAR KRAY

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For the first time, a record of Italian Wall Lizard *Podarcis siculus* (Rafinesque-Schmaltz, 1810) in Krasnodar is noted. The origin of this lizard, presumably, is associated with the importation of large-sized planting material. In addition, for the first time, reproduction of Red-eared Slider, *Trachemys scripta elegans* (Wied-Neuwied, 1839), in the nature was revealed near Sochi; the data from the moment of oviposition to the emergence of newborns from nesting chambers were collected. The size and color characteristics of *T. scripta* found in Sochi are described. Active resettlement allowed *T. scripta* to occupy the entire Imeretinskaya Lowland and the valley of the lower reaches of the Psou River. Monitoring of *Podarcis siculus* in the environs of Sochi indicates an increase in the range by almost eight times, with a modern habitat area of 200.6 ha. The high population density and a large number of young individuals clearly show the transition of the species from alien to invasive status. A new find in November 2021 of Mediterranean House Gecko, *Hemidactylus turcicus* (Linnaeus, 1758) indicates the strengthening of this exotic animal in the resort and a slight expansion of the range, about 1 km east of the initial record in Sochi. All of the listed species are, to varying degrees, synanthropic, what also contributes to their active distribution in the region.

Keywords: Krasnodar Kray; *Trachemys scripta*; *Hemidactylus turcicus*; *Podarcis siculus*.

INTRODUCTION

The Krasnodar Kray and, especially, the territory of Sochi are in focus of close attention of herpetologists on the issue of introduction of adventitious species into this territory since the beginning of the 21st century. For the Sochi region, the following species: *Trachemys scripta elegans* (Wied-Neuwied, 1839), *Cyrtopodion caspius* (Eichwald, 1831), *Hemidactylus turcicus* (Linnaeus, 1758), *Podarcis siculus* (Rafinesque-Schmaltz, 1810) were recorded (Tuniyev, Tuniyev, 2006; Dunaev and Orlova, 2017; Kukushkin et al., 2017; Dunaev and Imshe-nitzky, 2018; Tuniyev et al., 2020).

For *T. scripta*, in the case of naturalization on the Black Sea coast of the Caucasus, as the most suitable ter-

ritory of Russia in terms of its climatic parameters, it was assumed that it would become a dangerous competitor for the oppressed population of the Black Sea pond terrapin, *Emys orbicularis* (Kukushkin et al., 2017). This terrapin is listed in the Red Book of the Krasnodar Kray (Tuniyev and Tuniyev, 2017) with the highest rarity category 1 CR and the first priority of conservation measures in the second edition of the Red Book of the Russian Federation. It is a subspecies, *E. orbicularis colchica* Fritz, 1994 — endemic to Colchis with relict populations in the Russian Federation (Tuniyev, 2021).

Tendencies to become an invasive species in *Podarcis siculus* have also been noted since the first record of the forthcoming population in Sochi (Tuniyev et al., 2020). This opinion is based on the observations on the high density of the population and the forecast of a possible expansion of the area of colonization. It's obvious that it should inevitably lead to contact with native small sized lizards of the genus *Darevskia* Arribas, 1999, in particular, *D. braueri* (Méhely, 1909), *D. pontica* (Lantz et Cyrén, 1918) and, possibly, *D. derjugini* (Nikolsky, 1898) at the lower altitudinal limit of distribution of the

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latter species. The larger size of *Lacerta agilis grusinica* Peters, 1960 can be considered as an advantage for its competitiveness with *P. siculus*. However in the case with *L. a. grusinica*, a possible negative scenario in terms of food competition was assumed (Tuniyev et al., 2020), since one of the characteristics of successful colonization of new habitats for *P. siculus* was indicated as the widest range of food (Capula and Aloise, 2011; Mačat et al., 2015; Adamopoulou and Pafilis, 2019).

After the first records of two adventitious species, *Cyrtopodion caspius* and *Hemidactylus turcicus* no new information was earlier known. This paper presents the most recent materials for further monitoring of alien species in Sochi and Krasnodar.

MATERIAL AND METHODS

The material was collected in 2020 – 2022 by traditional route survey method in the region of the Krasnodar Kray (Russia). Some of the captured animals were fixed in 96% ethanol after species identification according to European Guides (Arnold and Burton, 1978; Engelmann et al., 1985; Glandt, 2015). The material is stored in the collection of the Sochi National Park. Population density was evaluated by the route method with two or three counters in a strip 2 m wide on routes covering the entire territory of the Imeretinskaya Lowland, the valley of the lower reaches of the Psou River within the boundaries of the federal territory “Sirius” and the park “Krasnodar” in Krasnodar. To identify the dynamics of *P. siculus* colonization, the area of the range expansion was identified and mapped annually in the area of all the clusters of the Natural Ornithological Park in the Imeretinskaya Lowland and adjacent urban areas. The reproduction process of *Trachemys scripta* was traced from the moment of egg laying to the leaving the nesting chambers by newborns. Measurements of newborn turtles were made with a caliper, with an accuracy of 0.1 mm.

RESULTS AND DISCUSSION

We included *Trachemys scripta* in the fauna list of the Sochi Black Sea region in 2011; the animals were observed mainly in artificial reservoirs of city parks and the Imeretinskaya Lowland. For the first time within the territory of the Sochi National Park, M. A. Reneva found the Red-eared slider near Yermolovka village in 2019. It was an old specimen with exfoliate carapace shields. The record of an animal of over 20 years old according to expert assessment, indicated a long period of introduction of this species in the region. In the recent years, the

T. scripta has become the dominant species in the parks “Yuzhnye Kultury” and “Dendriy,” has occupied almost all artificial reservoirs of the Imeretinskaya Lowland and floodplain reservoirs in the valley of the lower reaches of the Psou River, representing a real threat to the conservation of the Colchis pond terrapin. Already in 2020, *T. scripta* were observed in the regional protected area “Natural Ornithological Park in the Imeretinskaya Lowland,” in the territory of clusters No. 2, 5, 6, 9 in the Imeretinskaya Lowland and in all eight floodplain lakes of cluster No. 10 in the valley of the Psou River. Active movement facilitates the dispersal of the species over long distances on land.

It was believed that the *T. scripta* did not breed in its secondary range in Russia, from the Moscow region to the Caucasus. In 2021, we noted individuals of different ages, including newborn and juvenils, in the ponds of the Imeretinskaya Lowland, which allow to assume the reproduction of the species, but could not serve as an irrefutable argument in favor of the naturalization of the *T. scripta*, since the reproduction of the species until 2022 was not documented.

June 27, 2022 N. I. Marteniuk photographed *T. scripta* laying eggs in a dug-out nest chamber in “Yuzhnye Kultury” Park (Fig. 1A). Another egg laying was recorded by a park guard who wished to remain anonymous. We permanently observed these two clutches up to the moment when newborns leave the nesting chamber. Nesting chambers, 15 cm deep, were dug by females in rubble soil of semi-lit flat areas, at a distance of about 50 m from one another and about 100 m from the habitat pond. The soil above the clutches is completely leveled, and impossible to recognize the location of the nesting chamber (Fig. 1B). The newborns from the first clutch left the nesting chamber on October 2, 2022, their number and size remained unknown (Fig. 1C). Three and half months later, on October 14, 2022, twelve newborns hatched from the second clutch. To determine their sex at this age is difficult; presumably, these are eight females and four males, weighing 5 – 7 g, the measurements are given in Table 1. The young individuals in the nesting chamber were located tightly pressed against each other (Fig. 1D). In five to seven minutes, after they reach the surface they began to spread actively. The coloration of the animals immediately after appearance is dark olive with a light vertebral crest (Fig. 1E). After two days in the aqua-terrarium, the animals acquired a salad-green juvenile coloration with a marbled pattern on carapace shields, orange temporal spots, and an orange-yellow central cranial stripe (Fig. 1F). On the ventral side, all animals have 8-formed spots, individual for each specimen. A week later, the animals began to feed actively. Thus,

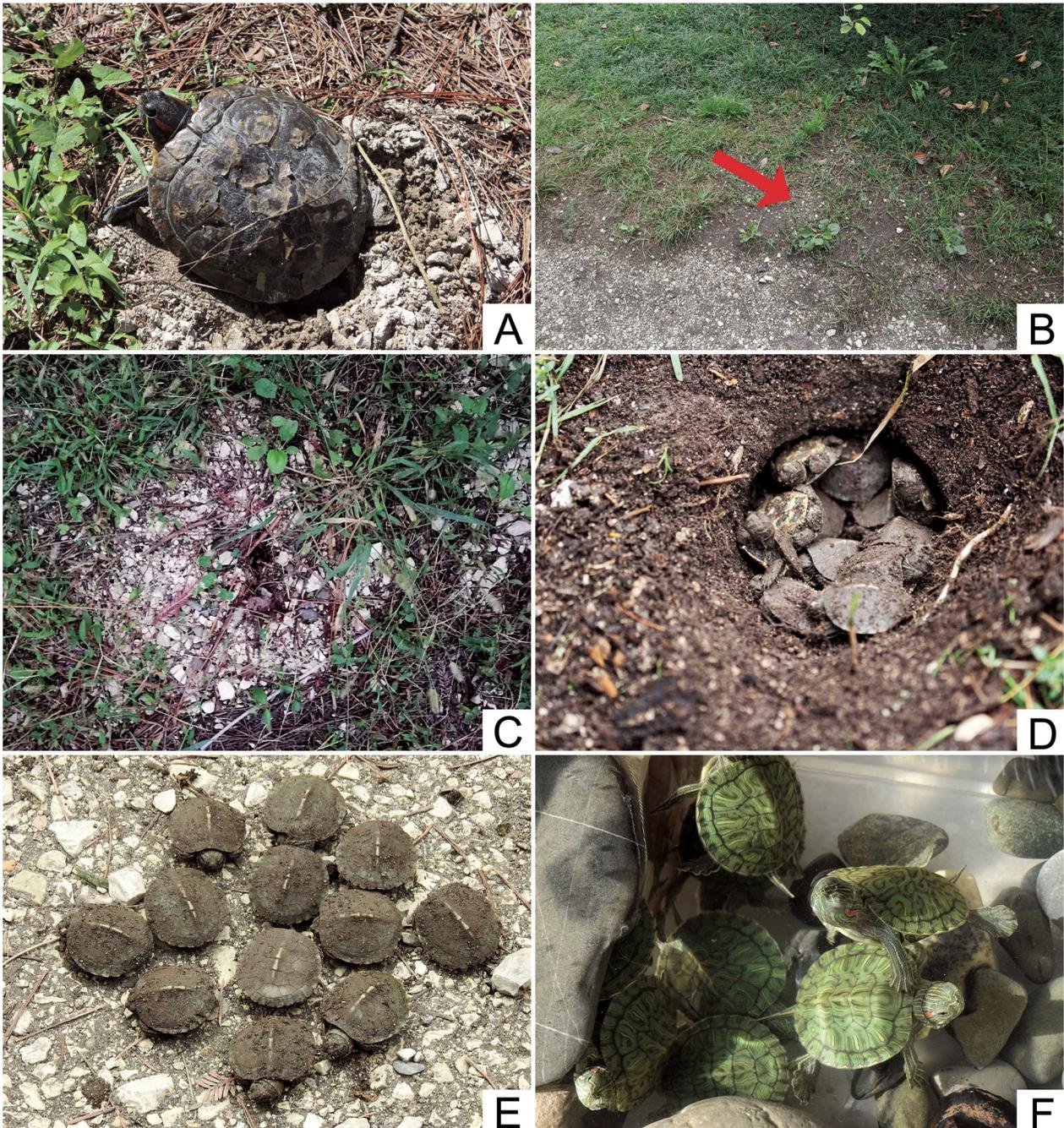


Fig. 1. A, *Trachemys scripta* oviposition 06.27.2022 “Yuzhnye Kultury” park; B, location of the *Trachemys scripta* nest chamber (indicated by the arrow) is well hidden; C, nest abandoned by young animals; D, Location of young *T. scripta* in the nesting chamber; E, the coloration of animals immediately after emergence is dark olive with a light vertebral crest; F, salad-green coloration characteristic of newborn appeared after 2 days.

the reproduction of the *T. scripta* on the Black Sea coast in Sochi was documented.

The occurrence of the *T. scripta* breeding in Romania was reported in 2021 (Iftime and Iftime, 2021). These authors pointed out that signs of reproduction are still sporadic

and have been recorded only in city parks in Constanta city and other cities.

European herpetologists point out the competition of *T. scripta* in prejudice of *E. orbicularis* (Cadi and Joly, 2003), although there are publications questioning this

competition, at least in some regions of Europe (Macchi et al., 2008; Kleewein, 2015). According to Romanian herpetologists (Iftime and Iftime, 2021), the ecological effect of marginal/suboptimal *E. orbicularis* habitats in southern Europe may increase the impact of *T. scripta*.

In Romania, any competition does not prevent the successful reproduction of both synanthropic species (Matei and Tudor, 2014). Ecological species preferences overlap, but only partially in diet, as *T. scripta* is more of a phytophagous and opportunistic species than the predominantly carnivorous *E. orbicularis* (Pérez-Santigosa et al., 2011). The conclusion by A. Iftime and O. Iftime (2021) about their different preferences for sunlight is not confirmed by our observations within the Russian range of the Colchian pond terrapin. Both species here use places for rest and basking that coincide in time and location. We did not record the facts of visible aggression, but the limited areas of such habitats can be considered as a factor of competition.

Presumably, since 2011, the Turkish Gecko, *Hemidactylus turcicus* has appeared in Sochi (Dunaev and Orlova, 2017; Dunaev and Ishmenitsky, 2018). After the introduced Caspian Gecko (*Cyrtopodion caspius* (Eichwald, 1831) noted by us (Tuniev and Tuniev, 2006) on the territory of the “Belye Nochi” Holiday House in Uch-Dere settlement, the Turkish Gecko became the second introduced species of the gecko family (Gekkonidae) in Sochi Black Sea region.

A new record on November 26, 2021 of a Turkish Gecko in Sochi evidenced about the anchorage of this exotic animal in the resort. A young specimen was found on a wall in a city apartment in the “Novaya Zarya” microdistrict. This gecko recently leaves the egg, apparently from the last autumn clutch (Fig. 2). These animals lay 4 – 6 clutches during the warm period of the year with two eggs per clutch.

From the countries of the Middle East, it was transported with goods to almost all continents, becoming perhaps the most common species of gecko in the world, and this process continues. Thus, in 2021, the species was first discovered on the coast of Romania (Iftime and Iftime, 2021).

At the time of the discovery of *Hemidactylus turcicus* in Sochi in 2011 at the site of abandoned Turkish warehouses, it was believed that the micropopulation numbered about 45 specimens. The young individuals observed annually until 2017 confirmed the success of reproduction and maintenance of the population. Our new record of a juvenile in the fall of 2021 confirmed the successful existence of this species in Sochi. It also indicates a slight expansion of the range, about 1 km east of the original find site.



Fig. 2. New find of *Hemidactylus turcicus* in Sochi (26.11.2021).

The Italian Wall Lizard, *Podarcis siculus*, was first noted on the Imeretinskaya Lowland in December 2017. It came to the territory of the “Imeretinsky” hotel in 2012 – 2013 with the supply of large-sized planting material, mainly European olive. This fact should be considered as the time of the introduction of the group of *P. siculus*, which subsequently gave rise to the local population (Tuniev et al., 2020). Special surveys of the territory, carried out in late spring and early summer 2020, made it possible to identify a large local population of the species over an area of over 25 ha (0.254 km²) on the territory of the Natural Ornithological Park in the Imeretinskaya Lowland, as well as on house lawns in the city. The population density varied from 8 to 40 individuals per 100 m of the route, and a high proportion of young individuals, exceeding 40%, indicated a prosperous state and growth of the emerging population (Tuniev et al., 2020).

In 2021, the entire habitat area of the species identified in 2020 was surveyed throughout the Imeretinskaya Lowland in the Mzymta – Psou rivers interfluvium, on an area of 169.7 ha. The range of the species increased by four times for 78.6 ha over the year, amounting 104 ha

TABLE 1. Measurements of Juveniles of *Trachemys scripta* (“Yuzhnye Kultury” park, 10.14.2022)

No.	L.car., mm	L.plastr., mm	L.t.car., mm
1	29.9	30.9	30.6
2	30.1	31.3	31.4
3	31.5	31.3	30.6
4	31.3	30.9	30.3
5	30	29.4	31.6
6	31.4	30.8	31.3
7	30.1	28.1	29.8
8	30.8	29.3	30.8
9	30.1	30.4	30.6
10	31.4	29.6	31.5
11	30.4	30.2	29.9
12	31.8	30.7	31.4
	30.73 ± 0.63	30.24 ± 0.77	30.82 ± 0.52



Fig. 3. Monitoring of the range of *Podarcis siculus* in the Imeretinskaya Lowland of Sochi.

(1.04 km²) (Fig. 3). Lizards were not observed on the area of 65.7 ha of the Imeretinskaya Lowland. An analysis of the expansion of the range in 2021 showed promotion to the east from the Zapovedny Quarter of the “Imeretinsky” Hotel to Olimpiyskiy Avenue and to the south to Parusnaya Street. To the west, the expansion of the distribution is more significant. Having crossed the Morskoy Boulevard, the Italian wall lizard completely mastered the residential quarter adjacent to cluster No. 1 of the Natural Ornithological Park in the Imeretinskaya Lowland. Then it crossed the Perspektivnaya Street settled along the canal, not reaching a short distance from of its confluence with Mzymta River on the street Golubaya. To the northwest, lizards occupied the entire territory of the “Yuzhnye Kultury” park and the surrounding areas up to the Tulpanov Street and Tsvetochnaya Street. A small isolated cluster occupied in 2021 a narrow strip along Olimpiyskiy Avenue to the Kazachya Street in the northeast. The population density of the species was still high: along the discharge channel, 10 individuals were counted per 100 m of the route; in the “Yuzhnye Kultury”

park, juvenile and semi-adult individuals predominated, indicating a recent introduction.

In 2022, territory identified in 2020 – 2021 was reexamined; monitoring covered the entire territory of the Imeretinskaya Lowland in the interfluvium of the Mzymta – Psou Rivers. The range of the species increased by another 96.6 ha over the year and amounted to 200.6 ha (2.006 km²), i.e., increased by two times over the year. Lizards occupied the mouth part of the left bank of the Mzymta River, the entire territory between the Olimpiyskiy Avenue and the seashore, in the north reached the Kaspiskaya Street and settled as a separate cluster along the Dibrova Street. The population density in some places reached 12 – 14 individuals per 100 m of the route, while more than half animals belonged to young and semi-adult age categories. It is noteworthy that the pronounced synanthropy of the species allows it to populate areas littered with household and construction waste, and young animals to settle along the drip irrigation systems of shrub borders of the *Pittosporum tobira* (Thunb.) W. T. Aiton on the sea embankment (Fig. 4A, B)



Fig. 4. A, juvenile *Podarcis siculus* (juvenile coloration) on construction debris — a piece of concrete; B, An adult female *P. siculus* at a shelter made of household waste; C, *P. siculus* found for the first time in Krasnodar (juvenile); D, Biotope of *P. siculus* in Krasnodar — plantations of clipped border of oriental beech near the palm trees and arborvitae in “Krasnodar” park.

The find of *P. siculus* in city of Krasnodar is of special interest. For the first time, an adult specimen was recorded on April 22, 2022 in the territory of the “Krasnodar” park, in its northern part. Repeated observations on November 5, 2022 allow finding two juveniles, indicating the successful reproduction of the emerging population. Basking of juveniles was recorded on a clear sunny day at an air temperature of about +13°C. Animals were observed near the clipped border of oriental beech (*Fagus orientalis* Lipsky) with a drip irrigation system, on the pipes of which they were heated (Fig. 4C). Large cracks were also found under the concrete base of benches and burrows, supposedly wintering places for lizards. Accurate data on the abundance and distribution of *P. siculus* in the territory of Krasnodar are not yet available due to a recent discovery. However, the presence of juvenils indicates that the lizards have success-

fully acclimatized, reproduce and use this territory for their life. The origin of lizards in the “Krasnodar” park is apparently associated with the importation of large-sized planting material in 2019. In March 2019 was started the third phase of the park development and its area was increased by 4 ha where the evergreen subtropical trees and shrubs were planted. In December 2019, the fourth phase of the park was started when palm trees and arborvitae were planted (Fig. 4D). In this regard, it can be assumed that the discovered group of *P. siculus* exists in Krasnodar for three years.

CONCLUSION

Concluding the review of the status of alien reptile species in the Krasnodar Kray, we note the absence of new data confirming the habitation of *Cyrtopodion caspius* in Sochi. For *Hemidactylus turcicus*, a slight ex-

pansion of the range of the remaining micropopulation was noted, without visible trends towards territorial and numerical expansion. *Trachemys scripta* leaving the city parks, due to active movement on land, and form the observed settlement of the territory in the valley of the lower reaches of the Psou River, including two protected areas (Sochi National Park and the Natural Ornithological Park in the Imeretinskaya Lowland). It allows us to classify the species as invasive. The observed reproduction of *T. scripta* in nature confirms this conclusion. The increase in the area of the range of *Podarcis siculus* by almost 8 times over three years of observations, the high density and proportion of young individuals clearly indicate the transition of the species from adventive to invasive status in the modern population near Sochi. The trends in the development of the discovered group of *P. siculus* in Krasnodar will become clear with time, and further monitoring is necessary. All of the listed species are, to varying degrees, synanthropic, which also contributes to their active distribution in the region.

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