

NEW RECORDS OF REPTILES ON THE RED SEA COAST, EGYPT, WITH NOTES ON ZOOGEOGRAPHY

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New records of 20 reptile species and subspecies on the Red Sea coast of Sinai Peninsula and Eastern Desert in Egypt are given. A zoogeographical analyses of the herpetofauna and comparison of the species compositions results to estimate the biodiversity for each subregion of Eastern Egypt. The faunal richness, taxonomic diversity and endemism level in hyperarid deserts of the Egypt are discussed. Mountainous South Sinai and southern part of the South Eastern Desert is suggested to consider as biodiversity hotspots in Eastern Egypt.

Keywords: reptiles; herpetofauna; biodiversity; zoogeography; Red Sea coast; Egypt; Sinai; Eastern Desert.

INTRODUCTION

Egypt is located in the transition zone between Asia and Africa, and the intermediate position of the Sinai Peninsula is traditionally regarded as the part of Asia. The eastern part of Egypt is a continental crust that covers part of the Neoproterozoic Arabian-Nubian Shield that extends from Jordan and southern Israel in the north to Eritrea in the south and from Egypt in the west to Saudi Arabia and Oman in the east. The Arabian-Nubian Shield outcrops around the Red Sea in north-east Africa and Western Arabia as a result of uplift and erosion on the flanks of the Red Sea in the Oligocene and more recent times (Stern et al., 1994; Stern et al., 2006). The separation of Arabia from Nubia and the associated extension in the Red Sea initiated in the Miocene roughly simultaneously with the onset of a continental collision between Arabia and Eurasia. The Sinai Peninsula and Levant region comprise a separate sub-plate sandwiched between the Arabian and Nubian plates (Reilinger et al., 2006). Orologically the Peninsula is divided between the mainly flat North Sinai and the distinctly mountainous South Sinai.

The Eastern Desert extends from the eastern edges of the Nile Delta down to the Nubian Desert and is bordered by the Nile Delta and the Red Sea Mountains ridge. The southern border lies approximately along 22° N. This structural plain is a medium elevated plateau dissected by a dense network of wadies, that are occasion-

ally filled with water. The Eastern Desert is divided geologically into three distinctive terranes: North Eastern Desert, Central Eastern Desert, and South Eastern Desert (Stern and Hedge, 1985) (Fig. 1). In the south the Eastern Desert meets the Nubian Desert, each characterized by different types of aridity. The Eastern Desert is a hyperarid desert with an aridity index of 0.03 – 0.06. Monthly mean temperature reaches 30°C in summer and not below 10°C in winter. Annual precipitation does not exceed 50 mm.

Most of the Sinai Peninsula is occupied by the Et-Tikh Plateau, as a gravel desert in the north and mountains of the South Sinai in the south. The plateau of Et-Tikh is an absolute desert with an aridity index <0.02. Annual precipitation is extremely low and does not exceed 30 mm in the south (Babayev et al., 1986).

The herpetofauna of Egypt is quite well known (Anderson, 1896, 1898; Flower, 1933; Marx, 1968; Schleich et al., 1996; Baha El Din, 2006). Taking into account the huge size of this territory, new and important distribution records cannot be excluded.

MATERIAL AND METHODS

The present work is based on several visits to the Red Sea Coast of Egypt in the period 2006 to 2014. Field work occurred in the vicinity of Sharm El Shekh, Dahab and Nuweiba in the South Sinai Governorate (Sinai Peninsula); Makadi Bay and Sharm El Arab Bay in Hurghada region; Marsa Alam, Marsa Eglā, Port Ghalib and Abu Dabab Bay in Marsa Alam region; Hamata Port

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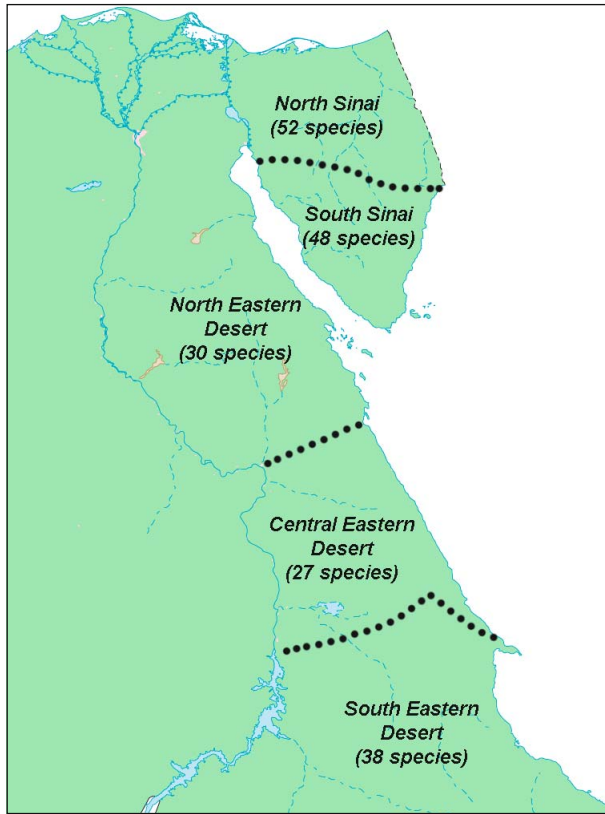


Fig. 1. Map of Eastern Egypt subregions with number of reptile species for each unit.

and Wadi Lahmi in Hamata region. A total of 20 species and subspecies of reptiles (Figs. 2 – 4) were recorded on the Red Sea coast during this period. The first part of this paper details species that were recorded, with comments on their known distribution and range extensions. The second part contains a zoogeographical analysis of the herpetofauna of Eastern Egypt. Comparison of species diversity from different units is estimated using a standard similarity index. Sørensen's Quotient of Similarity: $2 \times \text{number of taxa common to both areas} / \text{sum of totals of taxa from both areas}$, expressed as a percentage (Sørensen, 1948).

RESULTS AND DISCUSSION

List of records

Cyrtopodion scabrum (Heyden) — there is only one species of *Cyrtopodion* in the Egyptian fauna, widely distributed along the Red Sea coast of the Eastern Desert and Sinai Peninsula. Recorded in the central part of Sharm-El-Sheikh city on the walls formed by quarried

stones (27°52'08.3" N 34°18'44.3" E); in Taba 14 km north from Nuweiba, on the stone masonry and the buildings' walls (29°09'24.5" N 34°41'17.8" E).

Hemidactylus granosus Heyden — this species occurs in Arabia and on the Sinai Peninsula. In Egypt this species has been documented from only two locality: near Tower Bay in Sharm-El-Sheikh and Ayoun Musa in northern part of the Suez Channel (Šmíd et al., 2013). I observed this species near Rauabi village in Nabk, Sharm-El-Sheikh (27°59'52.8" N 34°26'04.3" E), 17 km NE from a previously known locality. This is the third record of *H. granosus* in Sinai. It is likely that all records of *H. turcicus* (Anderson, 1896, 1898; Baha El Din, 2006) from the coast of Aqaba Bay and western coast of the Sinai, and possibly Suez Gulf of Sinai, really belong to *H. granosus*. Because *H. granosus* is an original inhabitant of the coast of the Sinai Peninsula, the existence of *H. turcicus* in Sinai is possibly a result of ancient introduction by humans. Active human-mediated range expansion of this species westwards across the whole Mediterranean region and then across the Atlantic Ocean is known (Carranza and Arnold, 2006). It is likely *H. turcicus* reached the Red Sea coast in historical times.

Hemidactylus robustus Heyden — lives on the Red Sea coast in the southern part of Egypt (Baha El Din, 2006). Apparently it replaces *H. turcicus* in Eastern Egypt, where these species were not known previously (Flower, 1933; Marx, 1968). Recorded on buildings in urbanized landscapes on the coast of Hamata, Marsa Wadi Lahmi (24°14'17" N 35°24'39.1" E) where it is very common.

Ptyodactylus hasselquistii hasselquistii (Donndorff) — distributed on the Red Sea coast to Sudan and in the Nile River valley (Flower, 1933; Baha El Din, 2006; Metallinou et al., 2015). A typical synanthropic species that easily colonizes human settlements. On the African coast it is often replaced by *P. siphonorhinus*. Recorded between Hurghada and Safaga, on the coast of Makadi Bay (26°58'57.7" N 33°54'49.7" E). Unusual brightly colored geckoes were found in the southern part of the species range in Hamata, between Wadi Lahmi and Wadi Um Fahm, in the desert (24°12'24.8" N 35°22'25.7" E). All records of *Ptyodactylus ragazzii* from southern Egypt (Baha El Din, 2006) apparently belong to this subspecies of *Ptyodactylus hasselquistii*, because the distribution of *P. ragazzii* is restricted in the north by the Nubian Desert (Metallinou et al., 2015).

Ptyodactylus hasselquistii ssp. — the most common species in Sinai Red Sea Coast where is represented by the different form (Metallinou et al., 2015) possibly subspecies rank. Recorded in the center of Sharm-El-Sheikh (27°52'11.8" N 34°18'41.8" E), in the area near the old



Fig. 2. Gekkonid lizards from Eastern Egypt: *a*, *Cyrtopodion scabrum*, Nuweiba; *b*, *Hemidactylus robustus*, Hamata; *c*, *Hemidactylus granosus*, Sharm-El-Sheikh; *d*, *Pristurus flavipunctatus*, Hamata; *e*, *Ptyodactylus hasselquistii hasselquistii*, Hamata; *f*, *Ptyodactylus hasselquistii* ssp., Dahab; *g*, *Ptyodactylus siphonorhinus*, Marsa Alam; *h*, *Ptyodactylus hasselquistii* ssp., Nuweiba.



Fig. 3. Gekkonid and lacertid lizards from Eastern Egypt: *a*, *Tropicolotes steudneri*, Makadi Bay; *b*, *Tropicolotes steudneri*, Marsa Alam; *c*, *Acanthodactylus boskianus asper*, Nuweiba; *d*, *Acanthodactylus boskianus asper*, Marsa Alam; *e*, *Acanthodactylus boskianus asper*, Nuweiba; *f*, *Mesalina rubropunctata*, Hamata; *g*, *Mesalina guttulata*, Hamata; *h*, *Mesalina bahaeldini*, Dahab.



Fig. 4. Agamid lizards, snakes and sea turtles from Eastern Egypt: *a, b*, *Pseudotrapelus aqabensis*, Nuweiba; *c, d*, *Uromastix ornata*, Sharm-El-Sheikh; *e*, *Echis coloratus coloratus*, Nuweiba; *f*, *Psammophis aegyptius*, Dahab; *g*, *Chelonia mydas japonica*, Marsa Alam; *h*, *Eretmochelys imbricata bissa*, Hamata.

city (27°52'11.2" N 34°16'58" E), also on buildings in Nabk (27°59'52.8" N 34°26'04.3" E); in the gorges between Dahab and Ras Abu Galum (South) (28°33'39.5" N 34°30'56.6" E); between Nuweiba and Taba, 14 km from Nuweiba to the north, on buildings (29°09'26.4" N 34°41'24.8" E); in the big wadi (29°08'57.9" N 34°40'11.5" E); on the mountain slopes (29°10'42" N 34°41'23.6" E), on abandoned buildings (29°10'18.7" N 34°42'38" E).

Ptyodactylus siphonorhinus Anderson — distributed in the Eastern and Western Deserts. It can be difficult to distinguish from *Ptyodactylus guttatus*. Recorded on the walls of buildings 24 km to the north of Marsa Alam (25°15'25.3" N 34°47'19.7" E). This record is a new locality for this species on the coast where it is distributed very sporadically and known only from few localities (Baha El Din, 2006; Metallinou et al., 2015).

Pristurus flavipunctatus Rüppell — uncommon species, sporadically distributed in southern-eastern Egypt. Recorded in Hamata, Wadi Lahmi (24°12'02.6" N 35°23'40.7" E) on Acacia trees.

Tropicolotes steudneri (Peters) — widely distributed in Egypt where it occurs in deserts and oases on the Red Sea coast, and in the Eastern and Western deserts. It lives in suitable microhabitats in hyperarid deserts. This species is very common on the mainland Red Sea coast. Recorded between Hurghada and Safaga, to the south from Makadi Bay (26°56'53" N 33°54'14.4" E); to the north from Marsa Alam on the south shore of Abu Dabab Bay (25°19'50.7" N 34°44'35.4" E); also between Marsa Alam and Abu Dabab Bay (25°15'45.3" N 34°47'06.8" E); in the desert in Hamata, Wadi Lahmi (24°11'57.4" N 35°23'33.4" E) and at the foot of a mountain (24°10'43.9" N 35°23'16.2" E).

Pseudotrapelus aqabensis Melnikov, Nazarov, Ananjeva et Disi — recently described as a full species from Aqaba, Jordan. Reported in Egypt for the first time in 2014 (Melnikov et al., 2014; Tamar et al., 2016). Distributed in the north-eastern part of Sinai Mountains and possibly in Taba Highland. Very common in canyons along the Nuweiba-Taba Road, 14 km to the north from Nuweiba (29°10'05.9" N 34°41'16.9" E), in foothills (29°10'41.9" N 34°41'23.4" E) and in the big wadi (29°09'21.9" N 34°38'42.2" E). Same species recorded in the gorges and canyons near Dahab, between Dahab and Ras Abu Galum (South) (28°33'27.5" N 34°30'55" E).

Uromastix ornata Heyden — mountain-dwelling species distributed in southern Sinai and western Arabia. Recorded in vicinity of Sharm-El-Sheikh, near Sharm-El-Maya Bay in canyon (27°51'54.8" N 34°17'05.3" E)

and close to the southern extremity of the Sinai Mountains (27°53'56.3" N 34°14'43" E). Also found in the gorge between Dahab and Ras Abu Galum (South) (28°32'39.5" N 34°30'23.7" E) and in the same habitat on the coast 14 km to the north of Nuweiba (29°10'05.9" N 34°41'16.9" E).

Acanthodactylus boskianus asper (Audouin) — occurs almost everywhere in the northern part of the Eastern Desert and in Southern Sinai. Distribution of this species in southern Egypt is not well known (Goodman, Hobbs, 1994; Baha El Din, 2006). Recorded on the Sinai Peninsula near Rauabi village in Nabk, Sharm-El-Sheikh (27°59'46.6" N 34°25'50" E); near Nuweiba in the Colored Canyon (29°08'32.8" N 34°35'54.3" E); in the sand desert fragments on the coast along Nuweiba-Taba Road, 14 km to the north of Nuweiba (29°08'44.7" N 34°41'22.8" E) and in undamaged sector of sand and gravel desert in 17 km to the north from Nuweiba (29°10'19.9" N 34°42'52.1" E). In the Eastern Desert these lizards were found on sand sites near the sea shore between Marsa Alam and Abu Dabab Bay (25°16'03" N 34°46'49.7" E) and in the big wadi (25°14'30.9" N 34°46'58.9" E). Common in Hamata region, Wadi Lahmi, in the desert (24°12'08.2" N 35°23'45.6" E) and between the mountains (24°10'41.2" N 35°23'11.6" E); between Wadi Lahmi and Wadi Um Fahm (24°12'34.5" N 35°22'59.7" E), in El Heboni Depressions (24°14'10.9" N 35°22'47.4" E) and Wadi Um Fahm (24°13'29.1" N 35°22'55.2" E). This species has not been previously reported for Wadi Lahmi.

Mesalina bahaeldini Segoli, Cohen et Werner — mountain-dwelling endemic species of Southern Sinai, distributed at elevation from 600 m a.s.l. and higher. Records are located mainly in the inner part of the Peninsula, especially near St. Katherine Monastery (Segoli et al., 2002; Baha El Din, 2006). I discovered this lizard in foothills near the coast between Dahab and Ras Abu Galum (South) at an elevation 49.5 m a.s.l. (28°33'30.9" N 34°31'08.2" E). This is the first record on the Red Sea coast, and extends the species' range to this coastal and low elevation area. Both *M. bahaeldini* and *M. guttulata* have never before been recorded on the Egyptian side of the Aqaba Gulf. It seems that *M. bahaeldini* occurs over the full-range of elevation in the Sinai Mountains.

Mesalina guttulata (Lichtenstein) — common and widespread distribution in Egypt, but on the Red Sea coast it occurs sporadically (Goodman and Hobbs, 1994; Baha El Din, 2006). In southern Egypt, approximately in the Hamata region it was recorded in "the neighborhood of the Emerald Mines on the coast of the Red Sea,

in nearly the same latitude as Assuan," i.e., 24° N (Flower, 1933). I also recorded this species in Hamata, to the north from Marsa Wadi Lahmi (24°14'06.5" N 35°24'45.6" E) and at the foot of a mountain in the Wadi Lahmi (24°10'47" N 35°23'08.3" E). Both records are new for the Red Sea coast.

Mesalina rubropunctata (Lichtenstein) — uncommon and widespread species in Egypt, sporadically distributed in the Eastern Desert where it is known from several localities (Anderson, 1896, 1898; Marx, 1968; Baha El Din, 2006). Recorded in Hamata, Wadi Lahmi (24°11'52.9" N 35°23'41.6" E). The new record is 60 km south of previously documented locations on the coast and southernmost for Egyptian coast.

Trachylepis quinquetaeniata quinquetaeniata (Lichtenstein) — in Egypt occurs in the north and in the Nile River valley. Was recently introduced to the Red Sea coast, where it was reported for the first time in 2003, and now lives in sites with touristic development such as Hurghada, Safaga, Ain Sukhna, and Sharm-El-Shekh (Necas and Vigasova, 2004; Baha El Din, 2006). In the central part of Sharm-El-Sheikh (27°52'08.2" N 34°18'49.4" E) mabuyas occur in high density in *Eucalyptus* plantings, grass-plats with palm-trees and wastelands.

Platyceps saharicus Schätti et McCarthy — apparently, widely distributed in Egypt, but an understudied species. Recorded on the coast 14 km to the north of Nuweiba (29°08'42.4" N 34°41'02" E). In the Red Sea coast area it was known only from two localities (Schätti and McCarthy, 2004; Baha El Din, 2006; Geniez and Gauthier, 2008). This is a new record for the Sinai coast of Aqaba Gulf.

Psammophis aegyptius Marx — distributed across Northern Africa. In Egypt inhabits hyperarid deserts. Occurs in the southern part of the Sinai Peninsula, mainly in mountainous regions. Recorded twice in the gorges between Dahab and Ras Abu Galum (South) (28°32'39.5" N 34°30'23.7" E and 28°34'25.8" N 34°31'43.7" E). These records are new localities for Sinai.

Echis coloratus coloratus Günther — occurs in eastern Egypt, in the Eastern Desert and on the Sinai Peninsula. This species inhabits gravel deserts and rocky slopes of mountains. Recorded in the stony gorge 14 km north of Nuweiba (29°10'01.5" N 34°40'41.2" E).

Chelonia mydas japonica (Thunberg) — rare but locally common species in the Red Sea (Frazier and Salas, 1984; Baha El Din, 2006; Attum et al., 2014). Recorded in the localities of Marsa Alam: Bay of Abu Dabab (25°20'19.4" N 34°44'19.7" E), Marsa Eglia (25°10'20.3" N 34°50'31.8" E), near Port Ghalib in Mar-

sa Mubarak (25°30'38.7" N 34°39'05.5" E), in the bay near Wadi El Gemal (24°41'29" N 35°05'07.2" E) and Sharm Luli Bay (24°36'36.1" N 35°06'54.6" E). Turtles can be found in the sandy bays where they feed on the sea grass.

Eretmochelys imbricata bissa (Rüppell) — most common species of sea turtles in the Red Sea (Flower, 1933; Frazier and Salas, 1984; Baha El Din, 2006). Recorded in Sharm-El-Sheikh along the coastal reefs. Also recorded in Marsa Alam, in a bay near Wadi El Gemal (24°41'29" N 35°05'07.2" E); in Hamata, Wadi Lahmi (24°14'23.6" N 35°24'55.5" E).

Zoogeography of the Eastern Egyptian herpetofauna

The desert herpetofauna of Eastern Egypt is composed mainly of five faunal elements: Sahara-Sindian, Arabian, Saharan, Mediterranean, and Ethiopian. The Ethiopian element consists of species distributed in the eastern part of the Sahelian ecoregion and Ethiopian Plateau and not entering the Sahara.

Partly isolated position of the Southern Sinai creates a moderate level of species endemism. Contrariwise, in the absence of natural barriers in the Eastern Desert, endemism of reptile species on the Red Sea coast is very low, and possibly limited only by the Gebel Elba region.

The intermediate position of the Sinai micro-plate results in a mixture of Saharan and Arabian species. The terrestrial herpetofauna of the Sinai Peninsula includes 65 native species of reptiles. A characteristic of the Egyptian Red Sea coast region is an absence of amphibians. However several anuran species occur in the Mediterranean ecozone in the Northern Sinai. Reptilian fauna is very rich and comprises several biogeographic groups. Saharo-Sindian (27.7%), Mediterranean (26.1%) and Arabian (18.5%) species are the core of the Sinai herpetofauna. Saharan species form 12.3% (8 species), Ethiopian species — 4.6% (3 species) and Sinai endemics (*Hemidactylus mindiae*, *Mesalina bahaeldini*, *Platyceps sinai*) and subendemics (*Ptyodactylus guttatus*, *Pseudotrapelus sinaitus*, *Trapelus savignii*, *Telescopus hoogstraali*) — 10.8% (7 species). An addition to the native Sinai herpetofauna are the introduced species from South Asia (*Hemidactylus flaviviridis*, *Indotyphlops braminus*) and from the Nile Delta (*Trachylepis quinquetaeniata*) (see Table 1).

An important feature of the Sinai endemism is a claimed absence of reptile and amphibian species completely endemic to the territory of Sinai (Werner, 1982). Recently, the proportion of full Sinai endemics was established up to 4.6 and 10.8%, respectively, including subendemics (see Table 1). If subspecies are included in this list (*Laudakia stellio salehi*, *Mesalina bahaeldini*

curatorum, *Ptyodactylus hasselquistii* ssp.) the number of endemics will increase further.

The herpetofauna of South Sinai is composed mainly of mountain species, and a lesser portion of plain-dwellers that inhabit the Et-Tikh Plateau. The latter include species that live in gravel and psammophile species. The mountainous species inhabit the South Sinai Mountains. A separate ecological group includes the rock-dwellers (*Laudakia stellio*, *Pseudotrapelus sinaitus*, *Ptyodactylus guttatus*, *P. hasselquistii*, *Cyrtopodion scabrum*) that are strongly dependent on the availability of more or less presented vertical surfaces. The sea coast in the Southern Sinai is a narrow zone of deserts adpressed to the sea by the wall of mountains. The sand and gravel desert inhabitants (*Acanthodactylus boskianus*, *A. scutellatus*, *Mesalina guttulata*, *Cerastes cerastes*, *C. vipera*) occur here. A total 20 reptile species has been reported for the Egyptian coast of Gulf of Aqaba (Baha El Din, 2006). A surprising addition to this list was a record of *Mesalina bahaeldini* formerly known only from the mountainous part of South Sinai, where this species lives at altitudes not less than 600 m a.s.l. (Segoli et al., 2002; Baha El Din, 2006). According to our data this species inhabits also low altitudes and its distribution connects by mountain slopes to the sea coast. A recent record of *Mesalina bahaeldini* on a plain far from mountains near Suez seems surprising and possibly doubtful (Werner and Ashkenazi, 2010). I also collected new records of mountainous *Psammophis aegyptius* near the sea coast in Dahab.

The records of Arabian *Hemidactylus granosus* in Sinai suggest its autochthonous origin in this area. This species is an ecological equivalent of Mediterranean *Hemidactylus turcicus* on the Sinai Peninsula. It is possible

most of the records of the Turkish gecko on the Red Sea coast of Sinai should be referred to *Hemidactylus granosus*. Another interesting addition to the Sinai herpetofauna is *Pseudotrapelus aqabensis* known before only from Aqaba. This is a close relative of *P. sinaitus*, and it is very likely that a subspecies form inhabits the Taba upland and north-eastern part of the Sinai Mountains. Therefore two new lizard species are here added to the Sinai herpetofauna.

The native herpetofauna of the Eastern Desert is comparatively poor, and includes 51 reptile species. Biogeographically, most species relate to the Saharo-Sindian (33.3%) and Ethiopian (33.3%) groups. Remaining biogeographic groups are represented to a lesser extent: Saharan (13.7%), Arabian (9.8%), endemics and subendemics of the Eastern Desert (7.9%), Mediterranean (2%), and three invasive species (Table 2). Species of the Eastern Desert are represented by plain-dwellers that live in the gravel desert and rocky outcrops (*Mesalina guttulata*, *Echis coloratus*), sand desert (*Acanthodactylus aegyptius*, *A. boskianus*, *Scincus scincus*, *Cerastes cerastes*) and mountainous landscape (*Pseudotrapelus chlodnickii*, *Ptyodactylus* sp.). Some psammophylous species occupy a specific biotope of sandy coastal dunes (*Acanthodactylus boskianus*, *Mesalina martini*), the sandy beaches are also used for nesting sites by sea turtles. In general the herpetofauna of the Eastern Desert is low in species richness, several species (*Latastia longicaudata*, *Pseudemias mucronata*, *Psammophis punctulatus*, *Naja nubiae*, *Tropicolotes bisharicus*, *Ophisops elbanensis*) occur strictly in the southernmost part on the border with the Nubian Desert, penetrating only to the most humid part of the Eastern Desert.

TABLE 1. Biogeographic Affinities of the Terrestrial Reptile Species from Sinai

Biogeographic group	Species	%
Saharo-Sindian	<i>Ptyodactylus hasselquistii</i> , <i>Stenodactylus stenodactylus</i> , <i>Acanthodactylus boskianus</i> , <i>A. scutellatus</i> , <i>Mesalina guttulata</i> , <i>M. olivieri</i> , <i>Chalcides ocellatus</i> , <i>Varanus griseus</i> , <i>Myriopholis macrorhyncha</i> , <i>Lytorhynchus diadema</i> , <i>Spalerosophis diadema</i> , <i>Platyceps rogersi</i> , <i>P. saharicus</i> , <i>Malpolon moilensis</i> , <i>Psammophis schokari</i> , <i>Cerastes cerastes</i> , <i>Cerastes vipera</i> , <i>Echis coloratus</i>	27.7
Arabian	<i>Cyrtopodion scabrum</i> , <i>Hemidactylus granosus</i> , <i>Tropicolotes nattereri</i> , <i>Pseudotrapelus aqabensis</i> , <i>Trapelus pallidus</i> , <i>Uromastix aegyptia</i> , <i>Uromastix ornata</i> , <i>Mesalina brevirostris</i> , <i>Telescopus dhara</i> , <i>Atractaspis engaddensis</i> , <i>Walterinnesia aegyptia</i> , <i>Pseudocerastes fieldi</i>	18.5
Mediterranean	<i>Testudo kleinmanni</i> , <i>Hemidactylus turcicus</i> , <i>Tarentola mauritanica</i> , <i>Laudakia stellio</i> , <i>Chamaeleo chamaeleon</i> , <i>Ophisops elegans</i> , <i>Ablepharus rueppellii</i> , <i>Eumeces schneideri</i> , <i>Trachylepis vittata</i> , <i>Xerotyphlops vermicularis</i> , <i>Eryx jaculus</i> , <i>Eirenis coronella</i> , <i>Hemorrhoids nummifer</i> , <i>Hierophis jugularis</i> , <i>Macroprotodon cucullatus</i> , <i>Rhynchocalamus melanocephalus</i> , <i>Malpolon monspessulanus</i>	26.1
Saharan	<i>Stenodactylus petrii</i> , <i>Tropicolotes steudneri</i> , <i>Pseudotrapelus chlodnickii</i> , <i>Acanthodactylus aegyptius</i> , <i>Mesalina rubropunctata</i> , <i>Scincus scincus</i> , <i>Sphenops sepsoides</i> , <i>Psammophis aegyptius</i>	12.3
Ethiopian	<i>Myriopholis cairi</i> , <i>Platyceps florulentus</i> , <i>Psammophis sibilans</i>	4.6
Sinai endemic and subendemic	<i>Hemidactylus mindiae</i> , <i>Ptyodactylus guttatus</i> , <i>Pseudotrapelus sinaitus</i> , <i>Trapelus savignii</i> , <i>Mesalina bahaeldini</i> , <i>Platyceps sinai</i> , <i>Telescopus hoogstraali</i>	10.8
Introduced	<i>Hemidactylus flaviviridis</i> , <i>Trachylepis quinquetaeniata</i> , <i>Indotyphlops braminus</i>	—

The herpetofauna of the North Eastern Desert is enriched by Mediterranean and Saharan elements, and includes 30 native reptile species. The most arid Central Eastern Deserts are inhabited by only 27 reptile species. The herpetofauna of the South Eastern Desert is notably diverse (38 species) and includes all endemics of the Eastern Desert. The biological diversity of south-eastern Egypt, especially the Gebel Elba mountains is very high and includes a number of endemics and a number of species that represent the northern outpost of the biota of the Ethiopian highlands (Abd El-Ghani and Abdel-Khalik, 2006).

One of the Eastern Desert endemics, *Ptyodactylus siphonorhinus* is a sporadically distributed species on the Red Sea coast and sometimes replaces the more abundant species, *Ptyodactylus hasselquistii* in anthropogenic habitats. A record of this mountain-dwelling species on the coast near Marsa Alam confirms its sporadic distribution pattern in the Eastern Desert. Another species, *Ptyodactylus h. hasselquistii*, unusually bright colored geckoes were recorded in the southern part of species range. Baha-El-Din (1999) reported similar geckoes as *Ptyodactylus ragazzii* (see photo in Baha-El-Din, 2006) for southern Egypt on the basis of specimens from Gebel Elba. The presence of *Ptyodactylus ragazzii* (Baha-El-Din, 2006) in the south of the Eastern Desert has not been confirmed by recent investigations (Metallinou et al., 2015), but it is possible according to Baha-El-Din (1999). It seems like that *Ptyodactylus ragazzii* is represented by an isolated relict population on the range margin in Gebel Elba.

Three or four invasive species of herpetofauna now occur in the Eastern Desert (*Hemidactylus flaviviridis*, *Trachylepis quinquetaeniata*, *Indotyphlops braminus*

and, possibly, *H. turcicus*). *T. quinquetaeniata* was recorded for the first time in Sharm-El-Sheikh in 2003, and now inhabits several oases on the sea coast where this species occurs in anthropogenic sites with man-made irrigation. One or possibly two gecko species and blind-snake also were introduced by man.

The two most common species of sea turtles in the Red Sea have a pantropical distribution and are represented by subspecies (*Chelonia mydas japonica*, *Eretmochelys imbricata bissa*) in the Indian and Pacific Oceans (Formia et al., 2006; Bowen and Karl, 2007).

As mentioned above the Eastern Desert is hyperarid and characterized by the absence of such faunal groups as amphibians, terrestrial testudines, boid snakes (excluding *Eryx colubrinus* in Gebel Elba) and many meso- and hydrophilic species living in Northern Egypt, the Nile Valley and the comparatively moist Nubian Desert (excluding the Gebel Elba region).

The most diverse groups of reptiles in the Eastern Desert and Sinai Peninsula are Gekkonidae, Lacertidae, Colubridae, Lamprophiidae, and Viperidae (Table 3). The geckoes are a dominant group in all subregions of Sinai and Eastern Desert, whereas scincids and colubrids are more diverse in Sinai. Thus the gekkonid lizards are the most diversified group of reptiles, and best adapted to habitation in the hyperarid deserts of Egypt.

The number of endemic and subendemic species in Sinai and Eastern Desert are not equal; this may be explained by the unique position of Sinai at the junction of the Saharan, Arabian and Mediterranean faunas. Sinai endemics and subendemics occur in both the north and south parts of Peninsula. East Desert endemics are concentrated mainly in the South Eastern Desert.

TABLE 2. Biogeographic Affinities of the Terrestrial Reptile Species from Eastern Desert

Biogeographic group	Species	%
Saharo-Sindian	<i>Ptyodactylus hasselquistii</i> , <i>Stenodactylus stenodactylus</i> , <i>Acanthodactylus boskianus</i> , <i>A. scutellatus</i> , <i>Mesalina guttulata</i> , <i>M. olivieri</i> , <i>Chalcides ocellatus</i> , <i>Varanus griseus</i> , <i>Lytrohynchus diadema</i> , <i>Spalerosophis diadema</i> , <i>Platycephalus rogersi</i> , <i>P. saharicus</i> , <i>Malpolon moilensis</i> , <i>Psammophis schokari</i> , <i>Cerastes cerastes</i> , <i>C. vipera</i> , <i>Echis coloratus</i>	33.3
Arabian	<i>Cyrtopodion scabrum</i> , <i>Trapelus pallidus</i> , <i>Uromastix aegyptia</i> , <i>Myriopholis nursii</i> , <i>Walterinnesia aegyptia</i>	9.8
Mediterranean	<i>Hemidactylus turcicus</i>	2.0
Saharan	<i>Tropicolotes steudneri</i> , <i>Pseudotrapelus chlodnickii</i> , <i>Acanthodactylus aegyptius</i> , <i>Mesalina rubropunctata</i> , <i>Scincus scincus</i> , <i>Sphenops sepsoides</i> , <i>Psammophis aegyptius</i>	13.7
Ethiopian	<i>Ptyodactylus ragazzii</i> , <i>Hemidactylus robustus</i> , <i>Hemidactylus sinaitus</i> , <i>Pristurus flavipunctatus</i> , <i>Tarentola annularis</i> , <i>Agama spinosa</i> , <i>Uromastix ocellata</i> , <i>Latastia longicaudata</i> , <i>Mesalina martini</i> , <i>Pseudemias mucronata</i> , <i>Chalcides humilis</i> , <i>Myriopholis cairi</i> , <i>Eryx colubrinus</i> , <i>Telescopus obtusus</i> , <i>Psammophis punctulatus</i> , <i>Naja nubiae</i> , <i>Echis pyramidum</i>	33.3
Eastern Desert endemic and subendemic	<i>Hemidactylus foudaii</i> , <i>Ptyodactylus siphonorhinus</i> , <i>Tropicolotes bisharicus</i> , <i>Ophisops elbanensis</i>	7.8
Introduced	<i>Hemidactylus flaviviridis</i> , <i>Trachylepis quinquetaeniata</i> , <i>Indotyphlops braminus</i>	—

TABLE 3. Number of the Terrestrial Reptile Species in Subregions of Eastern Egypt

Number of the native reptile species	North Sinai	South Sinai	North Eastern Desert	Central Eastern Desert	South Eastern Desert
Testudinidae	1	—	—	—	—
Gekkonidae	7	10	6	10	12
Agamidae	6	7	5	3	3
Chamaeleonidae	1	—	—	—	—
Lacertidae	8	6	5	6	7
Scincidae	6	4	3	1	1
Varanidae	1	1	1	1	1
Typhlopidae	1	—	—	—	—
Leptotyphlopidae	—	2	—	—	1
Boidae	1	—	—	—	1
Colubridae	11	10	3	1	4
Lamprophiidae	4	3	3	3	3
Elapidae	1	1	1	—	1
Viperidae	4	4	3	2	4
Total	52	48	30	27	38
Endemic and subendemic species	3	4	1	2	4
Invasive species	—	3	2	1	—

TABLE 4. Quotients (%) of Similarity Obtained from Comparing Total Sinai and Eastern Desert Subregion Assemblages between Five Units, Gamma Diversity in Each Case

Subregions	North Sinai	South Sinai	North Eastern Desert	Central Eastern Desert	South Eastern Desert
North Sinai	—	70	56	38	31
South Sinai	70	—	59	45	42
North Eastern Desert	56	59	—	77	59
Central Eastern Desert	38	45	77	—	71
South Eastern Desert	31	42	59	71	—

The Quotient of Similarity of the herpetofauna of the Sinai Peninsula and Eastern Desert is 52%. The difference in the number of species in North Sinai and South Sinai is not significant (Table 4). The South Eastern Desert subregion has the highest species diversity among the subregions of the Eastern Desert (38 species). The greatest similarity of herpetofaunas is found between the North Eastern Desert and Central Eastern Desert (77%), Central Eastern Desert and the South Eastern Desert (71%), Northern and Southern Sinai (70%).

The Red Sea coast is one of three important dispersal corridors in Saharan Africa (Brito et al., 2013). Migration of the Sahelian and Ethiopian fauna occurs along the Red Sea coast up to the Mediterranean coast and Sinai, and is related to the mild climate influenced by the proximity of the sea.

The Arabian, Sahelian and Ethiopian species migrated to the Mediterranean coast and Sinai along the sea. The Arabian and East Desert species migrated backwards to the Eastern Sahel and Ethiopia. Relict populations of Ethiopian species in the Gebel Elba region (*Ptyodactylus*

ragazzii, *Latastia longicaudata*, *Psammophis punctulatus*, *Naja nubiae*) are the result of these transitions. The modern extreme climatic conditions in the Eastern Desert results in faunistic depletion that is especially noticeable in the Central Eastern Desert. Now only the South Eastern Desert comprises a large portion of Ethiopian species and several endemics.

Analyses of the biodiversity and estimation of endemism rates for each subregion results in recognition of the mountainous region of the South Sinai and southern part of the South Eastern Desert as biodiversity hotspots in the Eastern Egyptian deserts.

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