

DOI: 10.30906/1026-2296-2019-26-3-175-184

## FIRST REPORT ON THE REPTILE DIVERSITY OF WADI EL GEMAL NATIONAL PARK, EASTERN DESERT, EGYPT

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*Submitted February 26, 2019*

The herpetofauna of Wadi El Gemal National Park, Eastern Desert, Egypt currently includes 28 reptile species. Three large wadies, Wadi El Gemal, Wadi Abu Ghusoun and Wadi Sartout, were observed as a model of the species composition within the national park. Species assemblages, taxonomic and ecological diversity, and the biogeographical affinities of reptiles in the specific environment of the hyperarid desert are discussed.

**Keywords:** reptiles; herpetofauna; biodiversity; zoogeography; Egypt; Eastern Desert.

### INTRODUCTION

The Eastern Desert is a hyperarid desert, located between the Nile Valley and the Red Sea coast. Orologically, the Eastern Desert is a medium elevated plateau. The wadies that bisect the mountains and the plateau of the Eastern Desert provide natural routes between the well-drained landscapes of the Nile Valley and the Red Sea coastal zone. The Eastern Desert is divided geologically into three distinctive terrains: the North Eastern Desert, the Central Eastern Desert, and the South Eastern Desert. The Central Eastern Desert occupies the central part of the Eastern Desert and is characterized by the lowest concentration of granitic rocks and the greatest concentration of rocks with strong oceanic affinities (Stern and Hedge, 1985).

Wadi Ghemal National Park is located in the south-eastern part of the Central Eastern Desert and its territory of 4770 km<sup>2</sup> spreads from the Hamata mountains to the Red Sea coastal islands. The high mountain region occu-

pies the south-western corner of the park. It is a hyperarid desert zone characterized by a monthly mean temperature of 30°C in the summer and no lower than 10°C in the winter. Annual precipitation does not exceed 50 mm (Babayev et al., 1986).

The huge territory of this national park is a medium elevated plateau, dissected by a dense system of wadies. The largest wadi in the park is Wadi El Gemal, which originates in the Red Sea mountainous terrain and extends easterly to the Red Sea coast. This wadi is bound on both sides by elements of these high ridges of igneous rocks, which, due to frequent changes in their orientation, result in a meandering course. The bed of the Wadi is lined with clastic rocks, sand or pebbles. Depending on the substrate and hydro-regime, different plant communities are formed in the wadies. Two different types of plant communities are usually recognized in the Wadi El Gemal. The main part of the wadi bed is occupied by a community of xerophytic vegetation with the next most dominant species: *Senna italica*, *Zilla spinosa*, *Pulicaria undulata*, and *Panicum turgidum*. Another vegetation community, composed of *Zygophyllum coccineum*, *Limonium axillare*, and *Tamarix aphylla*, is distributed in the deltaic part of the wadi, which is characterized by relatively moist soils (El-Sharkawi et al., 1982; Mahmoud, 2010).

Wadies contain vegetation that is richer than that of other types of desert landforms and habitats that are accessible to many terrestrial vertebrate species, and firstly, reptiles. At present, 51 reptile species have been docu-

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mented in the Eastern Desert and 27 species have been documented in the Central Eastern Desert (Baha El Din, 2006; Milto, 2017).

Despite the well-studied flora of the Eastern Desert and Wadi El Gemal National Park (El-Sharkawi et al., 1982; Mahmoud, 2010; Galal, 2011; Galal and Fahmy, 2012; Mahmoud and Gairola, 2013), zoological studies have been relatively infrequent (Frazier and Salas, 1984; Baha El Din, 2006; Attum et al., 2009). In fact, there have been no vertebrate diversity studies in the territory of Wadi El Gemal National Park. Data on herpetofauna is not complete and only documented in Baha El Din (2006). In this paper, we discuss the diversity and biogeography of reptiles in this national park and the Central Eastern Desert of Egypt.

## MATERIAL AND METHODS

We conducted herpetological surveys in Wadi El Gemal National Park in September – October 2014, May 2015, January 2017 and March – April 2018. Nine wadies in protected area were observed: Wadi Lahmi, Wadi El Gemal, Wadi Abu Ghosoun, Wadi El Abyad, Wadi Sartout, Wadi Huluz, Wadi Nugruz, Wadi Skeet, and Wadi Al Mokhatatah (Fig. 1).

The inventory techniques included random quadrat searches, cruise collecting along transects, and general random collecting. All suitable habitats — sand and gravel wadi beds, wadi sides, rocky slopes, small gorges and rocky wadies, sandy areas, bushes, trunks of trees (*Acacia*, *Balanites*), sand dunes and building walls — were observed. The following information was recorded for each specimen: date, locality, approximate time of collection, microhabitat, elevation, age and sex. Photographs of animals and biotopes was taken *in situ*, and all records were tied to GPS coordinates. The preliminary description of vegetation included dominant species and was based on field observations along transects in the most typical reptile habitats.

## RESULTS AND DISCUSSION

### Checklist

Our survey of field work in the park resulted in 111 records of 20 reptile species (*Hemidactylus robustus* Heyden, *Pristurus flavipunctatus* Rüppell, *Ptyodactylus hasselquistii* (Donndorff), *Ptyodactylus siphonorhinus* Anderson, *Stenodactylus sthenodactylus* (Lichtenstein), *Tropiocolotes bisharicus* Baha El Din, *Tropiocolotes steudneri* (Peters), *Agama spinosa* Gray, *Pseudotrapelus chlodnickii* Melnikov, Śmiełowski, Melnikova, Nazarov

et Ananjeva, *Uromastix ocellata* Lichtenstein, *Acanthodactylus boskianus* (Daudin), *Mesalina guttulata* (Lichtenstein), *Mesalina rubropunctata* (Lichtenstein), *Ophisops elbaensis* Schmidt et Marx, *Varanus griseus* (Daudin), *Spalerosophis diadema* (Schlegel), *Psammophis aegyptius* Marx, *Cerastes cerastes* (Linnaeus), see Figs. 2 and 3). Herein, we provide three new species records for Wadi El Gemal National Park (*Ophisops elbaensis*, *Varanus griseus*, and *Spalerosophis diadema*) and two new species records for the Central Eastern Desert (*Ophisops elbaensis* and *Spalerosophis diadema*). Range extensions into the Eastern Desert for two reptile species (*Tropiocolotes bisharicus* and *Ophisops elbaensis*) were also recorded (Milto et al., 2018). According to an analysis of our data and literature sources, 28 reptile species belonging to 22 genera and 11 families were documented in Wadi El Gemal National Park (Table 1).

### Species assemblages — $\alpha$ Diversity

The total and component compositions of the three typical wadi herpetofaunas are summarized here. These three wadies, Wadi El Gemal, Wadi Abu Ghosoun and Wadi Sartout, were observed as a model of species composition in the national park. Wadi El Gemal extends in the west-east direction and is characterized by the most diverse environmental conditions, such as soil type, plant communities and animal species assemblages. The remaining wadies were less-intensely surveyed and, as expected, their species counts were lower. Thus, these herpetofaunas serve as touchstones for the less-thoroughly inventoried sites.

1.1. The upper stream of Wadi El Gemal (24°33'31.5" N 34°48'22.6" E – 24°32'15.0" N 34°44'39.8" E) is an enlarged sandy valley, passing into a plain. Woody perennials are represented here by the sparse trees of *Acacia tortilis* and *Balanites aegyptiaca*, and the sporadic distributed bush species *Leptadenia pyrotechnica*. Ground vegetation is well-developed and composed mainly of *Zilla spinosa* and sporadically of *Cotula cinerea* and *Citrullus colocynthis*. A number of reptile species were recorded here: *Agama spinosa*, *Uromastix ocellata*, *Acanthodactylus boskianus*, *Mesalina guttulata*, *Ptyodactylus hasselquistii*, *P. siphonorhinus*, *Stenodactylus sthenodactylus*, *Psammophis aegyptius*, and *Cerastes cerastes*. A dominance of the terrestrial ground dwelling species and a small portion of the petrophilous species, such as *Agama spinosa*, *Ptyodactylus hasselquistii*, *P. siphonorhinus*, recorded mainly on the high rock habitats, are typical for this area (Table 1).

1.2. In the middle stream of Wadi El Gemal, our study area was located near the confluence with Wadi Al Mokhatatah (24°33'45.9" N 34°51'21.1" E). There are



Fig. 1. Typical landscapes of Wadi El Gemal National Park: a, Wadi El Gemal, middle stream; b, Wadi Sartout.



**Fig. 2.** Gekkonid, phyllodactylid and sphaerodactylid lizards from Wadi El Gemal National Park: *a*, *Stenodactylus sthenodactylus*, Wadi El Gemal; *b*, *Tropicolotes bisharicus*, Wadi Sartout; *c*, *Tropicolotes steudneri*, Wadi El Ghusoun; *d*, *Tropicolotes steudneri*, Wadi El Gemal; *e*, *Ptyodactylus hasselquistii*, Wadi Sartout; *f*, *Ptyodactylus siphonorhinus*, Wadi El Gemal; *g*, *Tarentola annularis*, near southern border of national park; *h*, *Pristurus flavipunctatus*, Wadi El Gemal.



**Fig. 3.** Agamid and lacertid lizards and snakes from Wadi El Gemal National Park: *a*, *Agama spinosa*, Wadi El Gemal; *b*, *Pseudotrapelus chlodnickii*, Wadi Sartout; *c*, *Uromastix ocellata*, Wadi Sartout; *d*, *Acanthodactylus boskianus*, Wadi El Gemal; *e*, *Mesalina guttulata*, Wadi El Gemal; *f*, *Psammophis aegyptius*, Wadi Abu Ghusun; *g*, *Cerastes cerastes*, near southern border of national park; *h*, *Echis coloratus*, near southern border of national park.

wide valleys with sandy-clay bottoms and fixed dunes. Woody plants were represented by *Acacia tortilis* and *Balanites aegyptiaca*, and in the lower part of the wadi, near the delta associates, *Tamarix nilotica* and *Zygophyllum coccineum* are found. The hillocks in the central part are sporadically covered by the large bushes of *Salvadora persica*, and the associates are *Zilla spinosa*, *Leptadenia pyrotechnica*, *Pulicaria undulata*, and *Zygophyllum coccineum*. The wadi bed is inhabited by several species

of reptiles: *Uromastix ocellata*, *Tropicolotes steudneri*, *Acanthodactylus boskianus*, *Mesalina guttulata*, *Psammophis aegyptius*, *Spalerosophis diadema*, *Cerastes cerastes*, and *Varanus griseus*. *Pristurus flavipunctatus* was encountered on the *Balanites* trunks. Wadi walls and rocks are a suitable habitat for *Agama spinosa*, *Ptyodactylus hasselquistii*, *P. siphonorhinus*; rocks, screes and rocky slopes are inhabited by *Uromastix ocellata*, *Mesalina guttulata*, and *Psammophis aegyptius*.

**TABLE 1.** Locality Records and Habitats of Reptiles from Wadi El Gemal National Park

Species	Locality records	Habitat	Sources
<i>Hemidactylus robustus</i>	Wadi Lahmi	On the buildings, rare on the ground	Baha El Din, 2006; Milto, 2017
<i>Hemidactylus turcicus</i>	Wadi El Gemal Island, Qulan Island	On the buildings, rare on the ground	Baha El Din, 2006
<i>Pristurus flavipunctatus</i>	Wadi Lahmi, Wadi El Gemal, Gebel Hamata, Wadi Abu Ghusoun, Wadi Sartout	<i>Acacia</i> , <i>Balanites</i> , and <i>Tamarix</i> trees	Baha El Din, 2006; Milto, 2017; Our data
<i>Ptyodactylus hasselquistii</i>	Wadi El Gemal, Wadi Abu Ghusoun, Wadi Sartout, Wadi Huluz, Wadi Lahmi	Rocks, boulders, ledges, <i>Acacia</i> trees, building walls	Baha El Din, 2006; Milto, 2017; Our data
<i>Ptyodactylus siphonorhinus</i>	Wadi El Gemal, Wadi Abu Ghusoun, Wadi Sartout	Rocks, boulders, ledges, wadi walls	Our data
<i>Stenodactylus sthenodactylus</i>	Wadi El Gemal	Sandy wadi bed	Our data
<i>Tarentola annularis</i>	Wadi El Gemal	Cliffs, boulders, buildings, ruins	Baha El Din, 2006
<i>Tropicolotes bisharicus</i>	Wadi El Rada, Wadi Sartout	Sandy wadi bed with boulders and <i>Acacia</i> trees	Baha El Din, 2006; Our data
<i>Tropicolotes steudneri</i>	Wadi El Gemal, Wadi Abu Ghusoun, Wadi Lahmi	Sandy wadi beds, sandy plain with small ledges	Baha El Din, 2006; Milto, 2017; Our data
<i>Agama spinosa</i>	Wadi El Gemal, Wadi Abu Ghusoun, Wadi Sartout, Wadi Al Mokhatatah, Wadi Huluz, Wadi Nugruz	Rocks, cliffs, and rocky wadies	Baha El Din, 2006; Our data
<i>Pseudotrapelus chlodnickii</i>	Wadi Abu Ghusoun, Wadi Sartout	Boulders, rocky slopes, rocky outcrops	Baha El Din, 2006; Our data
<i>Uromastix ocellata</i>	Wadi El Gemal, Wadi Abu Ghusoun, Wadi Sartout, Wadi Nugruz, Wadi Seket	Mountainous deserts, wadies with rocky sides and <i>Acacia</i> trees	Baha El Din, 2006; Our data
<i>Acanthodactylus boskianus</i>	Wadi El Gemal, Wadi Abu Ghusoun, Wadi Nugruz, Wadi Huluz, Wadi Lahmi	Coarse substrate with moderate vegetation, sandy wadi beds, littoral dunes	Baha El Din, 2006; Milto, 2017; Our data
<i>Acanthodactylus scutellatus</i>	Wadi El Gemal	Sandy plains, dunes, sandy wadies	Baha El Din, 2006
<i>Mesalina guttulata</i>	Wadi El Gemal, Wadi Sartout, Wadi Huluz, Wadi Lahmi	Gravel plain with stones in mountains, small rocky wadies	Baha El Din, 2006; Milto, 2017; Our data
<i>Mesalina martini</i>	Wadi El Gemal	Sandy substrate among halophytic vegetation	Baha El Din, 2006
<i>Mesalina rubropunctata</i>	Red Sea coastal plain, Wadi El Gemal Island, Wadi Lahmi	Sandy and gravelly deserts, wide sandy wadies	Baha El Din, 2006; Milto, 2017
<i>Ophisops elbaensis</i>	Wadi Sartout	Rocky slopes of the hills	Our data
<i>Varanus griseus</i>	Wadi El Gemal	Sand and gravel wadi	Our data
<i>Chalcides ocellatus</i>	Wadi El Gemal	Littoral marshes in the mouth of wadi	Baha El Din, 2006
<i>Rhagerhis moilensis</i>	Coastal plain	Littoral marshes	Baha El Din, 2006
<i>Platycephalus saharicus</i>	Coastal plain	Rocky areas, wadies	Baha El Din, 2006
<i>Psammophis aegyptius</i>	Wadi El Gemal, Wadi Abu Ghusoun, Wadi Huluz, Wadi El Qulan	Sandy wadi beds with stones, rocky slopes, <i>Acacia</i> trees	Baha El Din, 2006; Gonçalves et al., 2018; Our data
<i>Spalerosophis diadema</i>	Wadi El Gemal	Rocky wadi side	Our data
<i>Cerastes cerastes</i>	Wadi El Gemal	Sandy and gravel wadies with vegetation	Baha El Din, 2006; Our data
<i>Echis coloratus</i>	Widespread in the Eastern Desert	Slopes with boulders, rocky wadies	Baha El Din, 2006
<i>Chelonia mydas</i>	Qulan islands, Wadi El Gemal islands, Marsa Wadi Gemal, Sharm El Luli	Sandy bays with sea grass bed	Baha El Din, 2006; Milto, 2017
<i>Eretmochelys imbricata</i>	Qulan islands, Wadi El Gemal islands, Marsa Wadi Gemal, Marsa Wadi Lahmi	Along the coral reefs in shallow waters	Baha El Din, 2006; Milto, 2017

1.3. The lower stream of Wadi El Gemal (24°38'33.0" N 35°02'30.7" E – 24°39'53.7" N 35°06'33.6" E) is a wide valley passing into a coastal plain. The wadi flow is a sand desert with a number of stones and boulders. The dominant plant association is composed of *Zilla spinosa*, *Zygophyllum coccineum*, *Z. simplex* and large specimens of *Tamarix nilotica*, forming accumulated sand hillocks. The coastal part represents a plain with saline soil and typical halophytic vegetation. Near the foot of the coastal mountains, *Acacia tortilis* and *Balanites aegyptiacus* were found in small numbers. Reptiles were represented by a number of species. Everywhere, we encountered the ubiquitous species *Acanthodactylus boskianus*, and the foothills were inhabited by *Pristurus flavipunctatus*. According to Baha El Din (2006), some species were found only on the coastal plain: *Acanthodactylus scutellatus*, *Mesalina martini*, *M. rubropunctata*, and *Platycephalus saharicus*. The specific habitat of the littoral marshes is suitable for a single reptile species, *Chalcides ocellatus*. The deltaic part of Wadi El Gemal is characterized by an original plant community of the coastal plain (*Zygophyllum album*, *Sarcocornia fruticosa*, *Suaeda monoica*, *Tamarix nilotica*, *T. aphylla*). A specific herpetocomplex of plain dweller species is formed here. In addition, the littoral zone of the Marsa Wadi Gemal is the habitat and breeding place for two marine species — *Chelonia mydas* and *Eretmochelys imbricata*.

2. Wadi Abu Ghusun (24°16'50.5" N 35°00'15.4" E – 24°25'08.2" N 35°07'29.3" E) is a wadi with sand flow and a rarefied association of *Acacia tortilis* and *Balanites aegyptiacus*. A monodominant association of *Acacia tortilis* is typical for the deltaic part. *Pulicaria incisa* and *Zygophyllum simplex* are common in the wadi. The following reptiles were recorded here: *Agama spinosa*, *Pseudotrapelus chlodnickii*, *Uromastix ocellata*, *Ptyodactylus hasselquistii*, *P. siphonorhinus*, *Pristurus flavipunctatus*, *Tropicolotes steudneri*, and *Psammophis aegyptius*. A high-density population of *Tropicolotes steudneri* was registered on the wadi bed.

3. Wadi Sartout (24°19'21.6" N 35°01'23.0" E – 24°16'33.1" N 34°59'51.9" E) is one of the wadies with a relatively humid condition. The upper stream of the wadi is a rocky gorge where small permanent water bodies exist throughout the year and is characterized by the following mesophyllic plant species: *Juncus rigidus*, *Imperata cylindrica*, *Phragmites australis*, and even *Adiantum capillus-veneris*, which grows around the springs. *Moringa peregrina*, *Tamarix nilotica*, and the rare species *Rhus tripartita* also occur here. The lower and middle part of the wadi are characterized by a sand floor and well-developed associations of *Acacia tortilis* and *Zilla*

*spinosa*. A rich diversity of both plant and animal species is typical for this wadi. Apparently, the proximity of the water sources and, as a consequence, the best moisture regime, allow mesophilic and rare species, such as *Ophisops elbaensis*, to exist here. Another rare species, *Tropicolotes bisharicus*, lives here, on the northern limit of its distribution. *Mesalina guttulata*, *Ptyodactylus hasselquistii*, *P. siphonorhinus*, *Pristurus flavipunctatus*, *Agama spinosa*, *Pseudotrapelus chlodnickii*, *Uromastix ocellata*, and *Psammophis aegyptius* are common too.

#### Taxonomic and Ecological Groups — $\beta$ Diversity

Gekkota is the most taxonomically diverse group of reptiles in the Wadi Gemal National Park, including nine species in three families. Geckos occupy many different types of habitat: rocks, wadi walls, gorges and small rocky wadies, separately lying boulders, wadi beds and desert, and tree trunks. Several species were found exclusively or primarily on the vertical rocks, and sometimes on the *Acacia* trees (*Ptyodactylus hasselquistii*), on the rocks and boulders (*P. hasselquistii*, *P. siphonorhinus*), on the trees only (*Pristurus flavipunctatus*) and exclusively on the ground (*Stenodactylus stenodactylus*). All gecko species form three ecological groups, including petrophilous (5 species), terrestrial (3 species) and arboreal (1 species) species. Moreover, both species of *Ptyodactylus* were recorded frequently on the big stones and boulders and demonstrated the facultative petrodophilous (*P. hasselquistii* and *P. siphonorhinus*) or facultative arboreal modes of life (*P. hasselquistii* on *Acacia* trees); only *Pristurus flavipunctatus* was completely arboreal (Table 2).

The second most diverse group in the deserts of Wadi El Gemal is Lacertidae, with six terrestrial species. *Acanthodactylus boskianus* and *Mesalina guttulata* are the two most common and abundant eurytopic species. Two obligate psammophilic species, *Acanthodactylus scutellatus* and *Mesalina martini*, were recorded locally in Wadi Gemal and evidently did not have a wide distribution. Heavily dissected landscapes led to the long-term isolation of sand areas. In general, a near absence of psammophilous species is a typical characteristic for the Central Eastern Desert.

Agamid lizards are represented by three ecologically separate species. A typical petrophilous species, *Agama spinosa*, inhabits rocks, the upper line of the wadi sides and other vertical sites. *Pseudotrapelus chlodnickii* is a petrodophilous species that mainly inhabits large boulders, the lower line of rocks, small rocky ridges and outcrops. A third species, *Uromastix ocellata*, was recorded only in mountainous and foothills areas, where it inhab-

**TABLE 2.** Biogeographic Affinities and Ecological Groups of Reptile Species from Wadi El Gemal National Park

Species	Family	Biographic affinities	Ecological group
<i>Hemidactylus robustus</i>	Gekkonidae	Ethiopian	Petrophilous
<i>Hemidactylus turcicus</i>	Gekkonidae	Mediterranean	Petrophilous
<i>Stenodactylus sthenodactylus</i>	Gekkonidae	Saharo-Sindian	Terrestrial
<i>Tropiocolotes bisharicus</i>	Gekkonidae	Eastern Desert subendemic	Terrestrial
<i>Tropiocolotes steudneri</i>	Gekkonidae	Saharan	Terrestrial
<i>Ptyodactylus hasselquistii</i>	Phyllodactylidae	Saharo-Sindian	Petrophilous/petrodophilous/arboreal
<i>Ptyodactylus siphonorhinus</i>	Phyllodactylidae	Eastern Desert subendemic	Petrophilous/petrodophilous
<i>Tarentola annularis</i>	Phyllodactylidae	Ethiopian	Petrophilous
<i>Pristurus flavipunctatus</i>	Sphaerodactylidae	Ethiopian	Arboreal
<i>Agama spinosa</i>	Agamidae	Ethiopian	Petrophilous
<i>Pseudotrapelus chlodnickii</i>	Agamidae	Saharan	Petrodophilous
<i>Uromastyx ocellata</i>	Agamidae	Ethiopian	Terrestrial/petrodophilous
<i>Acanthodactylus boskianus</i>	Lacertidae	Saharo-Sindian	Terrestrial
<i>Acanthodactylus scutellatus</i>	Lacertidae	Saharo-Sindian	Terrestrial
<i>Mesalina guttulata</i>	Lacertidae	Saharo-Sindian	Terrestrial
<i>Mesalina martini</i>	Lacertidae	Ethiopian	Terrestrial
<i>Mesalina rubropunctata</i>	Lacertidae	Saharan	Terrestrial
<i>Ophisops elbaensis</i>	Lacertidae	Eastern Desert subendemic	Terrestrial
<i>Chalcides ocellatus</i>	Scincidae	Saharo-Sindian	Terrestrial
<i>Varanus griseus</i>	Varanidae	Saharo-Sindian	Terrestrial
<i>Platyceps saharicus</i>	Colubridae	Saharo-Sindian	Terrestrial
<i>Spalerosophis diadema</i>	Colubridae	Saharo-Sindian	Terrestrial
<i>Rhagerhis moilensis</i>	Lamprophiidae	Saharo-Sindian	Terrestrial
<i>Psammophis aegyptius</i>	Lamprophiidae	Saharan	Terrestrial/semiarboreal
<i>Cerastes cerastes</i>	Viperidae	Saharo-Sindian	Terrestrial
<i>Echis coloratus</i>	Viperidae	Saharo-Sindian	Terrestrial
<i>Chelonia mydas</i>	Cheloniidae	Circum-subtropical	Aquatic
<i>Eretmochelys imbricata</i>	Cheloniidae	Pantropical	Aquatic

ited wadies, gorges and rocks and can be attributed to the terrestrial/petrodophilous ecological type.

Other families are represented by one to two mainly terrestrial species (Table 2). Only *Psammophis aegyptius* was registered in the different habitats, including wadi beds, rocks and trees, and sometimes demonstrated a rather semiarboreal mode of life.

A weakly developed woody perennial in the Wadi El Gemal National Park is the cause of the almost complete absence of arboreal species (3.9%). There are only three species that use tree trunks as their habitat: the obligate arboreal *Pristurus flavipunctatus* and two occasionally arboreal species, *Ptyodactylus hasselquistii* and *Psammophis aegyptius*. The absence of a river net and permanent water bodies, with the exception of a small number of waterholes located at the source of the wadies, led to a lack of freshwater non-marine species. The terrestrial species (65.4%) are the most represented ecogroup and includes psammophilic, sclerophilic and eurytopic species. The second most represented ecogroup is the petrophilous (23%) ecological group, represented by saxico-

philous and mountain dwelling species. A petrodophil species group (7.7%) can be considered an intermediate between the petrophilous and terrestrial groups. An interesting feature of the studied territory is an extremely low percentage of psammophilic species among the ground-dwellers (11.8%), with both species, *Acanthodactylus scutellatus* and *Mesalina martini*, recorded in a single locality each.

The diversity of reptiles both in the Central Eastern Desert and in the Wadi El Gemal National Park is characterized by the absence of some taxonomic groups that are represented in faunas of the Middle East, North Africa, and Sahel: Testudinoidea (Testudinidae, Emydidae), Anguillidae, Chamaeleonidae, Amphisbaenia (Trogonophidae, Blanidae), Scolecophidia (Typhlopidae, Leptotyphlopidae) and several families of advanced snakes, including Boidae, Natricidae, and Elapidae. The cause of this phenomenon is most probably the extreme climatic condition of hyperarid deserts. Aridity is the most important factor controlling reptile taxonomic diversity in the deserts of Egypt. For the adjacent South Eastern Desert

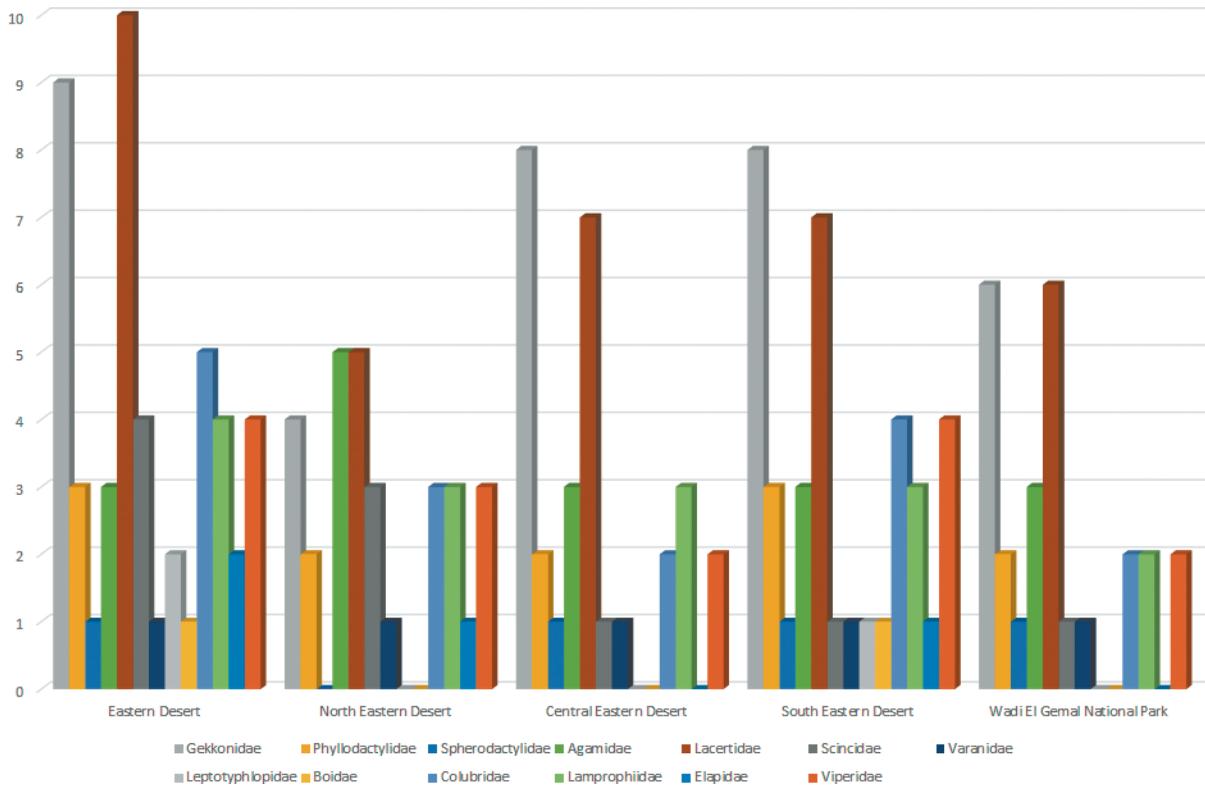


Fig. 4. Taxonomic diversity of reptiles at different subregions of the Eastern Desert.

and Mediterranean coast, the highest level of diversity is known from relatively more humid territories.

**Central Eastern Desert Herpetocomplex —  $\gamma$  Diversity**

Floristically, the territory of the Central Eastern Desert belongs to the Sahara-Arabian chorotype (Galal, 2011). The Wadi El Gemal – Hamata area is classified as a part of the southern (Nubian) section of the Eastern Desert (Mahmoud, 2010). Herpetologically, the central part of the desert is the most depleted and includes only 27 native species (Baha El Din, 2006; Milto, 2017). According to our results, the species list of the Central Eastern Desert is enriched by two new species and now consists of 29 native terrestrial species. Thus the quotient of similarity of the herpetofauna of the North Eastern Desert and Central Eastern Desert is 78%. The difference in the number of species in the North and Central Eastern Deserts is not significant (30 and 29 species, respectively). The South Eastern Desert subregion has the highest species diversity among the subregions of the Eastern Desert (38 species). The similarity of herpetofaunas between the South Eastern Desert and Central Eastern

Desert is 72% (38 and 29 species, respectively) (Milto, 2017, with modifications; see Fig. 4).

The level of endemism in reptiles of the Eastern Desert is low. No reptile species are completely endemic to the territory of the Eastern Desert, and the subendemic species and species with an Sudano-Ethiopian origin accounted for 7.8% of all species; these are *Ptyodactylus siphonorhinus*, *Tropicolotes bisharicus*, and *Ophisops elbaensis*. Only one species, *P. siphonorhinus*, is distributed principally in the Eastern Desert and can be a corresponding species for this desert. *Tropicolotes bisharicus* and *Ophisops elbaensis* penetrate to the Central Eastern Desert from the south and remove the zoogeographical border of the South Eastern Desert to the north, up to the Hamata mountains.

The species list of the Wadi El Gemal National Park now includes 2 marine and 26 terrestrial species, which is 92.9% of all species of the Central Eastern Desert and 50.9% of the Eastern Desert species. Biogeographically, most species relate to the Sahara-Sindian (46.2%) and Ethiopo-Nubian groups (23.1%); the remaining biogeographic groups are represented to a lesser extent by the Saharan (15.4%), Eastern Desert subendemic (11.5%) and Mediterranean (3.8%) faunal element. Lastly, one

species is possibly an invasive species, *Hemidactylus turcicus*. Six Ethiopian species and two species of southern, possibly Nubian origin, such as *Tropicolotes bisharicus* and *Ophisops elbaensis*, make the fauna of this national park closer to that of the South Eastern Desert.

**Acknowledgments.** This study was supported by RFBR 17-54-61015.

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