

Distribution and current status of herpetofauna in the Gediz Delta (Western Anatolia, Turkey)

Dilara Arslan¹, Anthony Olivier², Çağdaş Yaşar¹, İlhan Bayryam İsmail¹, Ömer Döndüren³, Lisa Ernoul², Nicolas Beck² and Kerim Çiçek^{1,*}

Abstract. In this study, we conducted an inventory of amphibians and reptiles between 2013 and 2016 in the Gediz Delta (İzmir, Turkey). The field results were combined with existing records. According to the data obtained, a total of 35 herpetile species live in the region, comprising 7 amphibians (2 urodeles, 5 anurans) and 28 reptiles (6 chelonians, 10 lizards and 12 snakes). Five species (*Lissotriton vulgaris*, *Triturus ivanbureschi*, *Heremites auratus*, *Platyceps collaris* and *Telecopus fallax*) were recorded for the first time in the Gediz Delta during the study. A chorotype classification and potential threats of the species are also presented.

Keywords: Gediz Delta, Herpetofauna, Distribution, Amphibians, Reptiles, Turkey

Introduction

Turkey is at the intersection of the continents and biota of Europe, Asia and Africa and has a rich and diversified herpetofauna based on this strategic location (Cox et al., 2006). Although there are many studies on Turkey's herpetofauna (e.g. Başoğlu and Baran 1977, 1980; Başoğlu et al., 1994), the detailed distributions of species are not completely known.

Gediz Delta extends over approximately 40,000 ha, covering the provinces of Uşak, Manisa and İzmir, starting from the Gediz River in the province of Kütahya and formed by aggregations of the alluvial materials carried by the Gediz River, and flowing into the Aegean Sea just north of İzmir. The Gediz Delta is composed of a mosaic of freshwater and saltwater ecosystems made up of shrub forests, salt meadows, reed beds, marshes, lagoons and rivers, salinas and beaches. Over half of the

delta is dedicated to agricultural production, including olives, cotton, tomatoes and other vegetable crops.

The Gediz Delta is internationally recognised for its diversity of bird species. The area qualifies as an Important Bird Area for more than 28 bird species (Gediz Delta Management Plan, 2007). Although there are some studies on herpetofauna of this specific area (Sıkı et al., 1998; Taşkavak, 1999; Gediz Delta Management Plan, 2007; Kızıl, 2014; Kızıl et al., 2016), the number and distribution of species are not completely known. The aim of this study is to determine which herpetiles live in the Gediz Delta, to obtain information on their distribution, and to report environmental factors that threaten the herpetofauna species.

Materials and Methods

Study area.—The Gediz Delta (38° 30'N, 26° 55'E) is situated between the İzmir Gulf (Bostanlı) in the south, the Aegean Sea in the west, Foça Hills in the north and the district of Menemen in the east within the provincial borders of İzmir (Fig. 1). Approximately 20,400 ha of the delta is a typical Mediterranean delta ecosystem, composed of a mosaic of salt and freshwater marshes (5000 ha), salt pans (3300 ha), four lagoons (Homa 1824 ha; Çilazmak 725 ha; Kırdeniz 450 ha; Taş 500 ha) (Onmuş and Sıkı, 2011), the Gediz River, and agricultural and dry hilly habitats. Over 20,400 ha of the delta are classified as a “wetland of international importance” according to the 1998 Ramsar Convention

¹ Section of Zoology, Department of Biology, Faculty of Science, Ege University, TR-35100, Bornova, İzmir/Turkey, Tel: (+90) 2323112409, Fax: (+90) 2323881036,

² Tour du Valat, Institut de Recherche pour la Conservation des Zones Humides Méditerranéennes, Le Sambuc – 13 200 Arles – France.

³ Izkuş Bird Paradise Union, İzmir, Turkey

* Corresponding author e-mails:

kerim.cicek@hotmail.com or kerim.cicek@ege.edu.tr

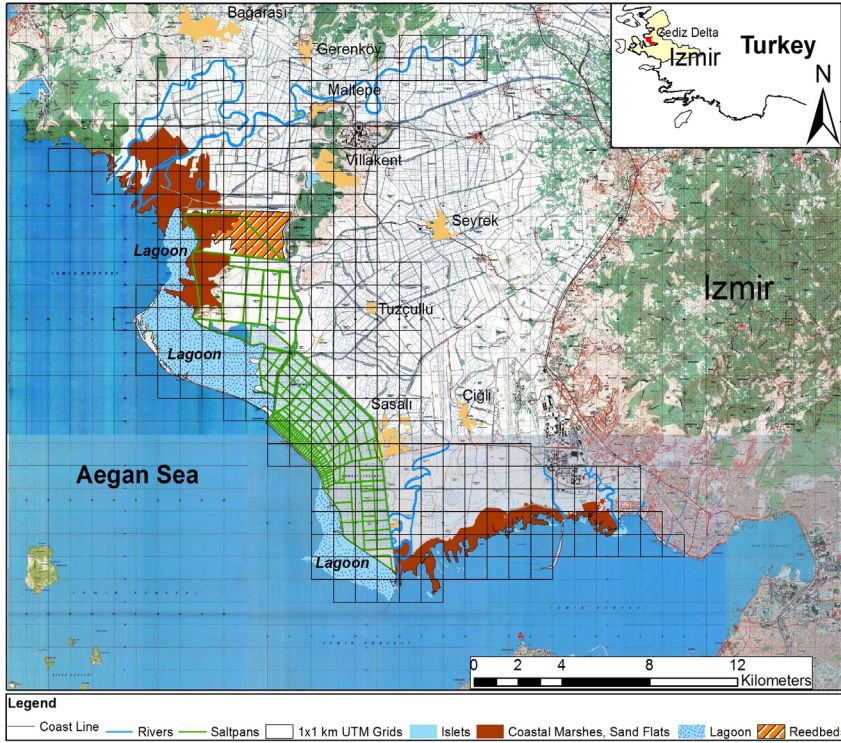


Figure 1. General view of study area.

(Ramsar, 2016). Additionally, Gediz Delta was included in the List of Areas of Special Conservation Interest-ASCI within the scope of Bern Convention of 2000 (Onmuş *et al.*, 2009).

The study area is mainly composed of the flat areas at sea level and also includes the small hills up to 350 m a.s.l. in and around the wetlands. The area has flora adapted to fresh, salt and brackish water habitats. The site has a typical Mediterranean climate consisting of hot and dry summers and mild but windy winters with annual average temperatures of 18°C (min. daily average 7.4°C and max. 26.7°C). Average annual rainfall is 544.2 mm (Onmuş and Siki, 2011).

Fieldwork.—The fieldwork (ca. 21,760 ha) was composed of approximately 305 1x1 km UTM grids (Fig. 1) that were previously designed by Onmuş *et al.* (2009). The study focused primarily on the grids located in Bird Paradise, the north of the delta and the hills and wetlands surrounding Villakent. The salines, lagoons and the southern part of the delta were visited less frequently in this study. Visual Encounter Surveys were used to

detect herptiles species during March–November at different intervals from 2013–2016. We recorded GPS points for all herptile species captured or observed in these non-systematic field surveys and identified the species according to Baçoğlu and Baran (1977; 1980), Baçoğlu *et al.* (1994), and Baran and Atatür (1998) with the nomenclature following Speybroeck *et al.* (2016). Each species was classified into major chorotypes according to Vigna Taglianti *et al.* (1999).

The records obtained from our field studies and the scientific literature were entered into the UTM grid maps. The locality information with no coordinate data was obtained by using Google Earth vers.7.1.2 (Google Inc.). All records were geo-referenced into WGS-84 coordinate system, checked and visualised with ArcGIS vers.10.0 (ESRI). Special field recording forms were designed, and UTM coordinates, date, habitat types, threats, and the herptile species that were seen and/or heard were noted for each grid separately. The habitat classification was made using CORINE land cover with two-level hierarchy and field observations. The species richness map created with python-based GIS tool

Table 1. Amphibians and reptiles reported from Gediz Delta (Western Anatolia, Turkey) including references (Çaydam, 1973; Baran, 1976; Başoğlu and Baran, 1977; Başoğlu and Baran, 1980; Başoğlu et al., 1994; Sıki et al., 1998; Taşkavak 1999; Sindaco et al., 2000; Teynié et al., 2005; Franzen et al., 2008; Kızıl, 2014; Taşkavak et al., 2015; Kızıl et al., 2016), Global IUCN categories and chorotype classification according to VignaTaglianti et al. (1999). Habitat types; 1: settlements, 2: agricultural areas, 3: scrub and/or herbaceous vegetation associations and open spaces with little or no vegetation, 4: salty marshes, 5: marine waters, 6: industrial, commercial - transport units and construction sites.

Species	Lit.	Our inventory	Habitat Type	Chorotype	IUCN
Salamandridae (2)					
<i>Lissotriton vulgaris</i> (Linnaeus, 1758)		+	3	Mediterranean	LC
<i>Triturus ivanbureschi</i> (Arntzen and Wielstra 2013)		+	3	E-Mediterranean	LC
Bufoidea (2)					
<i>Bufo bufo</i> (Linnaeus, 1758)	+	+	1,2,3	European	LC
<i>Bufo variabilis</i> (Pallas, 1769)	+	+	1,2,3	Turano-European-Mediterranean	DD
Hylidae (1)					
<i>Hyla orientalis</i> (Bedriaga, 1890)	+	+	2,3	European-Mediterranean	LC
Pelobatidae (1)					
<i>Pelobates syriacus</i> (Boettger, 1889)	+		2	Turano-European	LC
Ranidae (1)					
<i>Pelophylax bedriagae</i> (Camerano, 1882)	+	+	1,2,3,6	Turano-European-Mediterranean	LC
Chelonidae (2)					
<i>Caretta caretta</i> (Linnaeus, 1758)	+	+	4	Cosmopolitan	EN
<i>Chelonia mydas</i> (Linnaeus, 1758)	+	+	4	Cosmopolitan	EN
Dermodochelyidae (1)					
<i>Dermodochelys coriacea</i> (Vandelli, 1761)	+		4	Cosmopolitan	VU
Emydidae (1)					
<i>Emys orbicularis</i> (Linnaeus, 1758)	+	+	1,2,3	Turano-European-Mediterranean	NT
Geoemydidae (1)					
<i>Mauremys rivulata</i> (Valenciennes, 1833)	+	+	1,2,3	Turano-Mediterranean	LC
Testudinidae (1)					
<i>Testudo graeca</i> (Linnaeus, 1758)	+	+	1,2,3	Turano-Mediterranean	VU
Agamidae (1)					
<i>Stellagama stellio</i> (Linnaeus, 1758)	+	+	1,2,3,6	E-Mediterranean	LC
Anguidae (1)					
<i>Pseudopus apodus</i> (Pallas, 1775)	+	+	1,2,3,6	Turano-Mediterranean	LC
Chamaeleonidae (1)					
<i>Chamaeleo chamaeleon</i> (Linnaeus, 1758)	+		2,3	Mediterranean	LC
Gekkonidae (2)					
<i>Hemidactylus turcicus</i> (Linnaeus, 1758)	+	+	1,2,3,6	Mediterranean	LC
<i>Mediodactylus kotschy</i> (Steindachner, 1870)	+	+	2	E-Mediterranean	LC
Lacertidae (3)					
<i>Anatololacerta anatolica</i> (Werner, 1902)	+	+	2	SW-Anatolian endemic	LC
<i>Lacerta trilineata</i> (Bedriaga, 1886)	+	+	2,3	E-Mediterranean	LC
<i>Ophisops elegans</i> (Ménétriés, 1832)	+	+	1,2,3,6	E-Mediterranean	LC
Scincidae (2)					
<i>Ablepharus kitaibelii</i> (Bibron and Bory, 1833)	+	+	2,3	E-Mediterranean	LC
<i>Heremites auratus</i> (Linnaeus, 1758)		+	3	SW-Asiatic	LC
Typhlopidae(1)					
<i>Xerotyphlops vermicularis</i> (Merrem, 1820)	+	+	1,2,3,6	Turano-Mediterranean	LC
Boidae (1)					
<i>Eryx jaculus</i> (Linnaeus, 1758)	+	+	3	Mediterranean	LC
Colubridae (9)					
<i>Dolichophis caspius</i> (Gmelin, 1789)	+	+	1,2,3	Turano-Mediterranean	LC
<i>Eirenis modestus</i> (Martin, 1838)	+	+	1,2,3	SW-Asiatic	LC
<i>Platyceps collaris</i> (Müller, 1878)		+	2,3	E-Mediterranean	LC
<i>Telescopus fallax</i> (Fleischmann, 1831)		+	1,3	Turano-Mediterranean	LC
<i>Elaphe sauromates</i> (Pallas, 1811)	+	+	3	Turano-Mediterranean	NE
<i>Zamenis situla</i> (Linnaeus, 1758)	+			E-Mediterranean	LC
<i>Natrix natrix</i> (Linnaeus, 1758)	+	+	2,3	Centralas.-europ.-Mediterr.	LC
<i>Natrix tessellata</i> (Laurenti, 1768)	+	+	3	Centralasiatic-european	LC
<i>Malpolon insignitus</i> (Geoffroy Saint-Hilaire, 1827)	+	+	2,3	Mediterranean	NE
Viperidae (1)					
<i>Montivipera xanthina</i> (Gray, 1849)	+	+	2, 3	E-Mediterranean	LC
Total		30	31		

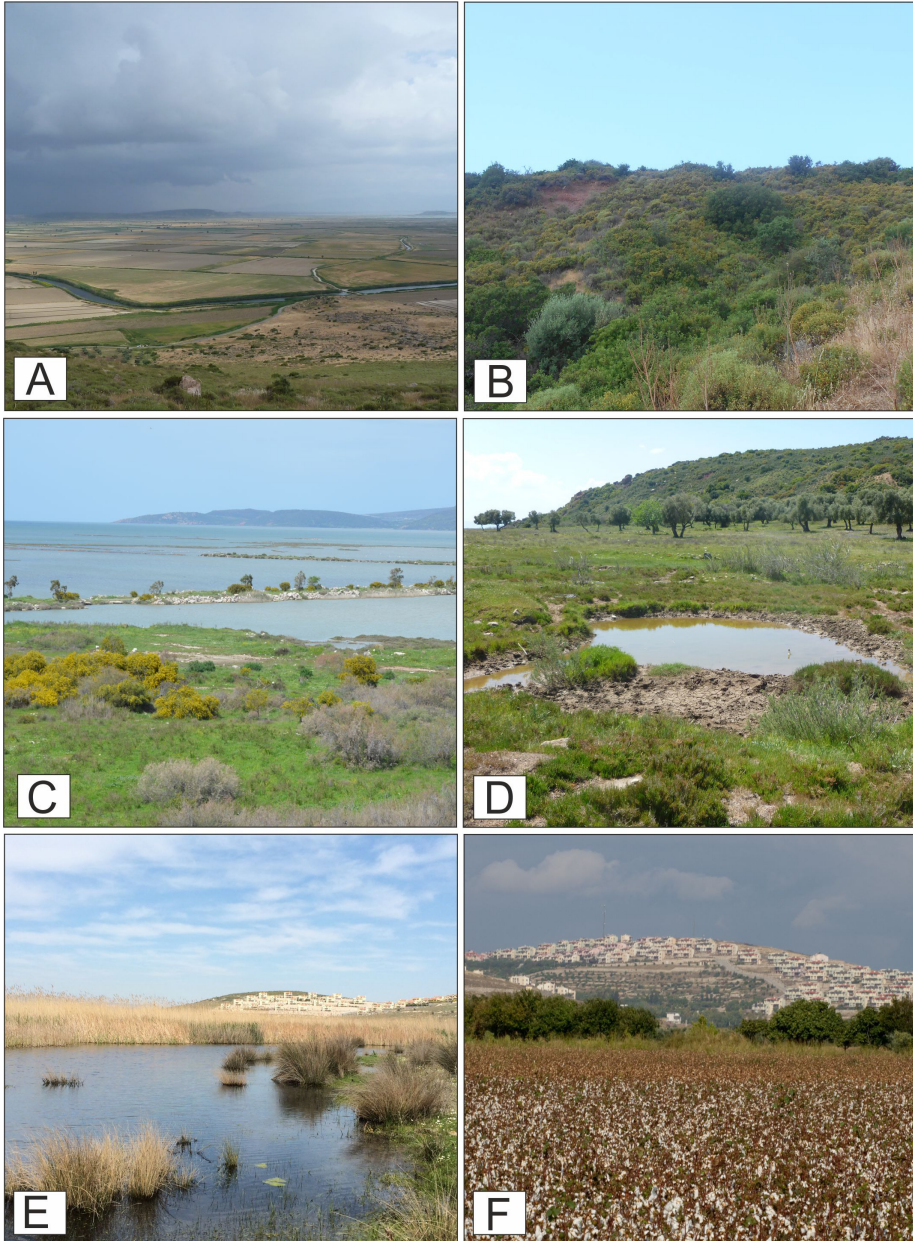


Figure 2. Major habitats from Gediz Delta (Western Anatolia, Turkey). A: Agricultural areas, B: Scrubby vegetation, C: Salty marshes, D: Temporary ponds and olive gardens, E: Freshwater marshes, F: Agricultural areas and settlements.

SDMtoolbox (Brown, 2014). Information on threats to species and habitats was taken from our observations made during the field studies and a literature review (Eken *et al.*, 2007; Gediz Delta Management Plan 2007).

Results

According to the study results, it was determined that a total of 35 herptile species, comprising 7 amphibians (2 urodeles, 5 anurans) and 28 reptiles (6 chelonians, 10 lizards and 12 snakes) live in the region (Table 1; Figs.

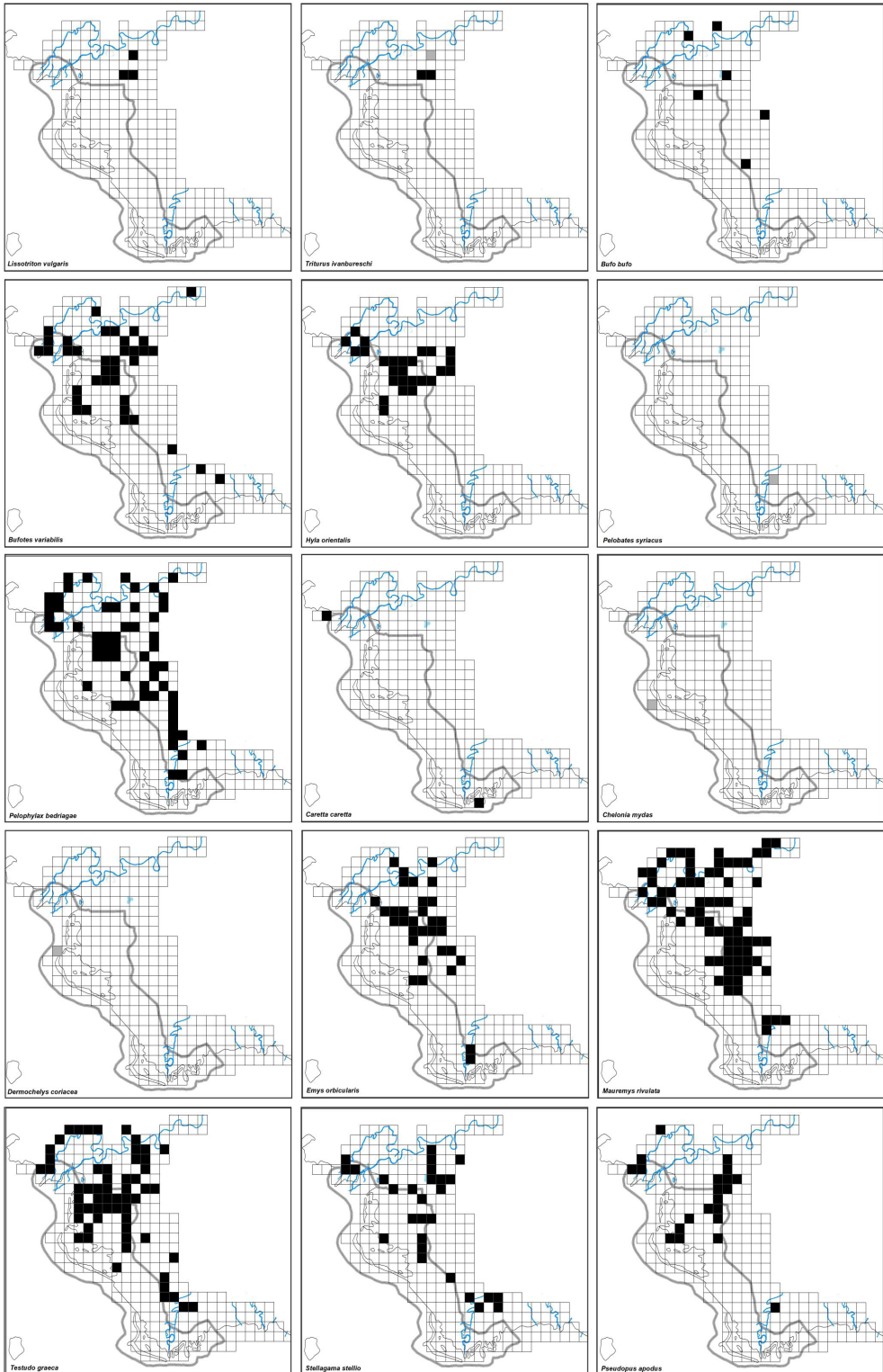


Figure 3. Distribution maps of amphibians and reptiles from Gediz Delta (Western Anatolia, Turkey). [Black squares=field records, Grey squares= literature records, Hatched squares= interview of local people, Gray line=Ramsar site delimitation]

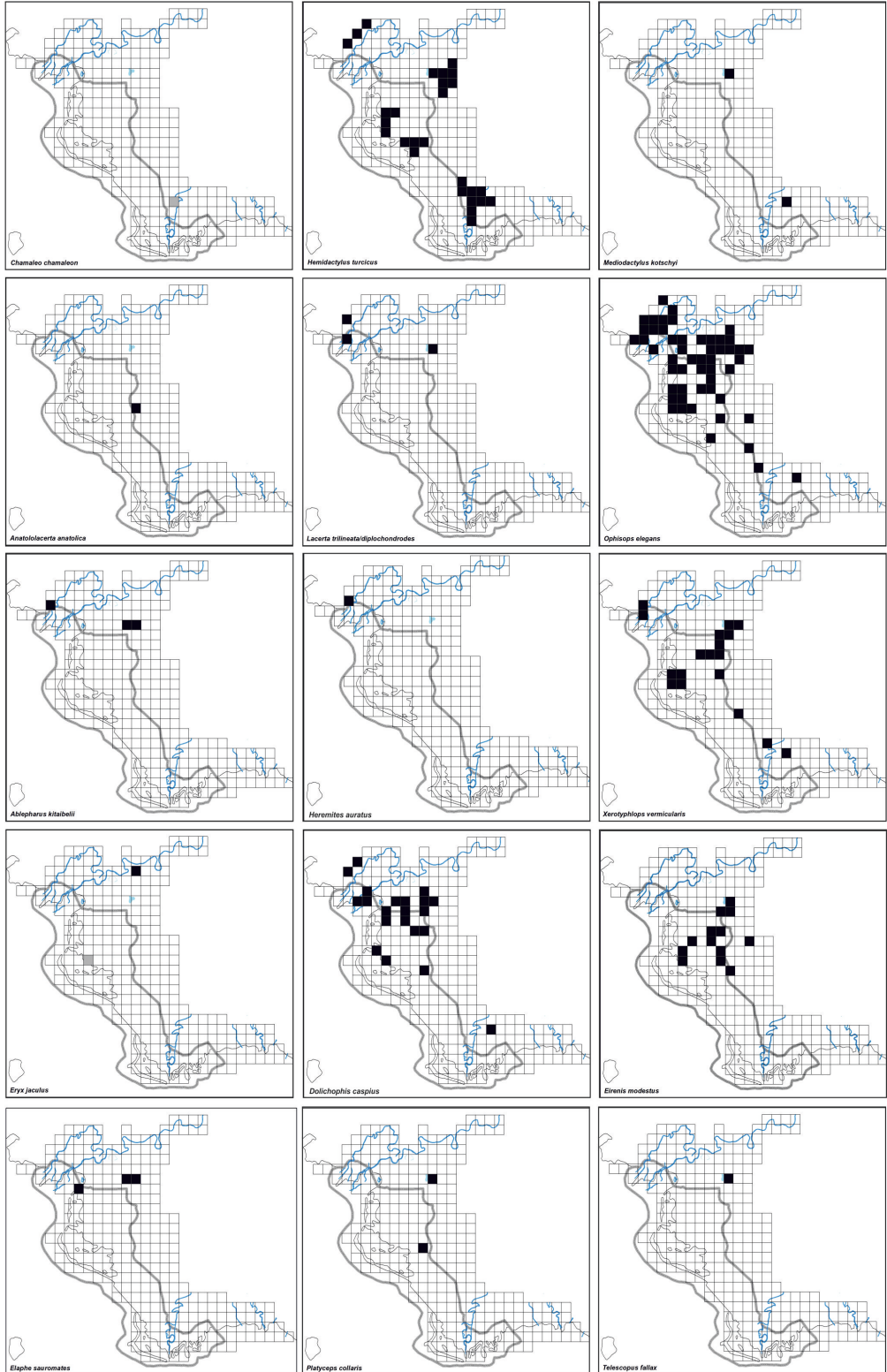


Figure 3. Continued.

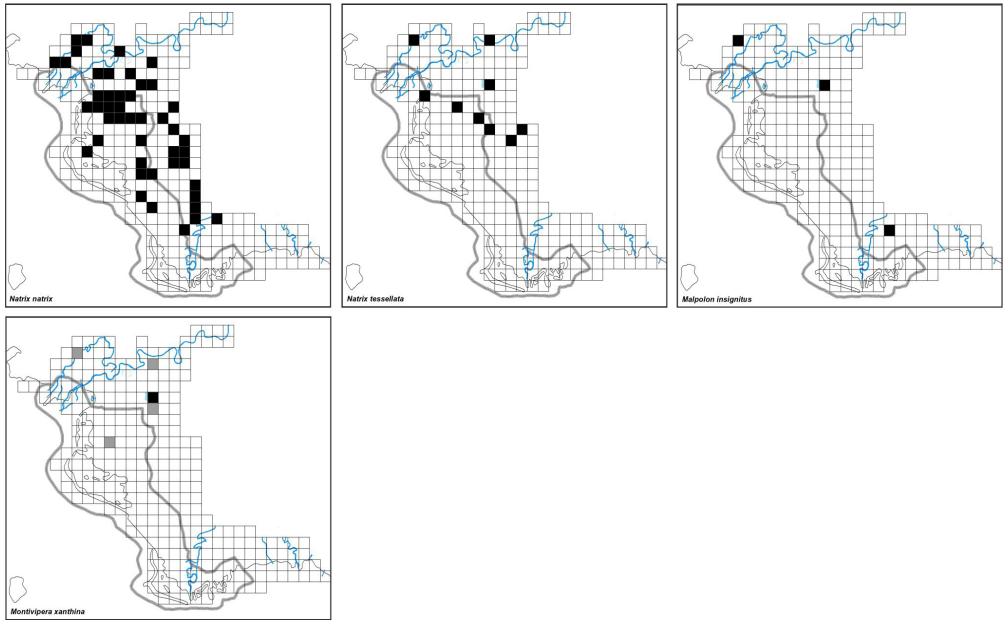


Figure 3. Continued.

2–5). Thirty species were observed during the previous studies conducted in Gediz Delta (Çaydam, 1973; Baran, 1976; Başoğlu and Baran, 1977; Başoğlu and Baran, 1980; Başoğlu et al., 1994; Sıkı et al., 1998; Taşkavak, 1999; Sindaco et al., 2000; Teynié et al., 2005; Franzen et al., 2008; Kızıl, 2014; Taşkavak et al., 2015; Kızıl et al., 2016). Below we provide brief accounts for these species, based on our survey work and records from the literature.

Species account

Lissotriton vulgaris (Linnaeus, 1758) – Smooth newt

The smooth newt can be found from western and northern Anatolia and Thrace in Turkey (Başoğlu et al., 1994). During this study we documented the presence of this species for the first time in the delta. It was observed in only three grids in central Gediz Delta (Fig. 3). This species seems to be very localised in the delta, living in and around the Lake Sazlı wetlands. Individuals with a pedomorphic form were identified in 2015 (Kızıl et al., 2016). The Gediz populations are distributed along the southern limit for the species (Franzen et al., 2008) and according to Raxworthy (1988) and Wielstra et al. (2015), belong to the subspecies *Lissotriton vulgaris schmidlerorum* (Raxworthy, 1988).

Triturus ivanbureschi (Arntzen and Wielstra, 2013) – Buresch’s crested newt

The Buresch’s crested newt is spread from northwestern Anatolia and Thrace in Turkey (Wielstra and Arntzen, 2016). This species was not previously cited in the literature covering the Gediz Delta. It was observed in two grids in 2015 with one possible location in the central Gediz Delta (Fig. 3) and co-occurs with smooth newts in Lake Sazlı. However, we observed the smooth newt is comparatively abundant compared to the Buresch’s crested newt. Similar to the smooth newt, the populations of Buresch’s crested newt here are also at the southern most range limit (Franzen et al., 2008; Wielstra et al., 2015).

Bufo bufo (Linnaeus, 1758) – Common toad

The Common toad is distributed throughout southern, western, and northern Anatolia and Thrace in Turkey (Başoğlu et al., 1994). The relative density of this species appears to decrease from north to south. It was only observed in six grids (Fig. 3). This species was previously mentioned by Taşkavak (1999). Its principle habitats are settlements, agricultural areas and scrubby and herbaceous vegetation near water bodies. The taxonomic position of Common toads from southern

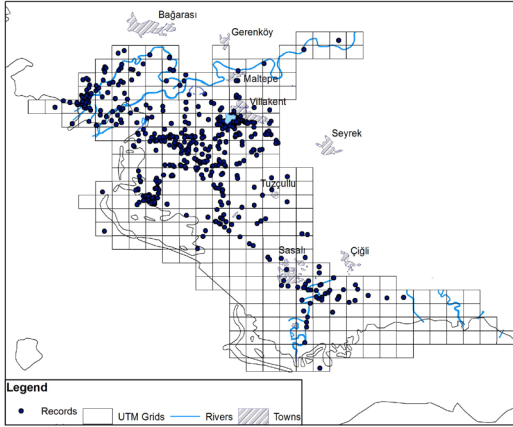


Figure 4. The herpetile observations and literature records of Gediz Delta (Western Anatolia, Turkey).

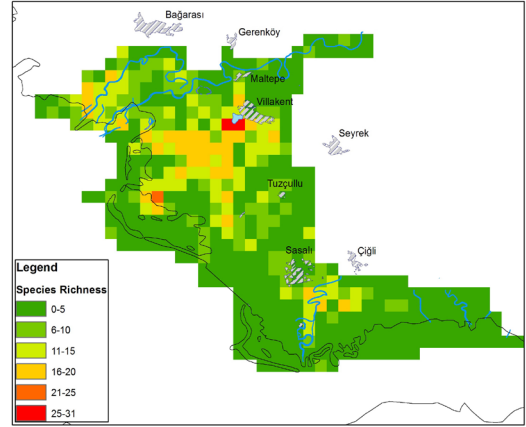


Figure 5. Herpetile species richness map of Gediz Delta (Western Anatolia, Turkey).

Turkey is not clearly elucidated. They fall in a large clade with *Bufo bufo bufo* and *B. b. verrucosissimus*, in opposition of the western clade, *B. b. spinosus*.

Bufo variabilis (Pallas, 1769) – Variable toad

This species is very common in the study area and was observed in 37 grids (Fig. 3). The Variable toad was previously recorded by Sıkı et al. (1998), Taşkavak (1999) and Franzen et al. (2008). It occurs throughout Turkey (Başoğlu et al., 1994) and was found in settlements, agricultural areas and scrub or herbaceous vegetation near water bodies. According to Stöck et al. (2006), Turkish Green toads are a “phylogenetic species” of *Bufo variabilis* (Pallas, 1768), but are not recognised by some authors (cf. Speybroeck et al., 2016).

Hyla orientalis (Bedriaga, 1890) – Eastern tree frog

The Eastern tree frog was recorded in 26 grids. This species is spread throughout Thrace, western, south-western and northeastern Anatolia (Stöck et al., 2008; Gvozdik et al., 2010; Gul et al., 2012). It was found in different freshwater bodies surrounded by agricultural areas and scrub or herbaceous vegetation. This species was previously recorded as *Hyla arborea* by Sıkı et al. (1998), Taşkavak (1999) and Franzen et al., (2008).

Pelobates syriacus (Boettger, 1889) – Eastern spadefoot toad

There is a single record in the literature (Çaydam, 1973) from southern Gediz Delta, but we did not observe this species during our study. This could be due to low density or habitat loss over the last 40 years. The closest existing population is found at the Efes ruins south of the delta (Franzen et al., 2008; Kordges et al., 2013).

Pelophylax bedriagae (Camerano, 1882) – Levant water frog

The Levant water frog is the most common anuran in the study area, and it was recorded in 58 grids. It lives in all water bodies and even near salty marshes. This species is only present in the west and southwest of Anatolia in Turkey. Recent work has shown that the population around Izmir is declining (Başkale and Kaya, 2016).

Caretta caretta (Linnaeus, 1758) – Loggerhead turtle

The delta is not a nesting site for Loggerhead turtles or other sea turtles and it does not seem to have suitable habitat for breeding sites. The area is about 250 km away to nearest known nesting site (Ekincik beach, Köyceğiz, Muğla). This species was observed in two grids by fishermen and birdwatchers. The delta shore and the lagoon could provide good feeding habitat for sea turtles. The Loggerhead turtle has already been documented in previous work by Sıkı et al. (1998) and Taşkavak (1999).



Figure 6. Some amphibians and reptiles from Gediz Delta (Western Anatolia, Turkey). A= *Triturus ivanbureschi*, B= *Hyla orientalis*, C= *Mauremys rivulata*, D= *Pseudopus apodus*, E= *Platyceps collaris*, F= *Montivipera xanthina*.

Chelonia mydas (Linnaeus, 1758) – Green turtle

There is only one literature record for Green turtles (Taşkavak, 1999). The area is about 350 km away to nearest nesting site (Patara beach, Fethiye, Muğla). Interviews with local fishermen indicated that this species could be observed occasionally and attached to fishing nets.

Dermochelys coriacea (Vandelli, 1761) – Leatherback turtle

The Leatherback turtle was not detected during our study, but there is at least one record in the literature (Franzen et al., 2008). Taşkavak et al. (2015) also reported that a dead individual was found in Izmir Bay.

Emys orbicularis (Linnaeus, 1758) – European pond turtle

The European pond turtle is distributed across Anatolia except in the northeastern region (Baran *et al.*, 2012). It was observed in 32 grids in the delta. This species could generally be seen in irrigation channels and permanent freshwater bodies. The European pond turtle density is lower than that of the Western Caspian turtle. This aquatic terrapin was previously mentioned by Sıkı *et al.* (1998) and Taşkavak (1999).

Mauremys rivulata (Valenciennes, 1833) – Western Caspian turtle

The Western Caspian turtle is common in almost all permanent water bodies and canals in the delta. It is even found in irrigation and drainage canals with high levels of pollution and concrete infrastructure. It was observed in 74 grids. This species was previously observed by Sıkı *et al.* (1998) and Taşkavak (1999). It is distributed from Thrace through western and southern Anatolia and is replaced by *Mauremys caspica* in central and eastern Turkey (Baran *et al.*, 2012).

Testudo graeca (Linnaeus, 1758) – Spur-thighed tortoise

The Spur-thighed tortoise was observed in 59 grids. This species is more common in the central and northern Gediz Delta than southern part, possibly caused by urbanisation pressure and habitat loss. Even if the species is common, the local people claim that the density of the species is reducing due to agricultural activities and urbanisation. This species was recorded in previous studies (Sıkı *et al.*, 1998; Taşkavak 1999; Franzen *et al.*, 2008).

Stellagama stellio (Linnaeus, 1758) – Rough-tailed agama

The Rough-tailed agama is one of the most common lizard species and was observed in 28 grids. It is observed evenly in dry and stony habitats. This species was previously observed by Sıkı *et al.* (1998), Taşkavak (1999) and Franzen *et al.* (2008), and is distributed throughout western, central and southern Anatolia (Baran *et al.*, 2012).

Pseudopus apodus (Pallas, 1775) – European glass lizard

The European glass lizard is another common lizard and was observed in 21 grids. It is especially dense near scrubs, herbaceous vegetation and open spaces. This lizard was already observed in the delta by Sıkı *et al.* (1998), Taşkavak (1999) and Franzen *et al.* (2008). The legless lizard is often killed by local people as they are thought to be harmful and dangerous.

Chamaeleo chamaeleon (Linnaeus, 1758) – Mediterranean chameleon

There are literature records for the Mediterranean chameleon (Franzen *et al.*, 2008; Taşkavak, 1999), yet there are very few habitats that are favourable for this species in the delta. This species is generally distributed in southern and southwestern Anatolia (Baran *et al.*, 2012) and the delta is near the northern limit for the species on the Aegean coast (Sindaco *et al.*, 2000; Teynié *et al.*, 2005).

Hemidactylus turcicus (Linnaeus, 1758) – Turkish gecko

The Turkish gecko was observed in 27 grids. It was previously recorded by Sıkı *et al.* (1998), Taşkavak (1999) and Franzen *et al.* (2008). It is probably present in all of the villages in the delta. This species is distributed across Thrace, western and southern Anatolia (Baran *et al.*, 2012) and common along the coastline of Turkey. Its density decreases toward central Anatolia.

Mediodactylus kotschy (Steindachner, 1870) – Kotschy's gecko

Kotschy's gecko was observed in only two grids and its density is low as compared to the Turkish gecko. This species was previously observed in the delta by Taşkavak (1999). Contrary to the Turkish gecko, the abundance of Kotschy's gecko increases in Anatolia.

Anatololacerta anatolica (Werner, 1902) – Anatolian rock lizard

The Anatolian rock lizard was observed in only one grid in 2015 near an agricultural area. This species was mentioned previously by Taşkavak (1999), but it was identified as *Podarcis muralis*. The Anatolian rock lizard is distributed in north-west Anatolia (Bellati *et al.*, 2014) and is often present in rocky areas in woodland and near streams.

Lacerta trilineata / diplochondrodes (Bedriaga, 1886) – Balkan green lizard

The Balkan green lizard was only observed in three grids, all of them found in the north of the delta. This species was previously recorded by Taşkavak (1999). This species is distributed in Thrace, and the central and western Black Sea region in Anatolia (Baran et al., 2012); however, the systematic presence of the Balkan green lizard continues to be discussed (Ahmadzadeh et al., 2013). It lives near scrub / herbaceous vegetation and open spaces.

Ophisops elegans (Ménétriés, 1832) – Snake-eyed lizard

The Snake-eyed lizard is another very common lizard, and was observed in 52 grids around the delta. This lizard was observed previously by Sıki et al. (1998), Taşkavak (1999) and Franzen et al. (2008). The species is also common and widespread in Anatolia (Baran et al., 2012).

Ablepharus kitaibelii (Bibron and Bory, 1833) – Snake-eyed skink

The Snake-eyed skink was observed in three grids in scrub and herbaceous vegetation. This skink was previously recorded by Sıki et al. (1998) and Taşkavak (1999). This species is distributed in Thrace and the western, central, and southern Black Sea region in Anatolia (Baran et al., 2012)

Heremites auratus (Linnaeus, 1758) [= *Trachylepis aurata* (Linnaeus, 1758)] – Levant skink

The Levant skink was observed in one grid in 2015 in shrubby vegetation in the hills of northern Gediz Delta. The species is distributed in western and southern Anatolia (Baran et al., 2012). This is the first record of the species in the Gediz Delta.

Xerotyphlops vermicularis (Merrem, 1820) – European blind snake

The European blind snake was observed in 18 grids around the delta. This species was recorded by Sıki et al. (1998) and Taşkavak (1999), and is widespread in Anatolia except some part of Black Sea region (Baran et al., 2012).

Eryx jaculus (Linnaeus, 1758) – Sand Boa

There are two literature records (Sıki et al., 1998; Taşkavak 1999) and one observation of the Sand Boa in 2016 in agricultural areas. This species is distributed throughout Anatolia with exception to the Black Sea region (Baran et al., 2012).

Dolichophis caspius (Gmelin, 1789) – Caspian whipsnake

The Caspian whipsnake is one of the most common snakes and was recorded in 21 grids in settlements, agricultural areas, scrub and herbaceous vegetation. This species was observed previously by Sıki et al. (1998), Taşkavak (1999) and Franzen et al. (2008). It is distributed throughout Thrace and the western and central Black Sea region (Baran et al., 2012).

Eirenis modestus (Martin, 1838) – Ring-headed dwarf snake

The Ring-headed dwarf snake was observed in 13 grids in settlements, scrub and herbaceous vegetation. This species is common in the hills in Bird Paradise and is distributed all-around Anatolia except southeastern regions (Baran et al., 2012). Taşkavak (1999) identified this species previously in the delta.

Platyceps collaris (Müller, 1878) – Collared dwarf racer

The Collared dwarf racer was observed in two grids in 2013 and 2015 in the salt pans and scrubby areas. This species was not previously recorded for the delta, though it is distributed in Thrace, western and southern Anatolia (Baran et al., 2012).

Telescopus fallax (Fleischmann, 1831) – European cat snake

The European cat snake was observed in only one grid in 2013 in stony and scrubby areas. This is the first mention of the species in the Gediz Delta. The observation was made near Lake Sazlı marshes. This species is distributed over western, southern, eastern and northeastern Anatolia (Baran et al., 2012).

Elaphe sauromates (Pallas, 1811) – Blotched snake

The Blotched snake was observed in three grids in agricultural and scrubby areas. This species was only observed in the marshes of Lake Sazlı. Taşkavak (1999) mentioned this species previously, but had identified it

as *Elaphe quatorlineata*. It has a patchy distribution in Turkey with the exception of western Anatolia (Baran *et al.*, 2012).

Zamenis situla (Linnaeus, 1758) – Leopard snake

This species has only been discussed in the literature for the Gediz Delta once by Taşkavak (1999), and it was identified as *Elaphe situla*. We were not able to observe this species during the four-year study; however, the Gediz Delta is considered part of the potential distribution area for Turkey (Sindaco *et al.*, 2000).

Natrix natrix (Linnaeus, 1758) – Grass snake

The Grass snake was detected in 46 grids and lives in different water bodies with the Dice snake. *Natrix natrix* is more common in the marshes than *Natrix tessellata*. This aquatic snake was mentioned in previous literature by Sıki *et al.* (1998) and Taşkavak (1999), and is distributed all-around Anatolia except the southeastern most region (Baran *et al.*, 2012).

Natrix tessellata (Laurenti, 1768) – Dice snake

The Dice snake was observed in nine grids. It was only observed in the Gediz River and in the canals; however, due to its strictly aquatic nature, it could be present in some other grids. The species can be found in different water bodies in all of Anatolia (Baran *et al.*, 2012). There is a previous record in the literature by Taşkavak (1999).

Malpolon insignitus (Geoffroy Saint-Hilaire, 1827) – Eastern Montpellier snake

The Eastern Montpellier snake was observed in three grids in agricultural and scrubby areas. Sıki *et al.* (1998) and Taşkavak (1999) recorded this species, and it is distributed throughout western, central and southern Anatolia (Baran *et al.*, 2012).

Montivipera xanthina (Gray, 1849) – Ottoman viper

The Ottoman viper was observed in one grid in 2016 and with four possible locations. The presence of the species in four grids was detected through interviews with local people. It is distributed throughout western, central and southern Anatolia (Baran *et al.*, 2012). This species lives in stony and scrubby areas in the Gediz Delta. The Ottoman viper was only previously mentioned in the work of Taşkavak (1999).

Of the 35 known species inhabiting the delta, 24% are E-Mediterranean (8 species), 21% are Turano-Mediterranean (7 species), and 15% Mediterranean (5 species) chorotype (Table 1, Fig. 6). Approximately 9% of these species (3 species, DD, Data Deficient +NE, Not Evaluated) are not evaluated in the IUCN Red List, and the remaining 76% are in the Least Concern (26 species), 3% Near Threatened (1 species), 6% Vulnerable (2 species), and 6% Endangered (2 species) categories. Accordingly, approximately 15% of the species living in this area are considered to be under threat.

Discussion

The Gediz Delta is composed of the sediments carried by the Gediz, and is the fourth largest delta in Turkey. This area is recognised for its role for breeding and migrating water birds, with 289 bird species having been recorded in the delta (Gediz Delta Management Plan, 2007). The studies on herpetofauna of the area have mainly focused on southern Gediz Delta and Bird Paradise (e.g. Sıki *et al.*, 1998; Kızıllı, 2014), with little or no attention given to the other areas in the delta.

Thirty-one species of herpetofauna were observed in previous studies carried out in the area. However, the presence of *Chelonia mydas* and *Caretta caretta* in the region was determined through interviews with local fishermen. *Pelobates syriacus*, *Dermodochelys coriacea*, *Chamaeleo chamaeleon* and *Zamenis situla* were among these species that were not observed during the field studies conducted between 2013 and 2016. *Lissotriton vulgaris*, *Triturus ivanbureschi*, *Heremites auratus*, *Platyceps collaris* and *Telecopus fallax* on the other hand were recorded for the first time in the area. By combining our field studies with previously published survey data, we determined the Gediz Delta contains at least 35 species of reptiles and amphibians.

Due to urbanisation and habitat fragmentation, it is possible that the unobserved species have lost part or all of their original habitats and are now only located in narrow patches. However, *Blanus strauchi* (Bedriaga, 1884), *Dolichophis jugularis* (Linnaeus, 1758), *Platyceps najadum* (Eichwald, 1831), and *Hemorrhois nummifer* (Reuss, 1834) have been recorded in different sites in the province of Izmir (Baran, 1976; Başoğlu and Baran, 1977; Başoğlu and Baran, 1980; Baran and Atatür, 1998; Sindaco *et al.*, 2000; Teynié *et al.*, 2005), yet these species were not observed in the delta during our study. The delta is cited as the western limit for the *Blanus strauchi* and the northern limited for *Dolichophis jugularis* along the Aegean coast. We have found one

observation of a juvenile *D. jugularis* by a nature photographer (TurkHerptil forum <http://turkherptil.org:gozlemDetay.asp?UyeId=603&Bilgild=10875>). The occurrence of the species should be checked in the Delta.

The most important threats to amphibians and reptiles in the area are habitat destruction due to urbanisation (Ernoul et al., 2012) and the pollution of Gediz River flowing into the delta. These problems especially impact the hydrophilous herptile species in the area. This pressure is magnified in the Lake Sazlı marshes in the central Gediz Delta (Fig. 2). The freshwater resource of Lake Sazlı is underground water, rain water, and drainage water from the surrounding houses. The drainage water is another source of pollution threatening the lake. Furthermore, the agricultural activities in the region (e.g. agrochemicals, stubble burning) and the industry (tanneries) are additional sources of pollution. The agricultural activities (stubble burning) can lead to physical injury for tortoises living in the area.

The wastes from industrial factories (tanneries) carried by the Gediz River and chemical substances originating from agricultural inputs (Parlak et al., 2006) are demonstrated threats to water birds (Sönmez and Onmuş, 2007), as well as amphibians and reptiles living in the area. In addition, recent GIS modeling studies indicated that sea level could rise between 3% and 13% by 2100 depending on climate change (Tulger et al., 2015). This means aquatic and terrestrial habitats could be greatly reduced in the future.

Sazlıgöl marshes are located in the Central Gediz Delta and fairly protected from outside water pollution, the lake has been threatened in the past by agricultural expansion and mosquito control. Today Lake Sazlı marshes are also threatened by illegal dumping of debris, and garbage and wastewaters from the community. Despite these threats, the marshes serve as a breeding site for 6 species of amphibians including the only population of paedomorphic salamanders in the delta. Two species of aquatic turtles are also found in these marshes. The natural areas around the lake are home to 19 reptile species and it holds an important population of *Testudo graeca*.

The main risks threatening herptiles in the region are the pollution, agricultural activities (e.g. irrigation, agrochemicals, and stubble burning) and domestic pollution, notably the habitat destruction and loss based on the urbanisation pressure, and industrial wastes of Gediz River (particularly by sand and gravel quarries and leather industry). Although Gediz Delta has many protection statuses, there are often gaps in the laws

or lack of enforcement. In order to protect the current status of the area, public and private sectors must come together to ensure the future of the habitats and species living in the area. Future research could help to reduce the environmental threats and propose solutions to ensure the sustainability of the delta.

In conclusion, a total of 35 herptile species, comprising 7 amphibians (2 urodeles, 5 anurans) and 28 reptiles (6 chelonians, 10 lizards and 12 snakes) were identified and mapped in the Gediz Delta. The spur-thighed tortoise was the only species in the delta that is classified as vulnerable (Table 1) on the IUCN Red List (other than the sea turtles which do not nest on the beaches in the delta). Up to now, herptile species have largely been ignored, but this study will act as a complement to the atlases on breeding and shorebird species in the Gediz Delta (Onmuş et al., 2009; Onmuş & Sıkı 2011). The herptile monitoring will be continued and the distribution maps will be updated in future years to help improve our knowledge and the conservation of the Gediz Delta. Extra effort should be made in the future to confirm the presence of other species that are considered to be within the limits of their distribution, but that were not observed during our present study.

Acknowledgements. This study is part of a project supported by Doğa Derneği (<http://www.dogadermegi.org/>) and the Tour du Valat (www.tourduvalat.org). We are grateful to these organisations and the PACA Regional Council and Mava Foundation for their generous financial support. We would also like to thank everyone who accompanied us during our field work over the four years of prospection. We are also grateful to Philippe Geniez and Pierre-André Crochet for their comments to previous versions of this article.

References

- Ahmadzadeh F., Flecks M., Rödder D., Böhme W., Ilgaz C., Harris D.J., Engler J.O, Üzüm N., Carretero M.A. (2013): Multiple dispersal out of Anatolia: biogeography and evolution of oriental green lizards. *Biological Journal of the Linnean Society* **110**(2): 398-408.
- Baran, İ. (1976): Türkiye yılanlarının Taksonomik Revizyonu ve Coğrafi Dağılımları [Taxonomical revision and geographic distribution of Turkish snakes]. TUBITAK Publications No: 309, TBAG Seri no 9: 1-177. [in Turkish]
- Baran, İ., Atatür, M.K. (1998): Turkish Herpetofauna (Amphibians and Reptiles). Republic of Turkey, Ministry of Environment, Ankara, 214 p.
- Baran, İ., Ilgaz, Ç., Avcı, A., Kumlutaş, Y., Olgun, K. (2012): Türkiye Amfibi ve Sürüngenleri. [The amphibians and reptiles of Turkey] Ankara, Turkey: TÜBİTAK, 204p (in Turkish).
- Başkale, E., Kaya, U. (2016): Decline of the Levantine Frog, *Pelophylax bedriagae* Cameron, 1882, in the western Aegean

- Region of Turkey: changes in population size and implications for conservation. *Zoology in the Middle East* **57**: 69-76.
- Başoğlu, M., Baran İ. (1977): Türkiye Sürüngenleri. Kısım I Kaplumbağa ve Kertenkeleler. [The reptiles of Turkey, part I. The turtles and lizards]. Ege University, Faculty of Science Book Series No 76, (İlker Publishing house) Bornova - İzmir, pp. 272. [in Turkish]
- Başoğlu, M., Baran, İ. (1980): Türkiye Sürüngenleri, Kısım II Yılanlar. [The reptiles of Turkey, part II. The snakes]. Ege University, Faculty of Science Book Series No 80, Bornova - İzmir. [in Turkish]
- Başoğlu, M., Özeti, N., Yılmaz İ. (1994): Türkiye Amfibileri (The Amphibians of Turkey: Taxonomic List, Distribution, Key for Identification pp. 183-194). Ege University, Faculty of Science Book Series No 151, Bornova-Izmir, Turkey, pp. 221.
- Bellati, A., Carranza, S., Garcia-Porta, J., Fasola, M., Sindaco, R. (2014): Cryptic diversity within the *Anatolalacerta* species complex (Squamata: Lacertidae) in the Anatolian peninsula: Evidence from the multi-locus approach. *Molecular Phylogenetic and Evolution* **82**: 219-233.
- Brown, J.L. (2014): SDMtoolbox: a python-based GIS toolkit for landscape genetic, biogeographic, and species distribution model analyses. *Methods in Ecology and Evolution* **5**: 694-700.
- Çaydam, Ö. (1973): İzmir’de bulunan Anura türlerinden *Bufo bufo*, *Bufo viridis* (Bufonidae), *Rana ridibunda* (Ranidae), *Pelobates syriacus* (Pelobatidae) ve *Hyla arborea* (Hylidae)’nin üreme biyolojisi üzerine araştırmalar [Research on breeding biology on *Bufo bufo*, *Bufo viridis* (Bufonidae), *Rana ridibunda* (Ranidae), *Pelobates syriacus* (Pelobatidae) and *Hyla arborea* (Hylidae)]. E.Ü. Fen Fak. İlimi Raporlar Serisi No 198: 1-22. [in Turkish].
- Cox, N., Chanson J., Stuart S. (2006): The status and distribution of reptiles and amphibians of a Mediterranean Basin. IUCN, Gland Switzerland and Cambridge. 42 p.
- Eken, G., Bozdoğan, M., İsfendiyar, S. (2007): Türkiye’nin Önemli Doğa Alanları (2. Cilt). [Key Biodiversity Areas in Turkey], Kitap Yayınevi, İstanbul, 1112 p. [in Turkish].
- Ernoul, L., Sandoz, A., Fellague, A. (2012): The evolution of two great Mediterranean Deltas: Remote sensing to visualize the evolution of habitats and land use in the Gediz and Rhone Deltas. *Ocean & Coastal Management* **69**: 111-117.
- Franzen, M., Bußmann, M., Kordges, T., Thiesmeier B. (2008): Die Amphibien und Reptilien der Südwest-Türkei. - Laurenti-Verlag, Bielefeld, 328 pp. [In German]
- Gediz Delta Management Plan (2007): Gediz Deltası Sulak Alan Yönetim Planı [Gediz Delta Wetland Management Plan]. TC Çevre ve Orman Bakanlığı Doğa Koruma ve Milli Parklar Genel Müdürlüğü, Sulak Alanlar Şubesi Müdürlüğü, Ankara, Turkey, 424 pp [in Turkish].
- Gül, S., Kutrup, B., Özdemir, N. (2012): Patterns of distribution of tree frogs in Turkey based on molecular data. *Amphibia-Reptilia* **33**: 95-103.
- Gvozdk, V., Moravec, J., Klütsch, C.F.C., Kotlík, P. (2010): Phylogeography of the Middle Eastern tree frogs (*Hyla*, *Hylidae*, *Amphibia*) as inferred from nuclear and mitochondrial DNA variation, with a description of a new species. *Molecular Phylogenetics and Evolution* **55**(3):1146-66.
- Kızıl, D. (2014): Gediz Deltası (İzmir)’nin Herpetofaunası. [Herpetofauna of Gediz Delta]. Unpublished Undergraduated thesis, Ege Univ, Department of Biology, Zoology Section, 31 pp. [in Turkish]
- Kızıl, D., İsmail, İ.B., Olivier, A., Çiçek K. (2016): A new case of facultative paedomorphosis in smooth newts, *Lissotriton vulgaris* (Caudata: Salamandridae) in Turkey. *Amphibian & Reptile Conservation* **10**(1): 28-33.
- Kordges, T., Thiesmeier, B., Franzen M., De Wijer P. (2013): Die Syrische Schaufelkröte (*Pelobates syriacus*) in der Südwest-Türkeimit Beschreibung neuer Fundorte und Angaben zur Larvalbiologie. *Zeitschrift für Feldherpetologie* **20**: 79-89.
- Onmuş, O., Sıki, M. (2011): Shorebirds in the Gediz Delta (İzmir, Turkey): breeding and wintering abundances, distributions, and seasonal occurrences. *Turkish Journal of Zoology* **35**(5): 615-629.
- Onmuş, O., Durusoy, R., Eken, G. (2009): Distribution of breeding birds in the Gediz Delta, Western Turkey: (Aves). *Zoology in the Middle East* **47**(1): 39-48.
- Parlak, H., Çakır, A., Boyacıoğlu, M., Arslan, Ö.Ç. (2006): Heavy metal deposition in sediments from the delta of the Gediz River (Western Turkey): A preliminary study. *Journal of Fisheries and Aquatic Sciences* **23**: 445-448.
- Ramsar (2016): Ramsar sites information service. <<https://rsis.ramsar.org/ris/945>>, accessed: November 29, 2016.
- Raxworthy, C.J. (1988): A description and study of a new dwarf subspecies of smooth newt, *Triturus vulgaris*, from Western Anatolia, Turkey. *Journal of Zoology* **215**(4): 753-776.
- Sıki, M., Tok, C.V., Mermer, A., Tosunoğlu, M. (1998): İzmir Kuş Cennetinin Avifaunası ve Herpetofaunası [Avifauna and Herpetofauna]. 14. Ulusal Biyoloji Kongresi, 7-10 Eylül 1998, Samsun. Cilt III, 181-193. [in Turkish].
- Sindaco, R., Venchi, A., Carpeneto, G.M., Bologna, M.A. (2000): The Reptiles of Anatolia: a checklist and Zoogeographical analysis. *Biogeographia* **21**: 441-554.
- Sönmez, İ.Ö., Onmuş, O. (2007): Gediz Deltası Yönetim Planı, Sosyo- Ekonomik Yapı Raporu [Gediz Delta Management Plan, socio-economical structure report], İzmir Kuş Cenneti Koruma ve Geliştirme Birliği, 145 p [in Turkish].
- Speybroeck, J., Beukema, W., Bok, B., Van den Voort, J. (2016): Field guide to the amphibians and reptiles of Britain and Europe. Bloomsbury, London: 432 p.
- Stöck, M., Moritz, C., Hickerson, M., Frynta, D., Dujsebaveva, T., Eremchenko, V., Macey, J.R., Papenfuss, T.J., Wake D.B. (2006): Evolution of mitochondrial relationships and biogeography of Palearctic green toads (*Bufo viridis* subgroup) with insights in their genomics plasticity. *Molecular Phylogenetics and Evolution* **41**: 663-689.
- Stöck, M., Dubey, S., Klütsch, C., Litvinchuk, S.N., Scheidt, U., Perrin, N. (2008): Mitochondrial and nuclear phylogeny of circum-Mediterranean tree frogs from the *Hyla arborea* group. *Molecular Phylogenetics and Evolution* **49**: 1019-1024.
- Taşkavak, E. (1999): Sucul ve Karasal omurgalılar [Aquatic and Terrestrial vertebrates] In: Wetland management project, Gediz Delta wetland management sub-project final report, vol II. Bornova, Izmir, 354-365 p.
- Taşkavak, E., Akçınar, S.C., İnanlı, C. (2015): Rare occurrence of the leatherback sea turtle, *Dermodochelys coriacea*, in Izmir Bay, Aegean Sea, Turkey. *Ege Journal of Fisheries and Aquatic Sciences* **32**(1): 51-52. doi: 10.12714/egejfas.2015.32.1.08.

- Teynié, A., Geniez, P., Crochet, P.A. (2005): Atlas des amphibiens et reptiles de Turquie. Document de travail inédit. Montpellier, 102 p.
- Tulger, G., Bilgiç, E., Gündüz, O. (2015): An inundation analysis for Gediz Delta under sea level rise conditions. *In: VIII. Ulusal Hidroloji Kongresi 08-10 Ekim 2015*, Harran Üniversitesi, Şanlıurfa, 1-12 p. (In Turkish with English abstract)
- Vigna Taglianti, A., Audisio, P.A., Biondi, M., Bologna, M.A., Carpaneto, G.M., Biase, A., de Fattorini, S., Piattella, E., Sindaco, R., Venchi, A., Zapparoli, M. (1999): A proposal for a chorotype classification of the Near East fauna, in the framework of the Western Palearctic region. *Biogeographia* **20**: 31-59.
- Wielstra, B., Bozkurt, E. Olgun, K. (2015): The distribution and taxonomy of *Lissotriton* newt in Turkey (Amphibia, Salamandridae). *Zookeys* **484**: 11-23.
- Wielstra, B., Arntzen, J.W. (2016): Description of a new species of crested newt, previously subsumed in *Triturus ivanbureschi* (Amphibia: Caudata: Salamandridae). *Zootaxa* **4109**(1): 73-80.