

ANALYSIS OF HERPETOFAUNAL DIVERSITY OF ISTANBUL ISLANDS WITH THE NEW RECORDS OF THREE LOCALITIES

Nilgun Kaya^{1,*}, Murat Tosunoglu²

¹Institute of Graduate Studies in Science, Istanbul University, Istanbul, Turkey

²Department of Biology, Faculty of Arts and Sciences, Canakkale Onsekiz Mart University, 17020 Canakkale, Turkey

ABSTRACT

Studies that aim to discover amphibian and reptilian species were conducted in the Istanbul islands which consists of Büyükada, Heybeliada, Burgazada and Kınalıada, during the years 2016-2019. The latest research of the islands was done 39 years ago and no studies were conducted since then. This study investigated the differences in species of amphibians and reptiles over these years. *Bufo variabilis* (Pallas, 1769) from Büyükada, *Hemidactylus turcicus* (Linnaeus, 1758) from Heybeliada and *Testudo graeca* Linnaeus, 1758 from Kınalıada were given as new records from these localities. Principal components analysis (PCA) was applied to analysis the correlation of the amphibian and reptile diversity between Istanbul islands, Marmara islands and mainland. PC1 (eigenvalue of 1.91082) was accounted for 45.86 % of the variation. Results of PCA, *Podarcis siculus* (Rafinesque & Schmaltz, 1810) was observed to display an extant and dominant population in all of the islands. Hierarchical Cluster Analysis was performed to assess the similarity in species among the islands. According to HCA, three cluster groups were formed. Islands of Istanbul have separate groups from other islands and mainland.

KEYWORDS:

Herpetofauna, Istanbul, Islands, PCA, HCA

INTRODUCTION

Turkey encompasses an area that consists of Mediterranean basin, Iranian – Anatolian basin and Caucasian basin, which are included in the globally recognized 35 biodiversity hotspots. This shows that, it is a very rich area in terms of diversity and endemism [8, 5, 9]. While the country gave rise to many studies regarding its biodiversity, there is only a few and limited number of studies about its islands. The islands are located in the southwest of Istanbul. It differs from the Trace–Kocaeli peninsular by its arkose and quartzite structure rooting from the Paleozoic era [10]. Büyükada, Heybeliada, Burgazada, Kınalıada, Sedef island, Kaşık island, Sivriada,

Tavşan island and Democracy and Freedom Island are located in southwest of Istanbul. Out of these islands, the biggest and closest one to the mainland is Büyükada which is also the most crowded island. It has 5.4 km² of surface area and its distance to mainland is approximately 3 km. The second biggest island is Heybeliada, followed by Burgazada and Kınalıada. These islands under the effect of Mediterranean climate and mostly consist of Red Pine (*Pinus brutia*) forests and scrub areas [4, 7, 11]. Since the metapopulations of the species in these islands are rooted from isolated mainland populations, they contribute important data for understanding speciation mechanisms and genetic studies. The rate of species differentiation increases as the islands are farther away from the mainlands. So far, studies of the Istanbul islands consist mostly of studies revolving around forest pests [1]. The only source for herpetofauna of the islands is “A Taxonomic and Ecological Research on the Herpetofauna of the Islands in North Aegean Sea, Marmara Sea and Black Sea” by Baran (1981). This research consists of a 2 years long study. Aside from the Istanbul islands, it is a comprehensive study that also includes islands of Marmara and Ege regions. However, this study tried to detect amphibian and reptilian species by collecting the specimens in a short time period. Baran (1981) has given the general herpetofauna of the islands and there is no study that reflects amphibian and reptilian species for each one of these islands. The geographic location and geology of the islands and their different climatological properties invoke the idea that they can hold a wider capacity for diversity. With this intent, a periodic set of fieldwork was done for detecting the amphibian and reptilian species. At the same time, this study puts forward the changes in the amphibian and reptilian species diversity over these 39 years.

MATERIALS AND METHODS

The fieldwork for detecting the amphibian and reptilian species of Büyükada, Heybeliada, Burgazada and Kınalıada was done between the years 2016 - 2019, and the months May-October.

The species were observed and collected with randomized walk design method. The fieldwork was done at forests, thickets and stony areas. Specimens were collected by hand and monitored at both day and night. At night specimens were found with flashlights and collected by hand. During the study, the GPS and habitat information of caught specimens were recorded. The identification of specimens were done according to Baran and Atatür (1998). Body measurements were made by a digital caliber (0.01 mm) and recorded. The samples are added to the herpetological collection of ZMUI Zoology Museum of University of Istanbul. For the newly recorded species, the locality information was mapped with QGIS 3.6 program.

The analysis of herpetofaunal diversity was calculated using Past 3.24 software programme [6]. The statistical methods; Principal components analysis (PCA) and Hierarchical Cluster Analysis (HCA) were applied. PCA were applied to compare the amphibian and reptile species on Marmara islands and mainland. HCA was performed to group the islands and mainland. The data was taken from the field studies and the literature.

RESULTS

Results of the fieldwork 3 species were recorded newly for the islands of Istanbul. 2 Individuals of the species *Bufo* *variabilis* was found in Büyükada (TURKEY • 1 ♀; Büyükada, Istanbul; 40.866129°N, 29.130664°E; 07 Oct. 2019, 110 m, Amp-19-001 • 1 ♀; Büyükada, Istanbul;

40.863716°N, 29.126683°E, 160 m, Amp-19-002) (Figure 1). One of the specimens was found near the road, under a bunch of thrown-away wooden material. The other one is found under some construction waste next to local ruins. Morphology of these 2 specimens does not differ from the populations on the mainland.

1 Individual from the species *Testudo graeca* was found between wild oats, during the fieldwork in Kınalıada (TURKEY • 1 ♂; Kınalıada, Istanbul; 40.905736°N, 29.046611°E, 14 June 2016, 10 m, Rept-16-001) (Figure 1). The specimen has 1 nuchal plate, which is elongate and protruded forward. There are 5 vertebral plates which are extended from Nuchal plate to Supracaudal plate. The number of Costal plates on one side is 4, Marginal plates is 11. There is 1 Supracaudal plate. The coloration of Carapace and Plastron are yellowish brown and there are dark spots on them. The recorded individual does not morphologically differ from the population on the mainland.

1 Individual of *Hemidactylus turcicus* was caught near a road, during the Heybeliada fieldwork (TURKEY • 1 ♂; Heybeliada, Istanbul; 08 July 2019, 40.873109°N, 29.091184°E, 70 m, Rept-19-001) (Figure 1). Morphology of *H. turcicus* is differ from the population on the mainland. Morphological examinations were recorded as follows: 80.71 mm of body length, a grey-brown colored dorsal surface, black, band-shaped spots on the head, black and irregularly dispersed oval spots on the tail. White and many-carinated tubercles were found on the sides and black tubercles were found on the body and in the middle of the tail. Ventral surface is spotless and colored white.

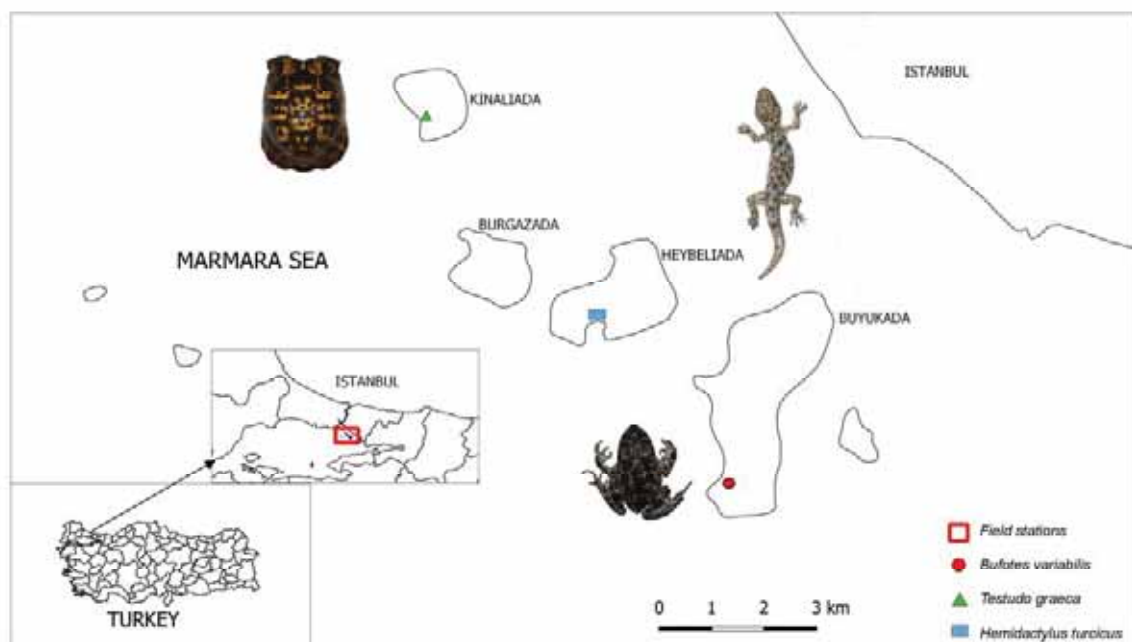


FIGURE 1
New localities of *Bufo variabilis*, *Testudo graeca* and *Hemidactylus turcicus* species on islands of Istanbul.

TABLE 1

The list of amphibian and reptile species of Istanbul islands compare with the mainland and Marmara islands (x: Baran, 1981; Baran and Atatür, 1998, +: this study; *: new localites, *?: Exoskeleton).

Species	Mainland	Marmara Island	Avşa Island	Paşalimanı	İmralı Island	Büyükada	Heybeliada	Burgazada	Kınalıada
<i>Bufo variabilis</i>	x	x	x	x	x	*			
<i>Pelophylax ridibundus</i>	x	x	x	x	x				
<i>Mauremys rivulata</i>	x	x		x	x				
<i>Testudo graeca</i>	x	x	x	x	x				*
<i>Psuedopus apodus</i>	x	x				*?			
<i>Mediodactylus kotschy</i>	x		x		x		x	x	
<i>Hemidactylus turcicus</i>	x			x	x		*		x
<i>Lacerta trilineata</i>	x	x							
<i>Podarcis siculus</i>	x					+	+	+	+
<i>Ophisops elegans</i>	x	x	x	x	x				
<i>Ablepharus kitaibelli</i>	x		x						
<i>Eryx jaculus</i>				x					
<i>Dolicophis caspius</i>	x	x	x						
<i>Platyceps najadum</i>	x	x		x					
<i>Malpolon insignitus</i>	x								
<i>Eirenis modestus</i>	x								x
<i>Natrix natrix</i>	x	x							
<i>Xerotyphlops vermicularis</i>	x	x		x					

Aside from the newly recorded species, a dried piece from the exoskeleton of *Psuedopus apodus* (Pallas, 1775) was found in Büyükada (20 May 2016, 40.842584°N, 29.113177°E, 40 m). But no alive specimens could be seen. The dominant species *P. siculus* was observed to be very common throughout the islands of our fieldwork; Büyükada, Heybeliada, Burgazada and Kınalıada.

The amphibian and reptile species of Istanbul islands, Marmara islands and mainland were listed with the literature based on Baran, 1981 and Baran and Atatür, 1998 (Table 1.).

Principal component analysis was applied based on variance covariance matrix (Figure 2.). The first principal component (eigenvalue of 1.91082) accounted for 45.86 % of the variation; PC2 (eigenvalue of 0.701502) accounted for 16.836 % of the variation; PC3 (eigenvalue of 0.52886) accounted for 12.693 % of the variation. According to PCA, mainland and Marmara island have higher herpetofaunal diversity. In spite of that islands of Istanbul have lower herpetofaunal diversity. The species *P. siculus* had developed a very dominant population.

Similarity of amphibian and reptilian species of

Marmara islands and mainland measured by a Classical Hierarchical Clustering Analysis with Euclidean distance index and UPGMA algorithm as clustering method (Figure 3.). HCA grouped three groups were formed; first group included islands of Avşa island, Paşalimanı island and İmralı island, second group included islands of Büyükada, Heybeliada, Burgazada and Kınalıada and third group included islands of Mainland and Marmara island.

DISCUSSION

In the light of our 3 year long studies between the years 2016-2019, only one species of the order Amphibia was found. The species is *B. variabilis* and is found in Büyükada. This species is the first one to be recorded from the Istanbul islands. Baran (1981) did not give a record of an amphibian from islands of Istanbul. In these areas, there are no natural water sources like streams or lakes. However, there are small pools and puddles formed by rains. It is thought that these water bodies contribute to the development of amphibian population.

The reptile species, *Testudo graeca* was recorded for the first time in Kınalıada with this study. This species is also a first time record for Istanbul islands. Baran (1981), has reported the species *Eirenis modestus* (Martin 1838), *H. turcicus* and *P. siculus* from Kınalıada. Out of these species, only *P. siculus* was observed in our study and throughout the island. The other 2 species could not be found during

our fieldwork.

The species *H. turcicus* is recorded from Heybeliada for the first time with this study. This species was reported before from Kınalıada, Sedef island and Tavşan island, of the Istanbul islands [2]. Baran (1981) reported that this species shows no difference from the specimens of Anatolian and

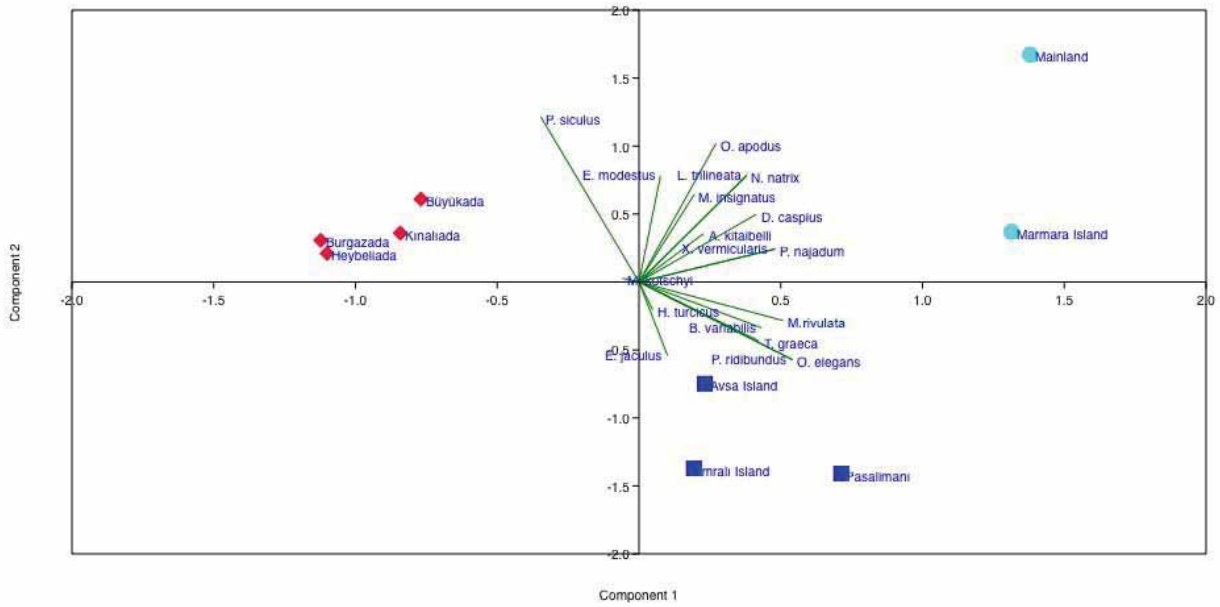


FIGURE 2
Principal Component Analysis of Istanbul islands, Marmara islands and mainland.

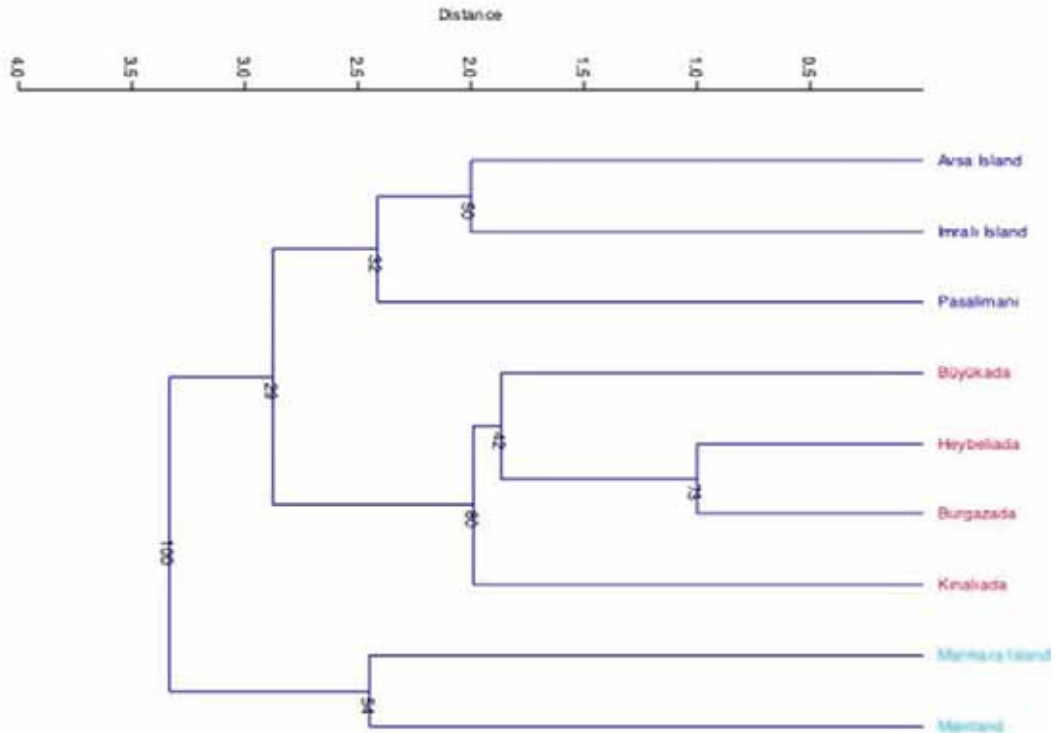


FIGURE 3
Results of Hierarchical Cluster Analysis of Istanbul islands, Marmara islands and mainland.

Trace regions. However, the specimen we recorded from Heybeliada does show morphological differences. Especially, it shows prominent thick bands on its head. Nonetheless, the decisive information can only be given after conducting morphological and genetic studies on this population. The species *Mediodactylus kotschy* (Steindachner, 1870) and *P. siculus* were reported from Heybeliada [2].

This study of the islands showed that the herpetofauna of the islands had changed over time. New records and dispersal information was given for islands of Istanbul. With the genetic studies to be done especially on these newly recorded species, the lineages and geographical origin of the species will be detected. These studies will provide insight to understand the mechanisms which impact the distribution of amphibian and reptilian species.

ACKNOWLEDGEMENTS

I would like to thank the employees of Republic of Turkey Ministry of Agriculture and Forestry, Istanbul 1st regional directorate. I would like to thank to Assoc. Prof. Dr. Oya Ozuluğ, Master's students Ahmet Arihan Erozdin and Harun Inci and undergraduate student Selahattin Barış Cay from Istanbul University, Faculty of Science, Biology Department who helped with the fieldwork.

REFERENCES

- [1] Acatay, A. (1953) Researches on pine processionary moth (*Thaumetopoea pityocampa* schiff = *Thaumetopoea wilkinsoni* tams.) and its struggle on the islands. Journal of the Faculty of Forestry Istanbul University. 3(1-2), 29-45.
- [2] Baran, I. (1981) A Taxonomic and Ecological Research on the Herpetofauna of the Islands in North Aegean Sea, Marmara Sea and Black Sea. Doğa Bilim Dergisi, Temel Bilimler. 5, 155-162.
- [3] Baran, I., Atatür, M.K. (1998) Turkish Herpetofauna (Amphibians and Reptiles). Republic of Turkey Ministry of Environment, Ankara, 1-214.
- [4] Günel, N. (1998) Vegetation and climate relationship in Istanbul islands. Turkish Geographical Review. 33, 101-128.
- [5] Gür, H. (2016) The Anatolian diagonal revisited: Testing the ecological basis of a biogeographic boundary. Zoology in the Middle East. 62(3), 189-199.
- [6] Hammer, Q., Harper, D.A.T., Ryan, P.D. (2001) PAST: Paleontological Statistics software package for education and data analysis. Palaeontologia Electronica. 4(1), 9.
- [7] Kantarcı, M.D. (1984) An investigation on the habitat features, landscape and forestation of Istanbul islands. Journal of the Faculty of Forestry Istanbul University, Seri B. 34(3), 49-69.
- [8] Mittermeier, R.A., Turner, W.R., Larsen, F.W., Brooks, T.M. Gascon, C. (2011) Global Biodiversity Conservation: The Critical Role of Hotspots. In: Biodiversity Hotspots. Springer-Verlag Berlin Heidelberg. 3-22.
- [9] Mittermeier, R.A. Rylands, A.B. (2018) Encyclopedia of the Arthropocene. In: Biodiversity Hotspots. 1st ed. Elsevier. 67-75.
- [10] Kaya, H. (2019) Geomorphological features of Marmara Islands. International Journal of Environment and Geoinformatics. 6(1), 57-66.
- [11] Uzun, A. (1992). Researches on the place and importance of natural and exotic plant species of Istanbul islands in the landscapes of islands. Journal of the Faculty of Forestry Istanbul University, Seri A. 42(2), 160-181.

Received: 19.11.2020

Accepted: 20.03.2021

CORRESPONDING AUTHOR

Nilgun Kaya

Institute of Graduate Studies in Science,
Istanbul University,
Istanbul – Turkey

e-mail: nilgun.kaya@ogr.iu.edu.tr