



RESEARCH ARTICLE

**ALIEN VERTEBRATES AND VERTEBRATE PESTS IN TURKEY WITH AN OVERVIEW
OF RODENT MANAGEMENT**

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ABSTRACT

Considering alien and invasive species are major threat to indigenous species, the recent status of these type of vertebrates were reviewed along with the current rodent management application in Turkey. More than twenty-five alien, potentially invasive freshwater fish species have been reported in Turkey. Of these, seven were recorded from inland waters as alien and two as translocated. Eighteen marine fishes from the Mediterranean and three from the Black Sea have previously been reported as invasive or alien. In this study, of twelve fishes, eleven were determined as potential invader in our long term observations in Mediterranean Sea; puffer fish and Vanikoro sweeper (*Pempheris vanicolensis*) were evaluated as considerably successful invasive ones. Two reptile species are known as alien in Turkey: the Red-eared Slider (*Trachemys scripta*) is an imported species in south-western rivers of Anatolia; İstanbul Wall Lizard (*Podarcis siculus*) is a transported species found in the Marmara region in Turkey. Four bird species are alien and potential invaders; Laughing dove (*Spilopelia senegalensis*), Ring-necked parakeet (*Psittacula krameria*), White-spectacled bulbul (*Pycnonotus xanthopygos*) and Common myna (*Acridotheres tristis*). Mammalian species; nutria (coypu-*Myocastor coypus*) which is introduced to two rivers in Turkey, black and Norway rats (*Rattus rattus* and *Rattus norvegicus*) along with house mouse (*Mus musculus*) are alien and also synanthropic species. According to the rodent management report released in 2013 for agricultural areas, 1.202 kg zinc phosphide was used for rodent control in 73 provinces of Turkey; Konya province was most active against rodents, using 400 kg zinc phosphide in 19 956 kg poisoned baits. Only anticoagulant rodenticides are permitted to use in urban areas. Application doses of 50 mg/kg of anticoagulant rodenticides caused death three days later after poisoned baits were given to rats. In our experiments, no resistance to anticoagulant rodenticides was determined in black and Norwaybrown rats around

Ankara provinces. Control of other potential vertebrate pests such as snakes, Egyptian fruit bat and porcupine is not legally permitted in Turkey.

Keywords: alien vertebrates, rodent control, Turkey

1. INTRODUCTION

As a country connecting Asia to Europe, Turkey has high biological diversity due to the faunal migration routes through Europe, The Caucasus and the Arabian Peninsula. The Dardanelle and Bosphorus Straits play a major role in these routes. Recent colonisation of terrestrial vertebrate fauna in Turkey took place during the Pleistocene after the withdrawal of an internal sea in Central Anatolia, and Anatolia has also many endemic vertebrate species [1], [2], [3], [4], [5], [6], [7], [8], [9], [10]. [7] suggested that glacial contractions and expansions in Turkey during the Pliocene and Pleistocene created an area of convergence of many species with rich endemism. Recent vertebrate inventories of Turkey have reported 377 freshwater fish, 512 marine fish, 34 amphibians (17 frogs, 17 salamanders), 131 reptiles (1 blind lizard, 64 common lizards, 55 snakes, 11 testudines), 478 birds and 170 mammals (15 marine mammals) with total of approximately 1707 species [9], [10], [11], [12], [13], [3], [4], [14], [15], [16], [17], [18], [19], [20], [21], [22], [23]. Invasive species have been reported to cause extinction of animals [24], [25]. The alien and translocated fishes in Turkish inland waters were reviewed in detail by “İnnal and Erk’akan (2006), İnnal (2012), [10], Tarkan et al. (2012, 2015), Şaç and Özuluğ (2017), Yoğurtçuoğlu and Ekmekçi (2018), Özuluğ et al (2018) and [23]. [10] also pointed out that invader fishes can cause changes in species composition, and can replace native species in aquatic ecosystems. [17] reported that Turkey had 314 freshwater fishes with 54 endemic species and 49 under threat. [10] found that the total freshwater fish inventory was 350 species with 135 endemics.

[21] reported that total of 377 fish species live in the inland waters of Turkey. Among these species, three fishes are globally extinct, 5 fishes are extinct in Turkey, 28 of them are non-native, 340 of them are native, and 157 species are endemic to Turkey [23]. The number of the non-native fish species and distribution areas of these species have increased in recent years with new data about some species, such as *Heteropneustes fossilis*, *Pterygoplichthys disjunctivus*, *Pseudorasbora parva*, *Carassius gibelio*, *Gambusia holbrooki*, *Lepomis gibbosus*, *Pygocentrus nattereri*, *Pangasius sanitwongsei* “(Tarkan, 2006; Yalçın Özdilek, 2007; Ünlü et al., 2011; Tarkan et., 2012; Şaç & Özuluğ, 2017, Yoğurtçuoğlu & Ekmekçi, 2018, Özuluğ et al., 2018)”. Alien fish species are introduced into the freshwater ecosystems by different ways such as aquaculture, biological control, pet trade and fisheries. Within these species, *G. holbrooki* is the first species deliberately vaccinated in freshwater systems for biological control to fight against malaria [10]. “Copp et al (2005)” and “Kennard et al. (2015)” mentioned that the detrimental impacts of these fishes on ecosystems were recognized mainly with predation, food and habitat competition, hybridization, habitat degradations, and disease transfer “(Özuluğ et al., 2018)”. [10] also pointed out that invasive fishes can capable to change species compositions, and can replace the native species in aquatic ecosystems.

“Otero et al. (2013)” listed 18 marine fish species in a black list of Mediterranean invaders while drawing attention to factors causing invasions, such as the Suez Canal, Gibraltar Strait, rising salinity, warming sea temperatures and ballast water dumping. The marine fish of Turkey comprise 512 species and are reviewed in detail by [18]. The majority of fishes, including the black list of Mediterranean invaders (Otero et al., 2013), have also been recorded on Turkish coasts “(Artüz, 1999;

Bilecenoğlu et al., 2002a; Dobrovolov et al., 2003; Çınar et al., 2005; Çiçek, 2006; Aleksandrov et al., 2007; Engin et al., 2007; Vasil'eva, 2007; Tuncer et al., 2008; Bilecenoğlu, 2010; [18])”.

Although the exact numbers of Turkish amphibians and reptiles is not certain, according to recent reports, the Turkish herpetofauna comprises approximately 34 amphibians and 132 reptilian species “(Baran et al., 2012; [21]; the reptile database, 2015)”. Until now, no amphibian species have been reported as introduced or invasive, but two reptilian species — the Red-eared Slider and İstanbul Wall Lizard — have been reported as invasive species “(http://www.europe-aliens.org/pdf, Hür et al., 2008; Mollov, 2009; Ficetola et al., 2012; Ilgaz et al., 2013; Silva-Rocha et al., 2014; Tok et al., 2015; [21], The reptil database, 2015)”.

The avifauna of Turkey includes nearly 483 bird species. These are native, migrant, and rare or transit birds. IUCN Invasive Species Specialist Group (ISSG-2017) reported that eleven bird species are invasive in Turkey; *Acridotheres tristis*, *Oxyura jamaicensis*, *Psittacula krameri*, *Alectoris chukar*, *Anas platyrhynchos*, *Anser anser*, *Bubulcus ibis*, *Columba livia*, *Cygnus olor*, *Porphyrio porphyrio* and *Streptopelia decaocto* (http://www.iucngisd.org/gisd/). Turkey consists of two major geographic parts, Turkish Thrace and Anatolia (Asia Minor). Due to its geographical isolation and its location at the crossroads of three migration routes, the Turkish mammalian inventory comprises species mixtures of arboreal mammals from Europe, steppe mammals from The Caucasus and desert mammals from the Arabian Peninsula. With recent records, the number of mammalian species has reached 170 [3], [4], [12], [15], [16]. Nutria (*Myocastor coypus*) is known as alien among these species (Mursaloğlu, 1973; Özkan, 1999; İliker et al., 2009)”. “Khlyap et al. (2010)” stated that 62 mammalian species are alien to Russian territory grouping such as (1) Intentional introduction, (2) Reintroduction, (3) Self-dissemination and (4) Accidental introduction. Some rodent species especially Synanthropic and Agrophilic have been considered as alien species “(Khlyap and Warshavsky 2010)”. In consistent with these, “Kosoy et al. (2015)” reported that the term of invasive species indicates that Black (*Rattus rattus*) and Brown (Norway) (*Rattus norvegicus*) rats are characterized as historically introduced species; cosmopolitan in their distribution, and alien where they did not inhabit previously, and they mostly lives inside houses or using other man-made feature.

Biocides, including rodenticides, are used worldwide to manage pests in both agricultural and urban areas. Rodents are the one of the largest mammalian orders, with more than 2000 species, and cause economic losses, damage infrastructure, eat and contaminate large quantities of food, and transmit diseases to humans (e.g. bubonic plague, typhus, Weil's disease, toxoplasmosis, trichinosis, hantaviruses, babesiosis, Lyme disease, tularaemia, cutaneous leishmaniosis, etc.). Rodent management and related topics are explained in detail by “Buckle and Smith (1994), Atkinson (2000), Gratz (2006), and WHO (2006)”. In Turkey, rodent pest management is regulated and supervised in agricultural areas by the Ministry of Food, Agriculture and Livestock, and in urban areas by the Ministry of Health. In present study, the alien or invasive status of non-native vertebrate in Turkey were discussed, and also the current pest management on Turkish rodents was evaluated.

2. MATERIALS AND METHODS

The findings is based on data obtained from the entire Turkey between 2010-2019, comprising data from sampling, observations from both scuba diving and searching inland ecosystems, and previous studies. The vertebrate species (fishes, reptile and birds) listed in this study were mainly classified according to terms for ecological invasion and its corresponding stages defined by “Colautti and MacIsaac (2004)”, and mammalian species were classified by the definitions of “Khlyap and

Warshavsky (2010)”. Fish samples were collected from various rivers, dams and lakes in Turkey (Table 1, Figure 1). Equipment such as electro shocker, gill nets and scoop nets were used to sample fish. The samples were fixed in 4–5% formaldehyde solution and were deposited in the Biology Department of Ankara University. Our data on marine fishes was mainly obtained from three locations: at Kaş (m1), Alanya (m2) and Gazipaşa (m3) (see Figure 1). The data from Alanya is based on long term observation between 2010-2019. The data on reptiles, birds and mammals was obtained from field observations and published literature. The studies on rodent pest management were performed on both wild rats (n= 5 in each groups) (Black and Brown Rats from Ankara provinces) and laboratory (Wistar) rats using first and second-generation anticoagulant rodenticides (warfarin, brodifacoum, bromadiolone, chloropacinone, difenacoum, difethialone) readily available for commercial sale in Turkey. The active ingredients of rodenticides were analysed with HPCL before being given to rodents. Five samples were used in each experiment with application doses of 50 mg/kg.

Table 1. Record locations of alien inland fishes in the present study.

Record locations of inland fishes in the present study	Numbers on the map
Işıklı Lake (Denizli)	r1
Büyük Menderes, Eber Lake (Dinar, Çay, Afyon)	r2
Yamula Dam Lake (Kayseri)	r3
Su Çatı, Menzelet (Göksun, Kahramanmaraş)	r4
Eşen Çayı (Fethiye, Muğla)	r5
Alara river (Alanya, Antalya)	r6
Köyceğiz Lagoon (Muğla)	r7
Langır Creek (Dalaman-Muğla)	r8
Kızılırmak River (Yozgat)	r9
Kızılırmak River (Sivas)	r10
Büyük Menderes (Denizli)	r11
Çine Stream (Aydın)	r12
Topçam Lam Lake (Aydın)	r13
İznic Lake (İznic, Bursa)	r14
Gölmarmara (Manisa)	r15
Hirfanlı Dam Lake (Ankara)	r16
Kesikköprü Dam Lake (Kırıkkale)	r17
Mogan Lake (Ankara)	r18
Sakarya River and Sarıyar Dam Lake (Ankara)	r19
Uluabat Lake (Bursa)	r20
Bafa Lake (Muğla)	r21
Beyşehir Lake (Konya)	r22
Upper Ceyhan River (Ekinözü, Kahramanmaraş)	r23
Spring water around Burdur Lake (Burdur)	r24
Cuma Creek (Orhaneli, Bursa)	r25
Eğirdir Lake (Isparta)	r26

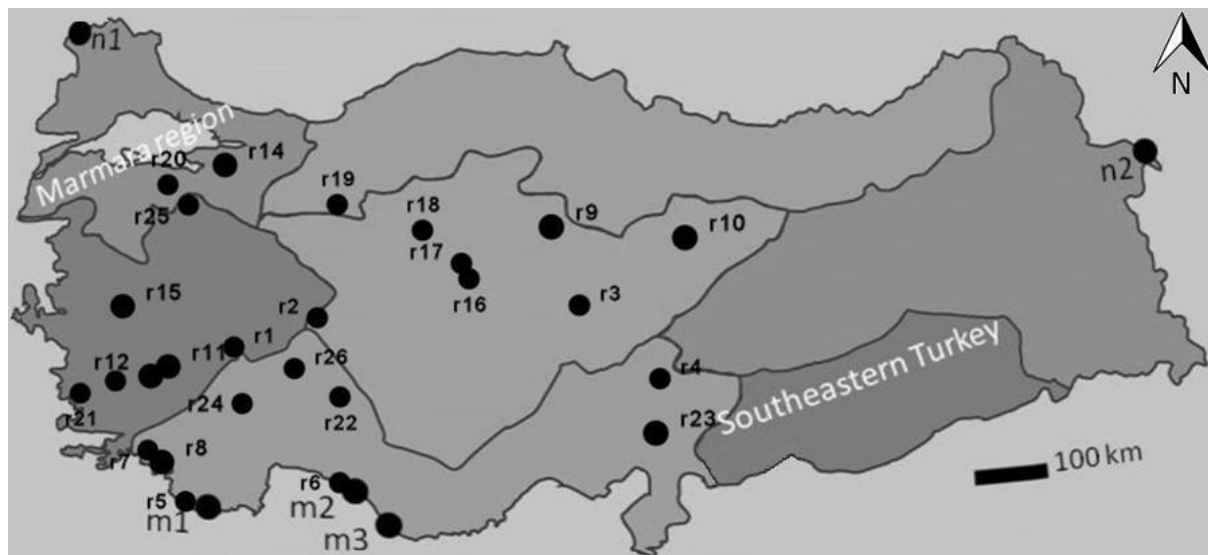


Figure 1. Record locations of alien vertebrates of Turkey; m (marine locations), n (locations of Nutria), r (rivers), see in Table 1 for abbreviations.

3. RESULTS

3.1. Alien Vertebrates in Turkey

The invasive status of alien vertebrate species recorded in Turkey was evaluated using our distribution records (Tables 2, 3, 4). A non-indigenous species may arrive in a country by means of travelling, or being transferred, transported, introduced or imported (terms described by “Colautti and MacIsaac, 2004”). Some of indigenous and non-indigenous species may be intentionally introduced from one parts of Turkey to another. Some species can be defined as synanthropic and agrophilic “(Khlyap and Warshavsky 2010)”. The statuses of Turkey’s vertebrate species were evaluated under this framework.

3.2. Freshwater Fishes

The numbers of fresh water fishes are controversial and have variously been reported to be 213 [14], 236 [13], 314 [17], 310 [10] and 377 [22], [23]. Thirty fishes were introduced from other countries (exotic) and sixteen translocated to Turkish inland waters by “İnnal and Erk’akan (2006). Later, İnnal (2012)” listed 30 fish species as alien and 24 species as translocated, including some marine genera such as *Liza*, *Mugil* and *Sparus*. In this study, nine fishes were reported to be alien and two translocated in 26 river systems in Turkey (Table 2), invasive ones; Gibel carps, Topmouth gudgeon, Rainbow trout, Eastern Mosquitofish, Zander, Piranha, Nile Tilapia, Pumpkinseed sunfish, Giant Pangasius. Piranha was only reported in Uluabat-Sapanca Lake, and Giant Pangasius in only Sakarya River. Other invasive fishes were recorded from more than one aquatic system, and translocated fishes are Tench and Sand smelt which are also invasive and occupy in many rivers and lakes (Figure 1, Table 2). However it is unknown whether these species have extended their range or have established natural populations in inland waters, and also taxonomic status of some of these fishes is uncertain. “İnnal (2012)” also reported that 12 species have established natural populations in inland waters. Within the invasive fish species, some “*Alburnus chalcoides*, *Cyprinus carpio*, *Sander lucioperca*, *Perca fluviatilis*, *Silurus glanis*” are vaccinated to the reservoir for fishery and production purpose,

some “*Acipener baeri*, *Captogon zilli*, *Oreochromis aureus*, *Oreochromis mossambicus*, *Oreochromis niloticus*, *Salmo salar*, *Salvelinus alpinus*, *Salvelinus fontinalis*” are accidentally released to the freshwater systems during research carried out in universities, some “*G. holbrooki*, *Ctenopharyngodon idella*, *Hypophthalmichthys malitrix*” vaccinated to the freshwater systems for biological control, and some of the aquarium species “*P. sanitwongsei*, *P. nattereri*” are intentionally entered into the freshwater system by human [10], Yoğurtçuoğlu and Ekmekçi, 2018”. Fishes alien to Turkish inland waters such as *C. gibelio*, *P. parva*, *Oncorhynchus mykiss*, *G. holbrooki*, *Sander lucioperca*, *Oreochromis niloticus* and *L. gibbosus* were introduced for commercial or pest management purposes, and are reported to be invasive species “(Wildekamp et al., 1997; Şaşı and Balık, 2003; Özuluğ et al., 2004, 2007; Uğurlu and Polat, 2007, Pyke, 2008; Ekmekçi et al., 2010; Przybylski and Zieba, 2011; Aydın et al., 2011; Tarkan et al., 2012; [10]; Karakuş et al., 2013; Tarkan et al., 2015)”. *C. gibelio*, one of the first invaders, has been recorded in eight rivers and lakes. It is important for commercial fishing, especially in the eutrophic and polluted Eber Lake (Table 2, see Figure 1), and it is said to be exported to Iraq. Alien fishes such as *Oreochromis* sp., *Captodon zillii*, and *L. gibbosus* are known to have spread to coastal reservoirs and creeks in the west and south-west of the country [11], Çalışkan and Yerli, 2000; İnnal and Erk’akan, 2006; Özcan, 2007; Mert and Çiçek, 2010, Aydın et al., 2011)”. Our records for *L. gibbosus* from Büyük Menderes River in Denizli and Cuma Creek in Bursa provinces (Table 1; r11, r25 and see Figure 1) prove the expansion of the distribution of the species. *Ctenopharyngodon idella* is other alien species that has been introduced into many aquatic systems, but has not established natural populations in most of these systems “(İnnal and Erk’akan, 2006; Tarkan et al., 2015)”. In consistent with these reports, this species was not caught in our survey of inland waters. Apart from this, Janitor fish (*P. disjunctivus*), Stinging catfish (*H. fossilis*) and Piranha (*P. nattereri*) are also alien to Turkish inland waters and are reported from the rivers of south-eastern Anatoli and Sapanca Lake “(Yalçın-Özdilek, 2007; Ünlü et al., 2011, [10], but there is no record for these species that establishing population in in the freshwater systems. *Salmo salar* and *Salvelinus fontinalis* occasionally appear in inland waters of Black Sea coast of Turkey “(İnnal and Erk’akan, 2006)”. The intentional introduced species *Tinca tinca* were caught at four locations. This species is known to be introduced to many aquatic systems, and is reported to have a harmful effect on natural populations “(Ekmekçi, 2010; [10]. Another intentional introduced species *Atherina boyeri*, which is native to the Black Sea coast of Turkey and has high ecological tolerance to salinity, was recorded from eight inland aquatic systems (Table 2). This species is known to be translocated to Turkish lakes and rivers, and to be a successful invader “(Balık et al., 2005)”. “Crivelli (1995)” has stated that fish introductions threaten endemic freshwater fishes in the northern Mediterranean region. Consistent with this report, the introduction of *Sander lucioperca*, *T. tinca*, *Pseudorasbora parva* and *A. boyeri* to Hirfanlı Dam Lake in Central Anatolia caused the extinction of *Alburnus* sp. “(Ekmekçi et al., 2010)”. In addition, two endemic fishes, *A. akili* and *Pseudophoxinus handlirschi* were extinct after *S. lucioperca* was introduced to Lake Beyşehir “(Küçük et al., 2009; [10]. Also “Pyke (2008)” pointed out the harmful effects of mosquito fishes on invertebrates, fishes and amphibians. The recent status and detailed evaluations of alien fresh water fishes were revised by “İnnal and Erk’akan (2006), İnnal (2012), [10] and Tarkan et al. (2015), Özuluğ et al. (2018) and [23]. In the assessment of “Tarkan et al. (2015)”, 30 species were reported to be introduced, 11 translocated, and 19 established self-sustaining populations, they used a term translocated as the range extension considering the criteria given by “Blackburn et al. (2011)”. According to this criteria, “Tarkan et al. (2015)” stated in consistent with our findings that invasive species were listed as fully invasive (criterion E: *A. boyeri*, *C. gibelio*, *Cyprinus carpio*, *P. parva*, *G. holbrooki*), self-sustaining populations in the wild, with individuals surviving and reproducing a significant distance from the original point of introduction (criterion D2: *T. tinca*, *L. gibbosus*, *Clarias gariepinus*) and self-

sustaining populations in the wild, with individuals surviving a significant distance from the original point of introduction but not reproducing (criterion D1: *Captodon zillii*).

3.3. Marine Fishes

Apart from fresh water fishes, the potential invader and alien Mediterranean and Black Sea marine fishes were listed by “Taşkavak and Bilecenoğlu (2001), Bilecenoğlu (2010), Otero et al. (2013) and Yankova et al. (2013)”. Of these species, sixteen from the Mediterranean and three from the Black Sea have been introduced due to range extension or human transportation and are evaluated along with our records in Table 3. The number of non-native fish species was 33 in 2002 “(Bilecenoğlu, 2002a)”; in 2008 that number reached 49 “(Bilecenoğlu, 2010)”, including 18 fish species as a black list of Mediterranean invaders “(Otero et al., 2013)”. In this study, *Alepes djedaba*, *Fistularia commersoni*, *Lagocephalus spadiceus*, *Lagocephalus sceleratus*, *Nemipterus randalli*, *Hemiramphus far*, *Pempheris vanicolensis*, *Sargocentron rubrum*, *Siganus luridus*, *Siganus rivulatus*, *Upeneus molluccensis* and *Upeneus pori* were captured and observed via scuba diving, fishing or in fish markets; *A. djedaba* was rarely and seasonally observed in fish markets. Supporting our records, “Golani et al. (2013)” reported that *A. djedaba* had expanded its westward distribution to the island of Crete. *F. commersoni* was observed in Kaş (see Figure 1; m1) as single individual at a depth of 10 m, and was also reported in Alanya Bay (see Figure 1; m2). The first puffer fishes were observed in 2005, the current density of these two species are very high and cause threat to angling in daytime, and the range expansion of *L. sceleratus* was given in detail by “Bilecenoğlu (2006)”, and *L. spadiceus* by “Tuncer et al., (2018)”. Although another Tetraodontid fish, *Torquigener flavimaculosus*, was reported to be very abundant in Fethiye Bay “(Bilecenoğlu, 2010)”, this species is not listed on the Mediterranean black list by “Otero et al. (2013)”, and not caught or observed in Alanya and Gazipaşa coasts. Randall’s threadfin bream (*N. randalli*) is frequently caught in fishing boats around Alanya and Gazipaşa bays, and is a commercial species in fish markets. This fish is reported to be a successful expander by “Bilecenoğlu and Russell (2008), Bilecenoğlu (2010)”. Vanikoro sweeper (*P. vanicolensis*), a successful invader, has begun to dominate in inshore caves. However, Redcoat (*S. rubrum*), which occupies the same niche as Vanikoro sweeper, has not increased in population density in the last ten years in Alanya and Gazipaşa coasts. According to “Bilecenoğlu (2010)”, *U. molluccensis* is a successful coloniser with commercial importance in trawl catches. This species is frequently seen at local fish markets, and is caught from the sandy grounds of Alanya and Gazipaşa Bays along with *U. pori*. “Çiçek (2006)” suggested that *U. molluccensis* formed 3% of alien fish biomass on the Turkish Mediterranean coast. *S. luridus* was rarely caught but *S. rivulatus* was abundant in the records from scuba diving and fishing with gill nets. Apart from the fishes listed as invasive by “Otero (2103)”, Black-barred halfbeak (*H. far*) was also caught in shore angling, but not considered as invasive due to the rarity in Alanya and Gazipaşa Bays. This fish is also listed as alien by being emphasized in their abundance in İskenderun Bay by “Bilecenoğlu (2010)”. Three fishes in the Black Sea are reported to be alien: *Parablennius incognitus*, *Gobius cruentatus*, and *Liza haematochelia*. *L. haematochelia* was introduced to the Black Sea, but this species seemingly has not expanded to the Marmara and Aegean Seas, and no detailed information is available about its invasive status “(Tuncer et al., 2008; Bilecenoğlu, 2010)”.

3.4. Reptiles

Currently there is no amphibian recorded as alien to Turkey, but one turtle species (*Trachemys scripta*, which are released to inland water by pet owners) and one species of lizard *Podarcis siculus* are known as alien species to Turkey (Table 4). The Red-eared Slider, *T. scripta*, was reported from a river in the south-west of Turkey “(Ficetola et al., 2012; [21])”. This species is reported to threaten native turtles and feed on aquatic insects, fishes and amphibians “(Ficetola et al., 2012)”, and its likely

distribution overlaps with two other native turtles in Turkey, *Emys orbicularis* and *Mauremys rivulata*. This species was not seen in the rivers in our surveys performed throughout south-west parts of the country, but the Red-eared Slider is considered to be a potential competitor with native turtles in the future.

P. siculus “İstanbul Wall Lizard” was first recorded from Istanbul by “Berthold (1842)” and is mostly distributed in the Marmara region of Turkey (mostly in the Asiatic part, see region in Figure 1). Even though this species is non-native, recent studies have shown that this lizard has not expanded its range extensively in Turkey “(Podnar et al., 2005; Uğurtaş et al., 2007; Mollov, 2009; Ilgaz et al., 2013; Silva-Rocha et al., 2014; Tok et al., 2015)”. It is found as far to the east as Zonguldak province in the western Black Sea region of Turkey “(Ilgaz et al., 2013)”. No additional records are presented in this study for this taxon and its invasive status is unknown.

3.5. Birds

Of eleven birds on the IUCN Invasive Species Specialist Group (ISSG-2017) invasive species list, three species are observed in Turkey. *A. tristis* (Common myna) is an alien species in Turkey and has been observed in İstanbul, Ankara, İzmir, Kayseri and Samsun “([19])”. *O. jamaicensis* (Ruddy duck) have been recorded as alien species in Turkey but there are no distribution records for the species. *P. krameri* (Ring-necked parakeet) has colonised some parts of Turkey. This species was imported and accidentally released in Ankara in the 1980s, and is frequently observed in Ankara. They were recorded in Ankara (in this study), and they have also been observed in İstanbul as large colonies, İzmir, Denizli, Antalya, Adana, Gaziantep, Şanlıurfa “([19])”. The native bird, *Pycnonotus xanthopygos* (White-spectacled bulbul), is not included in the ISSG list as an invasive species, but has been recorded as expanding its distribution and has started to colonise new localities “(Aslan and Erdoğan, 2007)”. *Streptopelia senegalensis* (Laughing dove) is not a native bird in Turkey but not covered in the ISSG list. However, its distribution is expanding; they now occur in many cities but were known only in İstanbul and south-east Turkey (see the region in Figure 1) in the early 20th century “(Albayrak, 2011)”. Record locations for these birds are given in Table 3.

3.6. Mammals

Among Turkish mammals, only one, *Myocastor coypus* (Nutria), was accidental introduced. It is known from only two river systems: the Tunca and Meriç Rivers in Turkish Thrace and the Aras River in eastern Turkey (Table 4, see Figure 1; n1, n2, “Mursaloğlu, 1973; Özkan, 1999; İliker et al., 2009”). We also observed nutria around the Tunca and Meriç Rivers. There is no information about its effects on ecosystems and local fauna. “Khlyap and Warshavsky (2010)” also reported that synanthropic and agrophilic rodents are a part of danger invasive alien mammals of Russia, and they also reported that Brown rat, the House mouse (*Mus musculus*), the Striped Field mouse (*Apodemus agrarius*), the East European vole (*Microtus levis*) are as synanthropic and agrophilic rodents in Russia. By the considering definitions of “Khlyap and Warshavsky (2010)”, three synanthropic/alien rodent species such as Western House Mouse (*Mus domesticus*), Brown (*R. norvegicus*) and Black (*R. rattus*) rats are common in Turkey. The genus *Mus* is represented by two species: *M. domesticus* and *M. macedonicus* (Balkan House Mouse), later occupies mostly rural areas and the grain fields. Brown rat is mostly distributed in central and northern urbans of country instead of southern parts through Mediterranean coast. Black rat is also common throughout the country with various colour morphs. Turkish synanthropic rodents belong to groups 3 (Self-dissemination) and 4 (Accidental introduction) according to the groups given by “Khlyap et al. (2010)”. In addition to Brown, Black rats and House mouse, *A. agrarius* and *M. levis* are distributed in Turkey but it is not possible to say anything about

their dissemination ways to Turkey, and they are not taken into account as synanthropic and agrophilic for Turkey.

3.7. Rodent Control in Agriculture and Urban Areas

In Turkey such rodents are regulated and supervised (rodent pest management) in agricultural areas by the Ministry of Food, Agriculture and Livestock, and in urban areas by the Ministry of Health. Rodents are classified simply as voles or moles in agricultural areas, according to a document on the plant health and application program released in 2014, and management procedures are explained in the related documents “(General Management of Food and Control, 2014)”. Many of these rodents are not alien and their distributions are detailed given by [4]. The first group of rodents (“voles”) includes mainly *Microtus* spp. (*M. hartingi*, *M. lydius*, *M. guentheri*, *M. socialis*, *M. anatolicus* and *M. dogramacii*) and *Meriones tristrami* which are distributed in grain fields, and *Rattus rattus frugivorus* in citrus gardens in Southern Turkey. However, the same fields are also occupied by non-target species such as grey dwarf hamster (*Cricetulus migratorius*), Turkish hamster (*Mesocricetus brandti*), Anatolian ground squirrel (*Spermophilus xanthoprimum*), and European ground squirrel (*Spermophilus citellus*).

The second group, “moles”, includes *Nanospalax leucodon* in Turkish Thrace and *N. nehringi* in the Asiatic part of Turkey. Poisoned grains (2–5% zinc phosphide) are traditionally used for rodent control in agricultural areas. According to a 2013 report, 1.202 kg zinc phosphide was used for rodent control in 73 provinces of Turkey in 2013. Konya province was most active against rodents, using 400 kg zinc phosphide in 19956 kg poisoned baits, followed by Afyon with 2610 kg, and Balıkesir and Elazığ with 2500 kg each. Mechanical methods are used for mole management “(General Management of Food and Control, 2014)”. Apart from zinc phosphide, the fumigant aluminium phosphide is also used for rodents and is freely available on the Turkish market.

In this frame first- and second-generation anticoagulant rodenticides are permitted for use in urban areas for synanthropic rodents. In our experiments performed on wild rats (Brown rat and Black rat) and Wistar rats (laboratory race of Brown rat), 50 mg/kg doses of anticoagulant rodenticides such as warfarin, brodifacoum, bromadiolone, chlorophacinone, difenacoum and difethialone caused death three days later after the poisoned baits were laid. No resistance to the rodenticides was observed in wild rats or Wistar rats captured around Ankara province. However, our findings were obtained from the small sample group, genetic tests for anticoagulant rodenticide resistance is needed for more precise results. Apart from the rodenticides listed above, other licensed rodenticides such as coumatetralyl and flocoumafen are used for rodent control and can be purchased from shops by individuals. However, the pest controls in urban areas are permitted to perform private licensed companies. The Ministry of Health also manages cases concerning public health. For example, the Ministry of Health successfully manages tularaemia, a well-known rodent-borne disease in rural settlements. Pest control procedures are not legally permitted for any species apart from rodents, despite complaints about snakes, Egyptian fruit bats *Rousettus aegyptiacus* and porcupines *Hystrix indica*. A naphthalene + sulphur mixture is permitted for use against snakes as a repellent, but there is no robust evidence of its efficacy. Egyptian fruit bat and porcupine are mainly found on the Mediterranean coast of Turkey. Egyptian fruit bat droppings foul the walls and windows of facilities when the flight path to fruit trees is close to buildings. The porcupine is a protected rodent and is under threat, but illegal hunting for folk remedies is very common in Turkey. There have been some complaints about porcupines gnawing avocado and olive seedlings. However, the control of Egyptian fruit bat and porcupine are not legally permitted in Turkey. Not all the listed harmful species are considered alien in Turkey.

Table 2. Alien and translocated (Tra) freshwater fishes recorded in Turkish aquatic ecosystems (Int: Introduced, Inv: Invasive, Col: Colonizing, r: record locations in the present study, see map).

Order/Family	Scientific name	Common name	Status	r
Cypriniformes/ Cyprinidae	<i>Carassius gibelio</i>	Gibel carps	Int, Inv	2, 9, 10,11, 12, 13,14,15
Cypriniformes/ Cyprinidae	<i>Pseudorasbora parva</i>	Topmouth gudgeon	Int, Inv	11,12,12,16 17,18,19,20
Cypriniformes/ Cyprinidae	<i>Tinca tinca</i>	Tench	Tra	9,10,16,17
Salmoniformes / Salmonidae	<i>Oncorhynchus mykiss</i>	Rainbow trout	Int, Col, Inv	1,2,3,4,5,6
Atheriniformes / Atherinidae	<i>Atherina boyeri</i>	Sand smelt	Tra, Col, Inv	3,14,16,17, 18, 21,22,23
Cyprinodontiformes / Poeciliidae	<i>Gambusia holbrooki</i>	Eastern Mosquitofish	Int, Inv	1,14,15,16,17, 23
Perciformes / Percidae	<i>Sander lucioperca</i>	Zander	Int, Inv	16,22,26
Charciformes/ Serrasalminidae	<i>Pygocentrus nattereri</i>	Piranha	Int, Inv.	20
Perciformes / Cichlidae	<i>Oreochromis niloticus</i>	Nile Tilapia	Int, Inv	7, 8
Perciformes / Centrarchidae	<i>Lepomis gibbosus</i>	Pumpkinseed sunfish	Int, Inv	12, 13, 25
Siluriformes Pangasiidae	<i>Pangasius sanitwongsei</i>	Giant Pangasius	Int, Inv	19

Table 3. Some potential invader fishes (based on Otero et. al., 2013) in Turkish coast of Mediterranean and Black Sea (PS: present study).

Order/ Family	Scientific name	Common name	PS (see map)	References
Mediterranean				
Perciformes/ Caragidae	<i>Alepes djedaba</i>	Shrimp scad	Alanya, Gazipaşa	Akyüz, 1957; Geldiay, 1969; Gücü et al., 1994; Otero et al., 2013
Perciformes/ Apogonidae	<i>Apogonichthyoides pharaonis</i>	Pearlycheek cardinalfish	-	Otero et al., 2013; [18]
Atheriniformes/ Atherinidae	<i>Atherinomorus forskalii</i>	Red sea hardyhead silverside	-	Kosswig, 1950; Geldiay, 1969; Otero et al., 2013
Syngnathiformes/ Fistulariidae	<i>Fistularia commersonii</i>	Bluespotted cornetfish	Kaş, Alanya	Bilecenoğlu, 2002a; Otero et al., 2013
Tetradontiformes/ Tetraodontidae	<i>Lagocephalus spadiceus,</i>	Puffer fishes	Alanya, Gazipaşa	Akyol et al., 2005; Bilecenoğlu et al.,

	<i>Lagocephalus scleratus</i>			2002b, 2006; Tuncer et al., 2008; Otero et al., 2013
Perciformes/ Nemipteridae	<i>Nemipterus randalli</i>	Randall's threadfin bream	Alanya, Gazipaşa	Bilecenoğlu and Russell, 2008; Gülşahin and Kara, 2013; Otero et al., 2013; Bilecenoğlu et al., 2013
Beloniformes/ Exocoetidae	<i>Parexocoetus mento</i>	African Sailfin flyingfish	-	Ben-Tuvia, 1966; Avşar and Çiçek, 2000; Otero et al., 2013
Beloniformes/ Hemiramphidae	<i>Hemiramphus far</i>	Black-barred halfbeak	Alanya	Kosswig, 1950; [18]
Perciformes/ Pemperidae	<i>Pempheris vanicolensis</i>	Vanikoro sweeper	Alanya, Gazipaşa	Papaconstantinou, 1988; Gücü et al., 1994; Otero et al., 2013
Beryciformes/ Holocentridae	<i>Sargocentron rubrum</i>	Redcoat	Alanya, Gazipaşa	Kosswig, 1950; Otero et al., 2013
Aulopiformes/ Synodontidae	<i>Saurida undosquamis</i>	Brushtooth lizardfish	-	Ben-Tuvia, 1966; 1973; Otero et al., 2013
Perciformes/ Siganidae	<i>Siganus luridus</i> , <i>Siganus rivulatus</i>	Spinefoot species	Kaş, Alanya	Ben-Tuvia, 1973; Fischer, 1973; Kosswig, 1950; Otero et al., 2013
Tetraodontiformes/ Monacanthidae	<i>Stephanolepis diaspros</i>	File fish	-	Ben-Tuvia, 1966; Çiçek, 2006; Otero et al., 2013; Bilecenoğlu et al., 2013
Perciformes/ Mullidae	a. <i>Upeneus molluccensis</i> b. <i>Upeneus pori</i>	Goatfishes	Alanya, Gazipaşa	Kosswig, 1950; Ben-Tuvia, 1973; Akyol et al., 2006; Otero et al., 2013
Black Sea				
Perciformes/ Blenniidae	<i>Parablennius incognitus</i>	Pygmy blenny	-	Vasil'eva, 2007; [18]
Perciformes/ Gobiidae	<i>Gobius cruentatus</i>	Red-mouthed goby	-	Artüz, 1999; Engin et al., 2007; [18]
Mugiliformes/ Mugilidae	<i>Liza haematocheila</i>	Redlip mullet	-	Kosswig, C., 1974; Dobrovolev et al., 2003; Aleksandrov et al., 2007; [18]

Table 4. Imported (Imp), intentional (Int), invasive (Inv), transported (Tra), travelling (Trv), spreading (Spr), colonizing (Col) reptiles, birds and mammals of Turkey (Ps: present study).

Order/Family	Scientific name	Common name	Status	PS (see map)	References
Reptiles					
Testudines/ Emydidae	<i>Trachemys scripta</i>	Red-eared slider	Imp, Col	-	Daisie., 2015; Ficetola et al., 2012
Squamata/ Lacertidae	<i>Podarcis siculus</i>	İstanbul Wall Lizard	Tra, Spr	-	[21]; Berthold, 1842; Bird, 1936; Bodenheimer, 1944; Başoğlu and Baran, 1977; Çevik, 1999; Uğurtaş et al., 2000; Hür et al., 2008; Mollov, 2009; Ilgaz et al., 2013; Silva-Rocha et al., 2014.
Birds					
Columbiformes/ Columbidae	<i>Streptopelia senegalensis</i>	Laughing dove	Inv, Col	Bursa, Niğde	Albayrak, 2011; [19]
Psittaciformes/ Psittaculidae	<i>Psittacula krameri</i>	Ring-necked Paraket	Imp, Col	Ankara, İstanbul	[19]
Passeriformes/ Pycnonotidae	<i>Pycnonotus xanthopygos</i>	White-spectacled Bulbul	Spr, Col	Mediterranean coast	Aslan and Erdoğan, 2007; [19]
Passeriformes/ Sturnidae	<i>Acridotheres tristis</i>	Common myna	Trv, Col	İstanbul	[19]
Mammals					
Rodentia/ Myocastoridae	<i>Myocastor coypus</i>	Nutria (coypu)	Int	n1: Meriç, Tunca, n2: Aras	Mursaloğlu, 1973; Özkan, 1999; İliker et al., 2009

4. CONCLUSIONS and DISCUSSION

Present research focused on the alien, invasive alien vertebrate species and pest management of synanthropic rodents in Turkey. We reported nine fresh water fishes as alien (seven potential invasive and two intentional introduced). Invasive freshwater fishes in Turkey are known to be harmful, and caused to extinction of the some native species. There are no certain data the effect of alien Marine fishes on the indigenous species in Turkish seas. No alien species was reported from amphibian classis. Two alien species from reptilian classis are thought to be potential threat for natural species, especially freshwater turtle in Turkish rivers. Mammalian alien is nutria in Turkey and there is no information about any threat on the natural population in the ecosystem occupied by nutria. There are

3 synanthropic rodents which are originally not native to the country. The pest control in urban are performed on these rodents using anticoagulant rodenticide. However, their efficiency on the target species and anticoagulant resistance are not reported up to now.

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REFERENCES

- [1] Görür, N., Sakınç, M., Barka, A., Akkök, R. (1995). Miocene to Pliocene palaeogeographic evolution of Turkey and its surroundings. *Journal of Human Evolution*, 28: 309-324.
- [2] Sarıca, N. (2000). The Plio-Pleistocene age of Büyük Menderes and Gediz grabens and their tectonic significance on N-S extensional tectonics in West Anatolia: mammalian evidence from the continental deposit. *Geological Journal*, 35: 1-24.
- [3] Yiğit, N., Çolak, E., Sözen, M., Özkurt, Ş. (2003). A study on the geographical distribution along with habitat aspects of rodent species in Turkey. *Bonn zoological Bulletin*, 50: 355-368.
- [4] Yiğit, N., Çolak, E., Sözen, M., Karataş, A. (2006). *Rodent of Türkiye*. Meteksan Co. Ankara. ISBN 9944-5560-0-9.
- [5] Strömberg, C. A. E., Werdelin, L., Friis, E. M., Saraç, G. (2007). The spread of grass-dominated habitats in Turkey and surrounding areas during the Cenozoic; Phytolith evidence. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 250: 18-49.
- [6] Provan, J., Bennett, K. D. (2008). Phylogeographic insights into crytic glacial refugia. *Trends in Ecology and Evolution*, 23: 564-571.
- [7] Bilgin, R. (2011). Back to the Suture: The distribution of intraspecific genetic diversity in and around Anatolia. *International Journal of Molecular Sciences*, 12: 4080-4103.
- [8] Kuzucuoğlu, C., Dörfler, W., Kunesch, S., Goupille, F. (2011). Mid-toLate-Holocene climate change in Central Turkey; The Tecer Lake record. *The Holocene*, 21(1): 173-188.
- [9] Baran, İ., Ilgaz, Ç., Avcı, A., Kumlutaş, Y., & Olgun, K. (2012). *Türkiye Amfibi ve Sürüngenleri*, Tübitak Popüler Bilim Kitapları.
- [10] Ekmekçi, F.G., Kırankaya, Ş. G., Gençoğlu, L., Yoğurtcuoğlu, B. (2013). Present status of invasive fishes in inland waters of Turkey and assessment of the effect of invasion. *İstanbul University, Journal of Fisheries & Aquatic Sciences*, 28: 105-140 (in Turkish with English summary).
- [11] Erk'akan, F. (1983). The Fishes of the Thrace Region. *Hacettepe Bulletin Natural Sciences and Engineering*, 12: 39-48.

- [12] Kryštufek, B., Vohrálik, V. (2001). Mammals of Turkey and Cyprus: Introduction Checklist of Insectivora. Knjizica Annales Majora, Ljubljana, 140 pp.
- [13] Kuru, M. (2004). Recent Systematic Status of Inland Water Fishes of Turkey. J of Gazi Education Faculty, Gazi University (Ankara, Turkey), 24(3): 1-21 (In Turkish with English summary).
- [14] Geldiay, R., and Balik, S. (2007). Fresh water fishes of Turkey. Publication of Fisheries Faculty of Ege University, No: 46, 644 pp. Bornova, İzmir.
- [15] Kryštufek B., Vohrálik, V. (2012). Taxonomic revision of the Palearctic rodents (Rodentia). Sciuridae: Xerinae 1 (*Eutamias* and *Spermophilus*). *Lynx, n.s.*, 43, 17 – 111.
- [16] Kryštufek B., Vohrálik, V. (2013). Taxonomic revision of the Palaeartic rodents Rodentia). Part. 2. Sciuridae: *Urocitellus*, *Marmota* and *Sciurotamias*. *Lynx, n. s.*, 44: 27 - 138.
- [17] Froese, R., and Pauly, D. (2013). FishBase. World Wide Web electronic publication, www.fishbase.org.
- [18] Bilecenoğlu, M., Kaya, M., Cihangir, B., & Çiçek, E. (2014). An updated checklist of the marine fishes of Turkey. *Turkish Journal of Zoology*, 38(6), 901-929.
- [19] Trakus., (2015). http://www.trakus.org/kods_bird/uye/?fsx=@ (Date accessed: 25 May 2015).
- [20] Tramem., (2015). <http://www.tramem.org/memeliler/?fsx=@> (Date accessed: 12 December 2009).
- [21] Turkherptil., (2015). <http://www.turkherptil.org/> (Date accessed: 16 April 2013).
- [22] Çiçek, E., Birecikligil, S. S., Fricke, R. (2015). Freshwater fishes of Turkey: a revised and updated annotated checklist. *Biharean Biologist*, 9(2): 141-157.
- [23] Özcan, G., Tarkan, A. S. (2019). Distribution Revised-Fifteen Years of Changes in the Invasion of A Freshwater Fish, *Pseudorasbora parva* (Temminck And Schlegel, 1846) in Turkey. *Transylvanian Review of Systematical and Ecological Research*, 21(2):69-80.
- [24] Clavero, M., García-Berthou, E. (2005). Invasive species are a leading cause of animal extinctions, *Trends in Ecology and Evolution*, 20 (3): 110.
- [25] Freyhof, J., and Brooks, E. (2011). European Red List of Freshwater Fishes. Luxembourg: Publications Office of the European Union.
- [26] İnnal, D., Erk'akan, F. (2006). Effects of exotic and translocated fish species in the inland waters of Turkey. *Reviews in Fish Biology and Fisheries*, 16: 39-50.
- [27] İnnal, D. (2012). Alien fishes in reservoir systems in Turkey: a review. *Management of Biological Invasion*, 3 (2): 115 – 119.

- [28] Tarkan, A.S., Gaygusuz, Ö., Gürsoy Gaygusuz, Ç., Saç, G., Copp, G. (2012). Circumstantial evidence of gibel carp, *Carassius gibelio*, reproductive competition exerted on native fish species in a mesotrophic reservoir. *Fisheries Management and Ecology*, 19 (2): 167–177.
- [29] Tarkan, A. S., Marr, S. M., Ekmekçi, F. G. (2015). Non-native and Translocated Freshwater Fish Species in Turkey. *FiSHMED Fishes in Mediterranean Environments*. 3(2015):28p.
- [30] Saç, G., Özuluğ, M. (2017). New data on distribution of three invasive freshwater fish species in İstanbul (Turkey). *Acta Biologica Turcica*, 30 (1): 11-15.
- [31] Yoğurtçuoğlu, B., Ekmekçi, F.G. (2018). First record of the Giant Pangasius, *Pangasius sanitwongsei* (Actinopterygii: Sluriformes: Pangasiidae), from Central Anatolia, Turkey. *Acta Ichthyologica et Piscatoria*, 48 (3): 241-244.
- [32] Özuluğ, M, Gaygusuz, O., Gaygusuz, Ç. G., Saç, G. (2018). New distribution areas of four invasive freshwater fish species from Turkish Thrace. *Turkish Journal of Fisheries and Aquatic Sciences*, 19 (10) (In press).
- [33] Tarkan, A. S., Gaygusuz, Ö., Acıpinar, H., Gürsoy, Ç., & Özuluğ, M. (2006). Length–weight relationship of fishes from the Marmara region (NW-Turkey). *Journal of Applied Ichthyology*, 22(4), 271-273.
- [34] Yalçın Özdilek, Ş. (2007). Possible threat for Middle East inland water: an exotic and invasive species, *Pterygoplichthys disjunctivus* (Weber, 1991) in Asi River, Turkey (Pisces: Loricariidae). *Ege University Journal of Fisheries and Aquatic Sciences*, 24: 303-306.
- [35] Ünlü, E., Çiçek, T., Değer, D., Coad, B.W. (2011). Range extension of the exotic Indian stinging catfish, *Heteropneustes fossilis* (Bloch, 1794) (Heteropneustidae) into the Turkish part of the Tigris River watershed. *Journal of Applied Ichthyology*, 27: 141-143.
- [36] Copp, G. H., Wesley, K. J., & Vilizzi, L. (2005). Pathways of ornamental and aquarium fish introductions into urban ponds of Epping Forest (London, England): the human vector. *Journal of Applied Ichthyology*, 21(4), 263-274.
- [37] Kennard, M. J., Arthington, A. H., Pusey, B. J., & Harch, B. D. (2005). Are alien fish a reliable indicator of river health?. *Freshwater Biology*, 50(1), 174-193.
- [38] Otero, M., Cebrian, E., Francour, P., Galil, B., Savini, D. (2013). *Monitoring Marine Invasive Species in Mediterranean Marine Protected Areas (MPAs): A strategy and practical guide for managers*. Malaga, Spain: IUCN. 136 pages.
- [39] Artüz, M. L. (1999). Inventory of existing species and their habitats in the Bosphorus area. *Oceanata*, 112(1): 552-564.
- [40] Bilecenoğlu, M., Taşkavak, E., Mater, S., Kaya, M. (2002a). Checklist of the marine fishes of Turkey. *Zootaxa*, 113: 1–194.

- [41] Dobrovolev, I., Ivanova, P., Vasilev, V. P., Jonkov, J. I. (2003). Genetic divergence of mugilid fishes (Genus Mugilidae, Pisces) in the Bulgarian Black Sea coastal waters. Proceeding of the 30th International Conference Pacem in Maribus; a year after Johannesburg. Ocean Governance and Sustainable Development: Ocean and Coasts – a Glimpse into the Future, October 27-30, 2003, Kiev, Ukraine.
- [42] Çınar, M. E., Bilecenoğlu, M., Öztürk, B., Katagan, T., Aysel, V. (2005). Alien species on the coasts of Turkey. *Mediterranean Marine Science*, 6 (2): 119-146.
- [43] Çiçek, E. (2006). Investigation on economic fishes captured by bottom trawling around the sea of Karataş (Adana city). Çukurova University (Adana, Turkey), Graduate School of Natural and Applied Science. PhD Thesis, 146 pp (In Turkish with English summary).
- [44] Aleksandrov, B., Boltachev, A., Kharchenko, T., Liashenko, A., Son, M., Tsarenko, P., Zhukinsky, V., (2007). Trends of aquatic alien species invasions in Ukraine. *Aquatic Invasion*, 27 (2): 215-242.
- [45] Engin, S., Turan, D., Kovacic, M. (2007). First record of the red-mouthed goby, *Gobius cruentatus* (Gobiidae), in the Black Sea. *Cybium*, 31: 87–88.
- [46] Vasil'eva, E. D. (2007). Fishes of the Black Sea. Key to Marine, Brackish-Water, Euryhaline and Anadromous Species with Color Illustrations collected by S.V. Bogorodsky. VNIRO Publishing, Moscow, (In Russian).
- [47] Tuncer, S., Aslan Cihangir, H., Bilecenoğlu, M. (2008). First record of the Lessepsian migrant *Lagocephalus spadiceus* (Tetraodontidae) in the Sea of Marmara. *Cybium*, 32: 347–348.
- [48] Bilecenoğlu, M. (2010). Alien marine fishes of Turkey – An updated review. In: Fish Invasions of the Mediterranean Sea: Change and Renewal. Golani, D. And Appelbaum-Golani, B., (Eds). Pensoft, Sofia, Moscow, pp: 189-217.
- [49] The reptil database, (2015). www.reptile-database.org (Date accessed: 07 August 2014).
- [50] <http://www.europe-aliens.org>
- [51] Hür, H., Uğurtaş, İ. H., İşbilir, A. (2008). The amphibian and reptile species of Kazdağı National Park. *Turkish Journal of Zoology*, 32 (3): 359–362.
- [52] Mollov, I. (2009). A new locality of the Italian Wall Lizard *Podarcis siculus* (Rafinesque-Schmaltz, 1810) from Turkey. *ZooNotes*, 6:1–3.
- [53] Ficetola, G. F., Rödder, D., Padoa-Schioppa, E. (2012). *Trachemys scripta* (Slider terapin). In: handbook of global freshwater invasive species (ed. Francis r). Earthscan, Taylor & Francis Group Abingdon, UK, pp.331-339.
- [54] Ilgaz, Ç., Kumlutaş, Y., Sözen, M. (2013). New locality record for *Podarcis siculus hieroglyphicus* (Berthold, 1842) (Squamata: Lacertidae) in the western Black Sea region of Anatolia. *Turkish Journal of Zoology*, 37: 123-127.

- [55] Silva-Rocha, I., Salvi, D., Harris, D. J., Freitas, S., Davis, C., Fosterz, J., Deichsel, G., Adamopoulou, C., Carretero, M. A. (2014). Molecular assessment of *Podarcis sicula* populations in Britain, Greece and Turkey reinforces a multiple-origin invasion pattern in this species. *Acta Herpetologica*, 9(2): 253-258.
- [56] Tok, C.V., Çiçek, K., Hayretdağ, S., Tayhan, Y., Yakın, B.Y. (2015). Range extension and morphology of the Italian Wall Lizard, *Podarcis siculus* (Rafinesque-Schmaltz, 1810) (Squamata: Lacertidae) from Turkey. *Turkish Journal of Zoology*, 39 (1): 103 – 109.
- [57] <http://www.iucngisd.org/>
- [58] Mursaloğlu, B. (1973). New records for Turkish rodents (Mammalia). *Communications*, 17: 213-219.
- [59] Özkan, B. (1999). Note: Feral coypus, *Myocastor coypus* (Molina, 1782) in European part of Turkey. *Israel Journal of Zoology*, 45: 289-291.
- [60] İliker, A., Arslan, A., Pamukoğlu, N., Albayrak, İ. (2009). C-Banded Karyotype of *Myocastor coypus* (Molina, 1782) from Turkey (Mammalia: Rodentia). *Folia biologica (Kraków)*, 57(1-2): 33-36.
- [61] Khlyap, L. A., Bobrov, V. V., Warshavsky, A. A. (2010). Biological Invasion on Russian Territory: Mammals. *Russian Journal of Biological Invasion*, 2010, vol.1, no.2 pp. 127-140.
- [62] Khlyap, L. A., Warshavsky, A. A. (2010). Synanthropic and Agrophilic Rodents as Invasive Alien Mammals. *Russian Journal of Biological Invasion*, 2010, vol.4, No. 4 pp. 301-312.
- [63] Kosoy, M., Khlyap, L., Cosson, J. F., Morand, S. (2015). Aboriginal and Invasive Rats of Genus *Rattus* as Hosts of Infectious Agents. *Vector-Borne and Zoonotic Diseases*, vol. 15, no. 1, pp. 3-12.
- [64] Buckle, A. P. and Smith, R. H. (1994). *Rodent pest and Their Control*. Solidus (Bristol) Limited Press. Cambridge. 405 pp.
- [65] Atkinson, W. P. (2010). *Vector Biology, Ecology and Control*. Springer Science+Business Media B.V. New York, pp 259.
- [66] Gratz, N. (2006). *Vectors- and Rodent –borne Diseases in Europe and North America: their distribution and public health of burden*. Cambridge University Press, 370 pp.
- [67] World Health Organization (WHO). (2006). *Pesticides and their application for the Control of Vectors and Pests of Public Health Importance*. Sixth edition. 114 pp.
- [68] Colautti, R. I., MacIssac, H. J. (2004). A neutral terminology to define “invasive species”. *Diversity and Distributions*, 10 (2):135-141.

- [69] Wildekamp, R. H., Van Neer, W., Küçük, F., Ünlüsayın, M. (1997). First record of the eastern Asiatic gobionid fish *Pseudorasbora parva* from the Asiatic part of Turkey, *Journal of Fish Biology*, 51: 858-861.
- [70] Şaşı, H., Balık, S. (2003). The Distribution of Three Exotic Fishes in Anatolia, *Turkish Journal of Zoology*, 27 (4): 319-322.
- [71] Özuluğ, M., Meriç, N., Freyhof, J. (2004). The distribution of *Carassius gibelio* (Bloch, 1782) (Teleostei: Cyprinidae) in Thrace (Turkey). *Zoology in the Middle East*, 31, 63-66.
- [72] Özuluğ, M., Tarkan, A. S., Özcan, K., Gürsoy, Ç. (2007). Two new records for the fish fauna of Sapanca basin (Sakarya, Turkey). *Journal of Fisheries Sciences*, 1 (3): 152-159.
- [73] Uğurlu, S. and Polat, N. (2007). Exotic fishes in inland water of Samsun province (Turkey). *Journal of Fisheries Sciences.com*, 1 (3): 139-151.
- [74] Pyke, G. H. (2008). Plague Minnow or Mosquitofish? A Review of the Biology and Impacts of Introduced *Gambusia* Species. *Annual Review of Ecology and Systematics*, 39: 171-191.
- [75] Przybylski, M., Zięba, G. (2011). NOBANIS – Invasive Alien Species Fact Sheet – *Lepomis gibbosus*. – From: Online Database of the European Network on Invasive Alien Species – NOBANIS www.nobanis.org, 01/03/2015.
- [76] Aydın, H., Gaygusuz, Ö., Tarkan, A. S., Top, N., Emiroğlu, Ö., Gürsoy Gaygusuz, Ç., (2011). Invasion of freshwater bodies in the Marmara region (northwestern Turkey) by non-native gibel carp, *Carassius gibelio* (Bloch, 1782), *Turkish Journal of Zoology*, 35(6): 829-836.
- [77] Karakuş, U., Ağdamar, S., Tarkan, A. S., Özdem, N. (2013). Range extension of the invasive freshwater fish species, gibel carp *Carassius gibelio* (Bloch, 1782) in western Turkey. *BioInvasions Records*, 2 (2): 153–157.
- [78] Çalışkan, M., & Yerli, S. (2000). Organochlorine pesticide residues in aquatic organisms from Köyceğiz Lagoon System. *Water Air Soil Pollut*, 121, 1-9.
- [79] Özcan, G. (2007). Distribution of the non-native fish species, pumpkinseed *Lepomis gibbosus* (Linnaeus, 1758), in Turkey. *Aquatic Invasions*, 2 (2): 146-148.
- [80] Mert, R., & Cicek, E. (2010). Range expansion of introduced tilapia species (*Oreochromis niloticus*, L. 1758, Cichlidae) in Turkey. *J. Ani. Vet. Adv*, 9, 1753-6.
- [81] Ekmekçi, F. G., Yalçın-Özdilek, Ş., Kırankaya, Ş. G. (2010). Determination of reproduction, feeding and growth of invasive species “*Pseudorasbora parva* (Temminck & Schlegel, 1846)” in the Hirfanlı dam lake. TÜBİTAK, Project no: TOVAG 107-O-718, Ankara.
- [82] Balık, S., Ustaoglu, M. R., Sarı, H. M., İlhan, A. İ., and Topkara, E. T. (2005). Fish fauna of river Yuvarlakçay (Köyceğiz, Muğla). *E.Ü. Su Ürünleri Dergisi*, 22 (1-2): 221-223 (In Turkish with English summary).

- [83] Crivelli, A. J. (1995). Are fish introductions a threat to endemic freshwater fishes in the northern Mediterranean region? *Biological Conservation*, 72 (2): 311–319.
- [84] Küçük, F., Sarı, H. M., Demir, O., Güle, İ. (2009). Review of the ichthyofaunal changes in Lake Eğirdir between 1915 and 2007. *Turkish Journal of Zoology*, 33: 277-286.
- [85] Blackburn, T. M., Pyšek, P., Bacher, S., Carlton, J. T., Duncan, R. P., Jarošík, V., Wilson, J. R. U., Richardson, D. M. (2011). A proposed unified framework for biological invasions. *Trends in Ecology and Evolution*, 26: 333-339.
- [86] Taşkavak, E. and Bilecenoğlu, M. (2001). Length-weight relationships for 18 Lessepsian (Red Sea) immigrant fish species from the eastern Mediterranean coast of Turkey. *Journal of the Marine Biological Association of U.K.* 81: 895-896.
- [87] Yankova, M., Pavlov, D., Ivanova, P., Karpova, E., Boltachev, A., Bat, L., Oral, M., Mgeladze, M. (2013). Annotated check list of the nonnative fish species (Pisces) of the Black Sea. *J. Black Sea/Mediterranean Environment*, 19 (2): 247-255.
- [88] Golani, D., Appelbaum-Golani, B., Peristeraki, P. (2013, July). Westward range extension of the lessepsian migrant the shrimp scad *alepes djedaba* (forsskål, 1775) in the mediterranean/estensione a ovest del migrante lessepsiano *carangide alepes djedaba* (forsskål, 1775) nel mediterraneo. In *Annales: Series Historia Naturalis* (Vol. 23, No. 2, p. 115). Scientific and Research Center of the Republic of Slovenia.
- [89] Bilecenoğlu, M., Kaya, M., Akalın, S. (2006). Range expansion of silverstripe blaasop, *Lagocephalus sceleratus* (Gmelin, 1789), to the northern Aegean Sea. *Aquatic Invasions*, 1: 289–291.
- [90] Bilecenoğlu, M., and Russell, B. C. (2008). Record of *Nemipterus randalli* Russell, 1986 (Nemipteridae) from Iskenderun Bay, Turkey. *Cybium*, 32: 279–280.
- [91] Berthold, A. A., (1842). Ueber verschiedene neue oder seltene Amphibienarten. *Abhandlungen der Königlichen Gesellschaft der Wissenschaften in Göttingen*, 1: 48–72.
- [92] Podnar, M., Mayer, W., Tvrkovic, N. (2005). Phylogeography of the Italian wall lizard, *Podarcis sicula*, as revealed by mitochondrial DNA sequences. *Molecular Ecology*, 14: 575–588.
- [93] Uğurtaş, İ. H., Yıldırımhan, H. S., Öz, M. (2000). Two new localities of *Lacerta sicula hieroglyphica* Berthold, 1842 (Reptilia, Lacertidae). *Turkish Journal of Zoology*, 24 (3): 253–256.
- [94] Aslan, A. and Erdoğan A. 2007. On the distribution of the White-spectacled bulbul, *Pycnonotus xanthopygos* (Hemprich & Ehrenberg, 1833), in Turkey. *Zoology in The Middle East*, 41: 31-34.
- [95] Albayrak, T. (2011). Current distribution, status and future of Laughing dove (*Streptopelia senegalensis*) in Turkey. *MAKUFEBED* (2011), 3: 32-40 (In Turkish with English summary).

- [96] General Management of Food and Control (Gıda ve Kontrol Gen. Müd.) (2014). Plant protection application program (Republic of Turkey Ministry of Food, Agriculture and Livestock). Hilal Form Matbaacılık Mak. San. ve Tic. Ltd. Şti.Öz Ankara Toptancılar Sitesi 2. Blok No.: 52 Macunköy / Ankara (In Turkish).
- [97] Akyol, O., Ünal, V., Ceyhan, T., Bilecenoğlu, M. (2005). First Record of the silverside blaasop, *Lagocephalus sceleratus* (Gmelin, 1789), in the Mediterranean Sea. Journal of Fish Biology, 66: 1183-1186.
- [98] Avşar D., and Çiçek, E. (2000). A new Lessepsian immigrant for the Cilician basin in eastern Mediterranean; flying fish (Exocoetidae: *Parexocoetus mento* (Valenciennes, 1846). Obelia, 26: 89-95.
- [99] Başoğlu, M., and Baran, İ. (1977). Turkish Reptile. Part I; Tortoises and Lizards. Ege University press, İzmir, (In Turkish).
- [100] Ben-Tuvia, A. (1966). Red Sea fishes recently found in the Mediterranean. Copeia, 2: 254-275.
- [101] Ben-Tuvia, A. (1973). Man made changes in the Eastern Mediterranean Sea and their effect on the fishery resources. Marine Biology, 19: 197-203.
- [102] Bilecenoğlu, M., Alfaya, J. E. F., Azzurro, E., Baldaconi, R., Boyacı, Y. Ö., Circosta, V., Compagno, L. J. V., Coppola, F., Deidun, A., Durgham, H., Durucan, F., Ergüden, D., Fernández – Álvarez, F. A., Gianguzza, P., Giglio, G., Gökoğlu, M., Gürlek, M., Ikhtiyar, S., Kabasakal, H., Karachle, P. K., Katsanevakis, S., Koutsogiannopoulos, D., Lanfranco, E., Micarelli, P., Özvarol, Y., Pena- Rivas, L., Poursanidis, D., Saliba, J., Sperone, E., Tibullo, D., Tiralongo, F., Tripepi, S., Turan, C., Vella, P., Yokeş, M. B., Zava, B., (2013). New Mediterranean marine biodiversity records (December, 2013). Mediterranean Marine Science, 14: 463–480.
- [103] Bilecenoğlu, M., Kaya, M., Cihangir, B., Çiçek, E., (2014). An updated checklist of the marine fishes of Turkey. Turkish Journal of Zoology, 38: 901-929.
- [104] Akyol, O., Unal, V. & Ceyhan, T. (2006). Occurrence of two Lessepsian migrant fish, *Oxyurichthys petersi* (Gobiidae) and *Upeneus pori* (Mullidae), from the Aegean Sea. Cybium, 30: 389–390.
- [105] Akyüz, E. (1957). Observations on the Iskenderun red mullet (*Mullus barbatus*) and its environment. GFCM Proceedings and Technical Papers, 4 (38): 305-326.
- [106] Bilecenoğlu, M., Taskavak, E., Kunt, K. B., (2002b). Range extension of three Lessepsian migrant fish (*Fistularia commersoni*, *Sphyræna flavicauda*, *Lagocephalus suezensis*) in the Mediterranean Sea. Journal of the Marine Biological Association of the United Kingdom, 82: 525–526.
- [107] Bodenheimer, F. S. (1944). Introduction into the knowledge of Amphibia and Reptilia of Turkey. Marmara Basemevi.

- [108] Geldiay R (1969). Fishes of İzmir (Turkey) bay and their likely invasions. Monographes published by Faculty of Science, Ege University, Izmir, Turkey 135 pp (in Turkish with English summary).
- [109] Gücü, A. C., Bingel F., Avsar, D., Uysal, N. (1994). Distribution and occurrence of Red Sea fish at the Turkish Mediterranean coast-northern Cilician Basin. *Acta Adriatica*, 34(1/2): 103-113.
- [110] Kosswig, C. (1950). Erythraische fische im Mittelmeer und an der grenze der Agais. *Syllegomena Biologica, Festschrift Kleinschmidt*, 50; 203-212.
- [111] Gülşahin, A., and Kara, A. (2013). Record of *Nemipterus randalli* Russell, 1986 from the southern Aegean Sea (Gokova Bay, Turkey). *Journal of Applied Ichthyology*, 29: 933–934.
- [112] Papaconstantinou, C. (1988). Check-list of marine fishes of Greece. *Fauna Graeciae IV*, Athens: Hellenic Zoological Society, 257 pp.
- [113] Fischer, W. (1973). FAO species identification sheets for for fishery purposes. Mediterranean and Black Sea. Fishing area 37, Vol. 1, FAO, Rome, 769 p.
- [114] Kosswig, C. (1974). Modifiability, a neglected factor for area expansion in marine fish. *Istanbul Univ. Fen Fak. Mec., Ser. B*, 39 (1-2): 1-7.
- [115] Daisie (Delivering Alien Invasive Species for Europe)., (2015). http://www.europe-alien.org/pdf/Trachemys_scripta.pdf.
- [116] Bird, C. G. (1936). The distribution of reptiles and amphibians in Asiatic Turkey, with notes on a collection from the vilayets of Adana, Gaziantep, and Malatya. *Journal of Natural History*, 18: 257–281.
- [117] Çevik, İ. E. (1999). Taxonomic Status of the Lizards Species Living in Turkish Tharace (Lacertilia: Anguidae, Lacertidae, Scincidae). *Turkish Journal of Zoology*, 23 (Supp. 1): 23-36.

ADDITIONS

Permission was given by Ankara University Local Ethics Committee for Animal Experiments (Document no: 2018-14-81).

T.C.
ANKARA ÜNİVERSİTESİ REKTÖRLÜĞÜ
Hayvan Deneyleri Yerel Etik Kurulu
HAYVAN DENEYLERİ YEREL ETİK KURULU KARARI

TOPLANTI TARİHİ : 04/07/2018
TOPLANTI NO : 2018-14
DOSYA NO : 2018-68
KARAR NO : 2018-14-81

Yürürlüğünü Üniversitemiz Fen Fakültesi Zooloji Anabilim Dalı öğretim üyelerinden Prof. Dr. Nuri YİĞİT'in yaptığı; araştırması olarak Prof. Dr. Ercimert ÇOLAK, Doç. Dr. Mustafa Türker DUMAN, Öğr. Gör. Enjin SELVİ ve Araş. Gör. Derya ÇETİNTÜRK'un katıldığı "Rattus rattus (Linnaeus, 1758) ve Rattus norvegicus (Berkenhout, 1769) Türlerinde Antikoagulan Direncinin VKORC1 Genindeki Mutasyonların Araştırılmasıyla Saptanması" başlıklı araştırma projesinin içeriği Kurulumuzca incelenmiştir. Söz konusu çalışma, Üniversite Senatosunun 12/2/2016 tarihli toplantısında 430/3642 sayılı kararı ile kabul edilen ve Hayvan Deneyleri Merkezi Etik Kurulu'nun 19/2/2016 tarih ve 42 sayılı kararı ile onaylanan "Ankara Üniversitesi Hayvan Deneyleri Yerel Etik Kurulu Yönergesi"ne göre değerlendirilerek uygun bulunmuş olup, Doğa Koruma ve Milli Parklar Genel Müdürlüğü'nden alınacak izin yazısının bir örneğinin Kurulumuzca sunulmasına oy birliği ile karar verilmiştir.

Hayvan Türü : Rattus norvegicus
Hayvan Sayısı : 30
Geçerlilik Süresi : 01/07/2018-01/07/2020

Unvanı / Adı / Soyadı	Uzmanlık Dalı	Kurumu	Cinsiyeti	İmza
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Prof. Dr. Fatih CEDDEN (Üye)	Hayvan Yetiştirme Anabilim Dalı	Ziraat Fakültesi	E	
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Uzm. Vet. Hek. Atilla İŞGÖREN (Üye)	Deney Hayvanları Yetiştirme ve Araştırma Laboratuvarı	Tıp Fakültesi	E	
Dr. Vet. Hek. Gürbüz ERTÜRK (Üye)	Active Veteriner Sağlık Merkezi	Serbest	E	
Uzm. Vet. Hek. Hüseyin DEDE (Üye)	Veteriner Hekimler Derneği	Serbest	E	
Fatma Aysun COŞKUN (Üye)	İktisat	Serbest	K	

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