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The Possible Role of Bird Migrations on Introduction and Spread of Invasive Alien Plants: A Case Study, *Solanum elaeagnifolium* Cav.

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ABSTRACT

Solanum elaeagnifolium (SOLEL), a native plant of the Americas is a highly spread invasive alien species worldwide with impacts on biodiversity and agriculture. It has a long history in Mediterranean basin and the Middle East where Türkiye is located but there was no record except one in 2006 from the eastern the Mediterranean of Türkiye of which introduction was attributed to migrating birds. Despite widespread and large populations in neighboring countries, not detecting SOLEL in Türkiye had been questionable. The aims of the study were to find out new populations of SOLEL in Türkiye and understand the reason of less population occurred in Türkiye. Two areas were selected near the country borders of Türkiye which are known as migrating bird routes. Areas were visited unregularly several times from 2020 to 2023 to find out SOLEL populations. New populations were detected in the eastern Mediterranean and Aegean Regions of Türkiye which are over 1000 km apart from each other. SOLEL populations and bird migration routes through Türkiye and countries SOLEL has already been recorded were compared. It is concluded that SOLEL might be introduced by migrating birds. It is suggested that more detailed research is needed to explain the role of migrating birds in invasive alien plants' introductions. Furthermore, plants around wetlands which birds use in their migration routes should be observed to prevent new plant invasions.

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ÖZET

Amerika Kıtasının yerli bitkilerinden olan Solanum elaeagnifolium (SOLEL), biyolojik çeşitliliği ve tarımı etkileyen, dünya çapında oldukça yaygın bir istilâcı yabancı türdür. Türkiye'nin de yer aldığı Akdeniz havzasında ve Orta Doğu'da uzun süredir bulunmasına rağmen 2006 yılındaki bir kayıt hariç Türkiye'de bulunduğuna dair bilgi bulunmamaktadır. Türkiye'nin doğu Akdeniz kısmında belirlenen bu popülasyonun Türkiye'ye girişinde göçmen kuşların rol oynayabileceği kaydedenlerce öne sürülmüştür. Çevre ülkelerde yaygın ve yoğun olarak bulunmasına rağmen SOLEL'in Türkiye'de tespit edilememesi şüpheyle karşılanmaktadır. Çalışmanın amaçları, Türkiye'deki yeni SOLEL popülasyonlarını belirlemek ve Türkiye'deki düşük SOLEL yoğunluğunun sebebini anlamaktır. Türkiye'de göçmen kuş yollarında bulunan ve ülke sınırlarına yakın iki alan seçilmiştir. Bu alanlarda 2020-2023 yılları arasında SOLEL popülasyonlarını saptamak için çok sayıda periyodik olmayan sürveyler yapılmıştır. Bu çalışma ziyaretlerinde, Türkiye'nin birbirinden 1000 km'den daha uzak olan Doğu Akdeniz ve Ege Bölgelerinde yeni popülasyonlar tespit edilmiştir. Türkiye'deki ve diğer SOLEL kaydedilmiş ülkelerdeki popülasyonlar ve göçmen kuşların

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Göç yolları

yolları mukayese edilmiştir. Sonuç olarak, SOLEL'in Türkiye'ye göçmen kuşlar tarafından getirilmiş olabileceği kanısına varılmıştır. İstilâcı yabancı bitkilerle göçmen kuşlar arasındaki ilişkinin ortaya konulması için daha ayrıntılı çalışmalara ihtiyaç olduğu düşünülmektedir. Ayrıca, kuşların göç yolları üzerindeki sulak alanlardaki bitkiler, yeni bitki istilâlarını önlemek için gözlemlenmelidir.

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INTRODUCTION

Solanum elaeagnifolium (SOLEL), a native plant or a clade consisting of five species, from Mexico, South America, and North America had been spread all over North America including Cuba and the Bahamas firstly by Spanish and Portuguese pioneers and then by merchants via railways (Roberts & Florentine, 2022; Knapp et al., 2017). Just after, in the 1600s, it reached the Philippines via sea trade then from there second spread has occurred to China followed by the western Indian Islands and other Asian countries. It was recorded in Australia in 1901 and South Africa in the 1940s. The earliest records from the Mediterranean basin are from Madrid and Montpellier herbariums in 1793 and 1855, respectively (Le Floc'h, 1991; Knapp, 2007). It was found in Egypt in 1956, Israel in 1957 and Morocco in 1958. One of the recent records from Mediterranean neighboring areas is from Iran (Arabsalmani et al., 2014). Its current distribution includes all Mediterranean countries, the Balkans, the Middle East, central and northern Europe, Africa, the Americas, and many parts of Asia (Knapp et al., 2017; Boyd et al., 1984; Mekki, 2007; Uludag et al., 2016; Krigas et al., 2021; EPPO, 2022).

SOLEL invades natural areas, semi-disturbed areas, and crop fields as well as urban areas. It has negative impacts mainly on crop and livestock production, the environment, trade, and human life and welfare (Uludag et al., 2016).

The first record of SOLEL from Turkey dates back to 2006 from Kahramanmaraş province (Ilçim & Behçet, 2007). The second record from three different populations came almost a decade later (Ilcım et al., 2016). All these populations were established not regarding size. Despite records from neighbors of Türkiye, from the Aegean Islands to Syria, from Bulgaria to Iran (Uludag et al., 2016), there were no records as much as expected or populations significantly large.

The pathway for the introduction and spread of SOLEL in the Mediterranean basin is not well-known, which was attributed to contaminated seeds and hays as well as crop and animal husbandry (Bouhache, 2010; Uludag et al., 2016; Krigas et al., 2021). On the other hand, there have been studies related to other *Solanum* species dispersal stating animals including birds and bats (Roberts & Lockett, 1978; Symon, 1979; Sobrino & del Monte, 1994; Defelice, 2003; Iudica & Bonaccorso, 1997). Its spread in Australia was attributed to animals, agricultural equipment, infested soils, animal feeds and packing materials (Stanton et al., 2012; Heap & Wu, 2018).

The introduction of alien species not regarding invasiveness is a result of human activities although it has not been mentioned in the definition. However, the role of animals in the dispersal of plants, native or non-native, is well-known and is considered an essential element for natural cycles including biodiversity, food web and ecosystem services although some contradictory views on the role of native and non-native birds in the introduction and/or secondary dispersal of IAP/weeds (Adams et al., 2022; Díaz Vélez et al., 2018; Nogales et al., 2012; Solarz et al., 2017; Reynolds et al., 2017; Sayari et al., 2022; Viana et al., 2016a).

Birds as well as land bridges, drifting continents, and ocean currents are the methods hypothesized for the dispersal of seeds among distant areas. The role of birds in plant dispersal goes back to Darwin (1859) which was followed by several researchers and compiled by Ridley (1930) (Cruden, 1966). Birds that are migratory or not, disperse seeds by legs, feet, or feathers or ingestion system either long-distance adaptation or not (Nogales et al., 2012). It is reported that seed dispersal by birds is mainly by water birds via epizoochory, but bird guts are also important for wetland plants (Nogales et al., 2012). Peregrine falcon (*Falco peregrinus*) who consumed a small seed-eaten bird with seeds in viscera could carry it up to 10000 km in 36 hours, where the seed might be germinated (Cruden, 1966; Polunin, 1960).

There are 11188 bird species recorded worldwide (IUCN, 2023). The palearctic region in where Türkiye is located has 10 % of species and 14% of the genus (Newton & Dale, 2001; Green & Moorhouse, 1995). One-fourth of all birds was migrating, which is almost 2600 species from 141 different families (Cox, 2010) although today it might be higher. The number of land

birds and raptors migrating African-Eurasian routes seasonally is several million (Guilherme et al., 2023). It is estimated that five billion birds migrate between Europe and Africa out of 50 billion migrating each year all around the world. Larger birds such as raptors, storks, flamingos, and pelicans use thermal air flows to conserve energy when migrating because they do not stock fats. These thermal air flows form in terrestrial areas, not on seas, which causes migrating routes through lands. Migrating birds keep preying and feeding on routings and stopovers.

The aim of this study was to (***i***) find out new populations SOLEL in Türkiye to show their current situation, (***ii***) understand the reason of less SOLEL populations occurred in Türkiye and (***iii***) discuss introductory pathways and dispersal ways of SOLEL in the context of bird migrations.

MATERIAL and METOD

Sampling of SOLEL populations

The main materials of this work were SOLEL populations from Türkiye and known bird migration routes. Locations of SOLEL populations were compared with the bird migration routes.

Former populations of SOLEL also used in comparisons that are following:

Population1-Türkoğlu, Kahramanmaraş Gavurgölü Marshland

37° 17' 34" N, 36° 51' 16" E Sl: 473 m

Population2- Kahramanmaraş outskirts of town, next to the road (Barbaros Caddesi) and olive groves

37° 35' 06" N, 36° 52' 11" E Sl: 626 m

Population3- İslahiye, Gaziantep, next to the road to Hatay.

37° 00' 05" N, 36° 37' 21" E Sl: 542 m

Population4- Hatay, the road between İskenderun and Karaağaç

36° 34' 26" N 36° 09' 38" E Sl:5 m

For detecting new populations, two regions where have known their role in bird migrations in Türkiye and closer to country terrestrial borders were chosen. Irregular field surveys/trips organized to detect new SOLEL populations from 2020 to 2023. The location of the population was recorded by GPS. The populations were photographed. Population sizes were estimated as area dimensions. In some cases the number of SOLEL individuals (shoots) were estimated. If possible, information about populations was taken via discussions with inhabitants.

RESULTS

New five SOLEL populations were detected in this study, which are numbered following to earlier four populations. They are the following:

Population5 was recorded from Kırıkhan district (36°28'56.9"N 36°20'45.7"E) of the Hatay province. The population is in an empty area in town, which is approximately 100 plants in 10 by 20 m area (200 m^{-2}) (Figure 1). Inhabitants told that plants had been seen for 4 to 5 years, i.e. since around 2015. The population has expanded down to the hill with sheep and goats, which are not consuming SOLEL but help movement via wool and bodies and 50-75 plants, which were scattered were noticed in 1000 m^{-2}.

Population6 was from Cırtıman village (36°31'36.5"N 36°10'34.3"E) of Iskenderun district of the Hatay province, again, 20 plants in a small 10 m^{-2} (1 by 10 m) non-agricultural land (Figure 2). Inhabitants also mentioned it has been there for 4-5 years.

Population7 was in Yüreğir district (36°58'05.8"N 35°33'08.3"E) of the Adana province where near D400 highway opposite to AFAD Building. Population covers 3 by 25 m along the wall of a depot building and 5 by 20 m along to paved road (total 175 m^{-2}) (Figure 3). It seems these plants are in this area for 5-6 years. There was no SOLEL in the fields around the population.

Population8 is around the road connecting Özdere and Gümüldür towns (38°02'51.7"N 27°03'18.3"E) of İzmir at Aegean region. Patches around a local market are 7.5 by 15m, 300 by 1.5 m, and 20 by 20 m (Total 963 m^{-2}) (Figure 4). The population has already spread widely, including house gardens.

Population9 is in Incirli village, Kurtpınar, Ceyhan, Adana (36°55'42"N 35°55'49"E) (Figure 5). All village have SOLEL individuals.

DISCUSSION

The distribution of SOLEL in Türkiye matches with important bird migration routes (Figure 6). When this data is combined with SOLEL populations in the Balkans mainly Northern Greece, Jordan Valley and South Africa, the role of bird migration can be seen (Figure 7). In addition, most populations in Turkey are away from human intervening areas, which emphasizes the role of birds (Reynolds et al., 2017).

According to the latest records, 500 species have been recorded in Türkiye (Akyildiz et al., 2020). Of these, 71 species are native species seen in all seasons and three species are no longer seen in Türkiye. Native birds, passage birds, summer migrants and winter migrant individuals of 426 species are seen in Türkiye seasonally **(See Supplementary Table 1)**. Turkey is located on one of the main routes of migrating birds (Figure 7). Eighteen soaring migrant birds were determined in 17 narrow passages studied and *Ciconia ciconia* was the most common species in the 10-year study, which migrates in large flocks (Akçay et al., 2020).

Figure 1. SOLEL population in Kırıkhan district of Hatay province (by İ.Üremiş)
Şekil 1. Hatay'ın Kırıkhan ilçesinde SOLEL populasyonu (by İ.Üremiş)

Figure 2. SOLEL population in İskenderun district of Hatay province (by İ.Üremiş)
Şekil 2. Hatay'ın İskenderun ilçesinde SOLEL populasyonu (by İ.Üremiş)

Figure 3. SOLEL population in Yüreğir district of Adana province
Şekil 3. Adana'nın Yüreğir ilçesinde SOLEL populasyonu

Figure 4. SOLEL population in İzmir province
Şekil 4. İzmir'de SOLEL populasyonu

Figure 5. SOLEL population in Incirli village of Adana province
Şekil 5. Adana'nın İncirli beldesinde SOLEL populasyonu

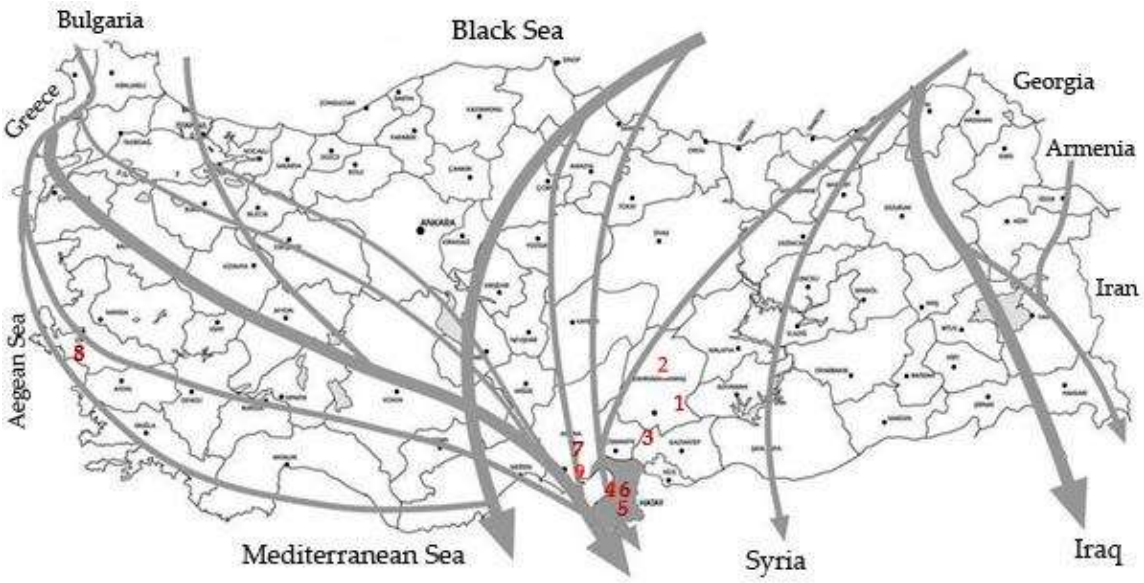

Figure 6. SOLEL populations (numbered) in Türkiye and the bird migration routes (Hacioğlu et al., 2017)
Şekil 6. Türkiye'deki SOLEL populasyonları (numarandırılmış) ve kuş göç yolları (Hacioğlu ve ark., 2017)

Wetlands and narrow passages make Türkiye important for migrating birds (Yarar & Magnin, 1997; Erdem, 1994). Türkiye with several narrow passages at northwest (İstanbul, Çanakkale), northeast (Artvin), and south (Hatay) that have been preferred by migrating birds to conserve energy throughout the route, has important bird migration routes between Europe and Africa (Grimmett & Jones, 1989) (Figure 8). In addition, İstanbul and Çanakkale passages were used by migrating birds from Eastern Europe to reach Iskenderun Bay in the Mediterranean Sea, then they passed Amanos Mountains using lower elevation passages to reach Africa. Belen Pass is the most important passage for migrating birds in the Amanos Mountains (Figure 8).

In a recent study, the highest bird diversity and the number of birds were found in Hatay/Belen which is a narrow passage for migrating birds and most SOLEL populations were found closer to an important route in the Western Palearctic (Akçay et al., 2020; Yarar & Magnin, 1997; Erdem, 1994; Grimmett & Jones, 1989; Shirihai & Christie, 1992; Porter and Beaman, 1985; Altundağ & Karataş, 2020). In Belen Pass in the spring of 2015, 29 migrating birds from five different families were determined and the number of birds was over 50000. The most abundant species were white stork (*Ciconia ciconia*) with 46525 individuals, great white pelican (*Pelecanus onocrotalus*) with 1142, common crane (*Grus grus*) (Linnaeus, 1758) with 723, lesser spotted eagle (*Clanga pomarina*) with 619, and black stork (*Ciconia nigra*) with 274 individuals (Figure 9) (Altundağ & Karataş, 2020).

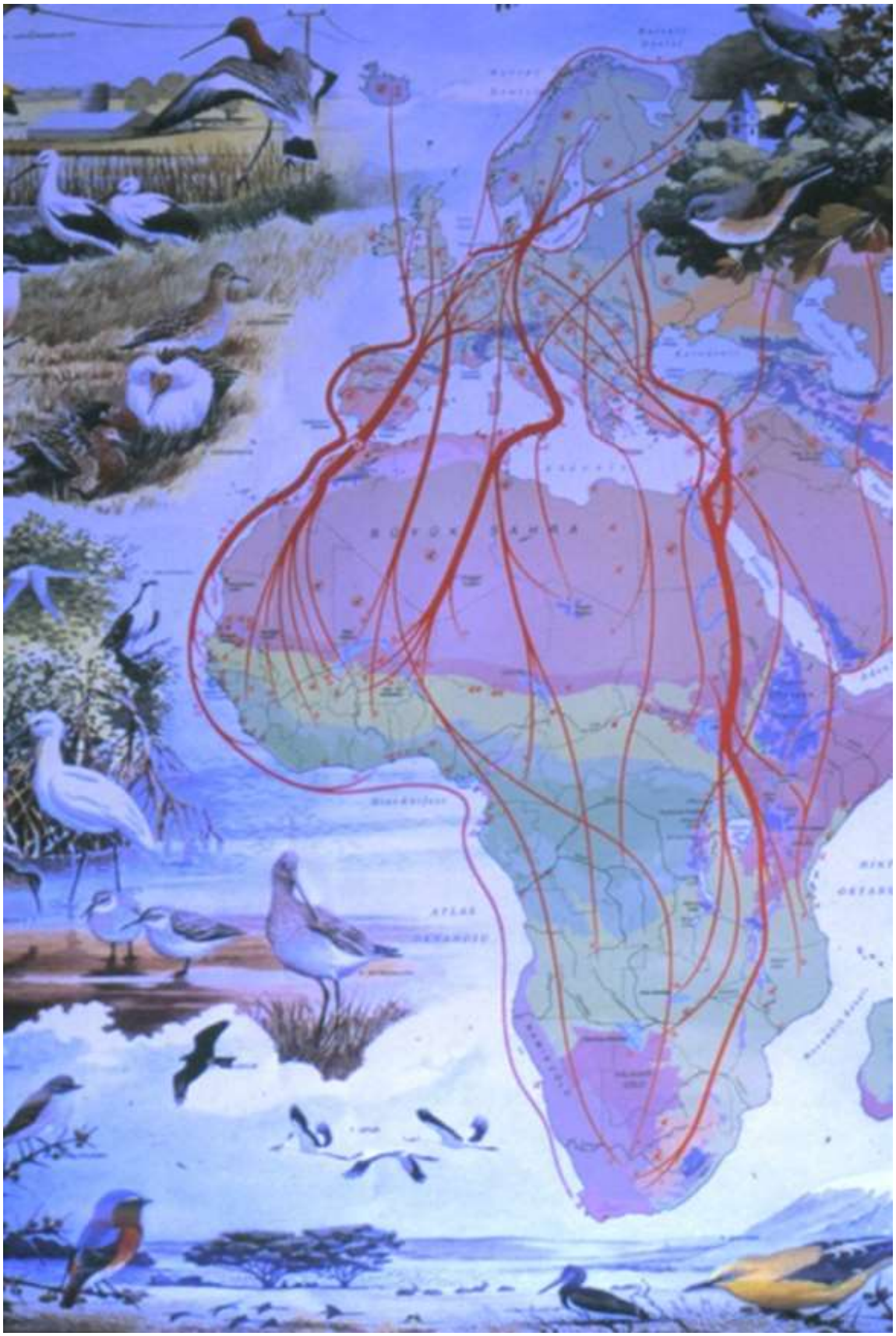

Figure 7. Migrating routes of birds between Eurasia and Africa (FAO, 2017)
Şekil 7. Kuşların Avrasya ve Afrika arasındaki göç yolları (FAO, 2017)

Figure 8. Bird migration routes in Turkey (Anonymous, 2018)
Şekil 8. Türkiye'de kuş göç yolları (Anonim, 2018)

Birds, especially migrating ones are the main alien plant propagules, invertebrates and microbes dispersing animals worldwide due to being long-distance vectors (Richardson & Rejmánek, 2011; Viana et al., 2016b). Plant seeds including non-natives can be carried over 1000 km which was shown in experiments with mallards, *Anas platyrhynchos* and graylag geese, *Anser anser* (García-Álvarez et al., 2015), modeling studies (Viana et al., 2016b) and observations on *Cotula coronopifolia*, a native plant of California dispersing by ducks to Australia and furthermore to Europe (Reynolds et al., 2017) and reviews such as Ridley (1930) (Cruden, 1966). In addition, native, or naturalized water birds is suggested as vectors for secondary dispersal after introduction (Solarz et al., 2017). Even for invasion success invasive plants need other dispensers in the new areas introduced. For instance, an invasive alien shrub *Cotoneaster franchetii* in Argentina is spread by a native bird *Turdus chiguanco* (Díaz Vélez et al., 2018).

Birds can disperse any seeds of an IAP through feeding (endozoochory) or adhering onto a bird (epizoochory/ectozoochory) after any casual interaction between vector and alien's propagule (Díaz Vélez et al., 2018; Solarz et al., 2017; Reynolds et al., 2017). Especially the role of water birds in Africa has been shown both ectozoochory and endozoohory dispersals for alien species such as *Bidens pilosa* and *Medicago arabica* (Reynolds & Cumming, 2016a) although the role of birds can be beneficial in disturbed habitats as well (Martínez-López et al., 2017; Sekercioğlu, 2006). This is considered a mutualistic relationship between plants and animals (González-Varo et al., 2019). Another way of dispersing was mentioned as synzoochory which is propagules can be dispersed from the mouth area, but not a common way for birds. Endozoochory has been mentioned that the most common and effective way which is caused by frugivorous birds (Reynolds & Cumming, 2016b). Seeds can stay longer duration in birds and keep germination capability (García-Álvarez et al., 2015). Waterbirds readily feed on seeds, a proportion of which survive and may show increased germination rates post-ingestion (Brochet et al., 2010). Even the birds that live in terrestrial areas have the role in the dispersal of alien species, which are mainly preferred

weeds and invasive alien plants for feeding facilitating the fast propagation of invasive alien plant species in and outside of oil palm and rubber plantations (Marthy, 2014; Hildebrandt, 2015). Not only do frugivorous birds cause plant dispersal, but also omnivorous and predatory birds carry seeds by eating fruits and small birds or other animals, respectively (Nogales et al., 2012).

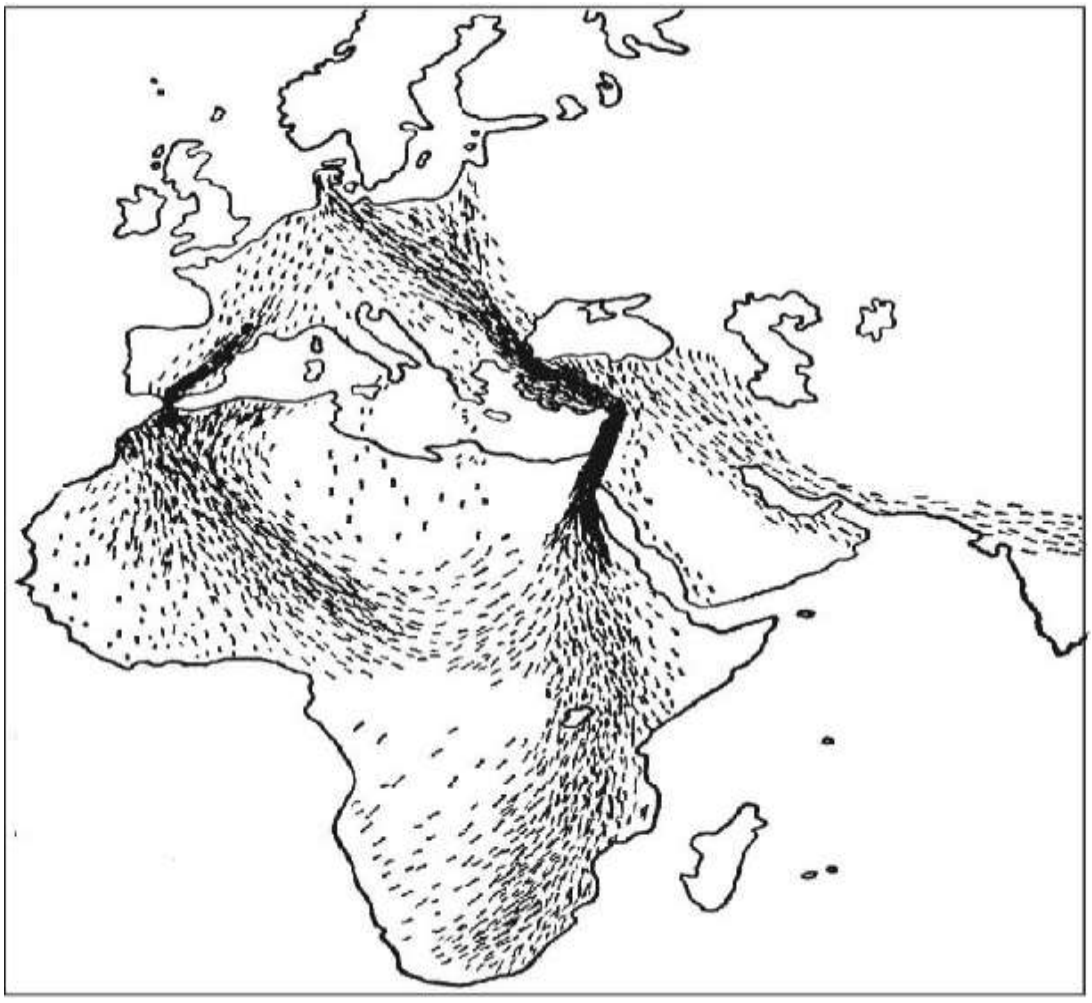

Figure 9. Flight directions of migrating White Stork (*Ciconia ciconia*). [From Dorst (1962), after Rüppell (1942), modified by Verheyen (1950)]

Şekil 9. Göçmen beyaz leyleklerin (Ciconia ciconia) uçuş yönleri. (Rüppell (1942)'den modifiye eden Verheyen (1950)'den değiştiren Dorst (1962)'tan

A study on the distribution of *Pistacia lentiscus*, a Mediterranean shrub, in the context of migration routes of frugivorous birds, showed genetical similarity among populations in North-South axes while dissimilarities in east-west axes (Martínez-López et al., 2020). Birds migrate from Europe to Africa and vice versa through different routes (Figure 9) which is consistent with the above-mentioned paper. The distribution of *P. lentiscus* through migration routes in North Macedonia, Greece, Türkiye, and Jordan is very similar to the distribution of SOLEL. If it is considered the role of birds migrating in short distances, it is more probable to the direction of seeds from Jordan to Türkiye.

Great white pelicans, migrating birds, have been counted near Thessaloniki and the Middle East where SOLEL has large populations and Belen Pass and Çukurova Delta of Türkiye, which might be carried and introduced SOLEL seeds or vegetative parts (Crivelli et al., 1991). The most abundant species counted in spring migration in the Belen pass was the white Stork, which comes from South Africa where SOLEL was introduced in the early 1900's (Viljoen & Wassermann, 2004). This could be another introductory route of SOLEL by birds.

Probably populations in Jordan Valley are one of the SOLEL sources for Türkiye because the records go back to 1994 for Jordan (Qasem, 2014) and 1957 for Israel and 1967 for Syria nearby countries of Jordan Valley (Qasem et al., 2019). Qasem (2014), reported

sheep, irrigation water and vehicles for the spread of SOLEL in Jordan Valley where has large populations in 14 sites except North Shunna, which is the nearest Jordan point to Syria (Qasem, 2014). This also supports our thesis on migrating birds because North Shaunna could have a bigger population if SOLEL had been introduced there any vector mentioned by Qasem (2014). Even in Jordan Valley, the role of migrating birds in the introduction and frugivorous local birds in the spread cannot be ignored. Indeed, house sparrows (*Passer domesticus* L.) were recorded picking fruit or seeds of SOLEL at three sites in Jordan Valley where all many areas cropped or natural not regarding soil type have been invaded (Qasem, 2014). Furthermore, high genetic and morphologic variations have been reported from a 40 km transect in Jordan Valley (Qasem et al., 2019), which can be interpreted that the reason can be multiple introductions coming from different locations with morphogenetic variations.

Water birds play a role not only among islands in oceans but also in wetlands and terrestrial areas as dispersal agents for plants and invertebrates (Ridley, 1930; Cruden, 1966; Green et al., 2013; Green et al., 2008; Green, 2016). It is proposed using a model that a waterbird may disperse five alive propagules of plants or invertebrates with over 100 km fly and after 300 km, one more propagule is calculated (van Leeuwen et al., 2012). Common lantana, *Lantana camara*, is an example of dispersal by birds through rivers (Vardien et al., 2012). It can be said for SOLEL, the role of birds in introduction and dispersal, but the latter happens through roads probably being a dryland plant.

CONCLUSION

The new SOLEL populations in Türkiye can be attributed to climate change such as increasing temperatures that affects behavior of migratory birds too (Both et al., 2010; Pulido & Berthold, 2010) or new introductions from Europe and Africa by migrating birds although there has been no study on South to North migration route which had been studied for North to the south as hypothesized for *Frangula alnus* (Hampe et al., 2003).

This study will contribute to finding out pathways and vectors of invasive alien species as requested by many international, regional, and national reports, agreements, and organizations such as CBD, UN, and FAO as well as an invitation to work together and combine to powers for countries on the same bird migration route to deal with IAS under global change.

Maybe this pathway which is unaided cannot be managed (Solarz et al., 2017) but an extensive citizen science system can help to detect earlier such alien species and immediately remove them from the area without establishment because there will not be a mass introduction which also makes detection of solo individuals.

This article shows the clues of bird migrations possible role as an invasive alien plant introduction pathways and birds' role as vectors. Furthermore, their possible roles with native birds in further spread. This study agrees with previous studies suggesting further research on birds such as Reynolds et al. (2017) either migrating or local birds to prevent introductions and spread (Reynolds et al., 2017).

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This paper is dedicated to victims of 06 February 2023 earthquakes in Türkiye, where the most SOLEL populations in this paper have been detected.

Author's Contributions

The contribution of the authors is equal.

Statement of Conflict of Interest

Statement of Conflict of Interest

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Supplemantary Table 1. Migratory birds seen in Turkiye
Ek Tablo 1. Türkiye'de görülen göçmen kuşlar

Familia	Latin Name	English Name	Status
Anatidae	*Anas acuta*	Northern Pintail	WM*
Anatidae	*Anas penelope*	Eurasian Wigeon	WM
Anatidae	*Anas strepera*	Gadwall	WM
Anatidae	*Anser albifrons*	Greater White-fronted Goose	WM
Anatidae	*Anser anser*	Greylag Goose	WM
Anatidae	*Branta ruficollis*	Red-breasted Goose	WM
Anatidae	*Bucephala clandula*	Common Goldeneye	WM
Anatidae	*Aythya fuligula*	Tufted Duck	WM
Anatidae	*Aythya nyroca*	Ferruginous Duck	WM
Anatidae	*Cygnus olor*	Mute Swan	WM
Anatidae	*Cygnus cygnus*	Whooper Swan	WM
Anatidae	*Netta rufina*	Red-crested Pochard	WM
Anatidae	*Melanitta nigra*	Common Scoter	WM
Anatidae	*Mergus albellus*	Smew	WM
Anatidae	*Mergus serrator*	Red-breasted Merganser	WM
Anatidae	*Tadorna tadorna*	Common Shelduck	WM
Burhinidae	*Burhinus oedicnemus*	Eurasian Stone-curlew	SM**
Charadriidae	*Charadrius alexandrinus*	Kentish Plover	SM
Charadriidae	*Charadrius dubius*	Little Ringed Plover	SM
Charadriidae	*Charadrius leschenaultii*	Greater Sand Plover	SM
Charadriidae	*Charadrius leschenaultii*	Greater Sand Plover	SM, TM***
Charadriidae	*Pluvialis apricaria*	European Golden Plover	TM, WM
Charadriidae	*Pluvialis squatarola*	Grey Plover	TM, SM, WM
Charadriidae	*Vanellus spinosus*	White-tailed Lapwing	SM
Charadriidae	*Charadrius morinellus*	Eurasian Dotterel	TM
Columbidae	*Streptopelia turtur*	European Turtle Dove	SM
Glareolidae	*Glareola pratincola*	Collared Pratincole	SM, TM
Gruidae	*Grus grus*	Common Crane	TM
Gruidae	*Grus virgo*	Demoiselle Crane	TM
Haematopodidae	*Haemantopus ostralegus*	Eurasian Oystercatcher	SM
Haematopodidae	*Himantopus himantopus*	Black-winged Stilt	SM
Laridae	*Larus ichthyaetus*	Pallas`s Gull	SM
Laridae	*Larus audouinii*	Audouin`s Gull	R****, WM
Laridae	*Larus fuscus*	Lesser Black-backed Gull	WM, TM
Laridae	*Hydrocoloeus minutus*	Little Gull	TM
Laridae	*Larus ridibundus*	Black-headed Gull	WM
Laridae	*Rissa tridactyla*	Black-legged Kittiwake	WM

Laridae	*Gelochelidon nilotica*	Gull-billed Tern	TM, WM, SM
Laridae	*Sterna caspia*	Caspian Tern	TM, SM
Laridae	*Sterna sandvicensis*	Sandwich Tern	TM, WM, SM
Laridae	*Sterna hirundo*	Common Tern	SM
Laridae	*Sternula albifrons*	Little Tern	SM
Laridae	*Chlidonias leucopterus*	White-winged Tern	SM
Laridae	*Chlidonias hybrida*	Whiskered Tern	TM
Laridae	*Chlidonias niger*	Black Tern	SM
Pycnonotidae	*Pycnonotus xanthopygos*	White-spectacled Bulbul	R
Rallidae	*Crex crex*	Corn Crake	WM
Rallidae	*Porzana porzana*	Spotted Crake	TM
Rallidae	*Rallus aquaticus*	Water Rail	WM
Rallidae	*Zapornia parva*	Little Crake	SM
Recurvirostridae	*Recurvirostra avosetta*	Pied Avocet	SM
Scolopacidae	*Calidris canutus*	Red Knot	WM
Scolopacidae	*Calidris ferruginea*	Curlew Sandpiper	TM, WM
Scolopacidae	*Calidris alpina*	Dunlin	TM
Scolopacidae	*Calidris alba*	Sanderling	TM
Scolopacidae	*Calidris minuta*	Little Stint	WM
Scolopacidae	*Calidris pugnax*	Ruff	WM
Scolopacidae	*Calidris temminckii*	Temminck`s Stint	TM
Scolopacidae	*Gallinago gallinago*	Common Snipe	WM
Scolopacidae	*Scolopax rusticola*	Eurasian Woodcock	R, WM, TM
Scolopacidae	*Limicola falcinellus*	Broad-billed sandpiper	WM
Scolopacidae	*Limosa limosa*	Black-tailed Godwit	TM
Scolopacidae	*Limosa lapponica*	Bar-tailed Godwit	TM
Scolopacidae	*Numenius phaepus*	Whimbrel	TM
Scolopacidae	*Numenius arquata*	Eurasian Curlew	WM
Scolopacidae	*Lymnocryptes minimus*	Jack Snipe	TM, WM
Scolopacidae	*Tringa erythropus*	Spotted Redshank	WM, TM
Scolopacidae	*Tringa stagnatilis*	Marsh Sandpiper	WM, TM
Scolopacidae	*Tringa glareola*	Wood Sandpiper	TM
Scolopacidae	*Tringa nebularia*	Common Greenshank	TM
Scolopacidae	*Xenus cinereus*	Terek Sandpiper	TM
Scolopacidae	*Arenaria interpres*	Ruddy Turnstone	TM, WM
Scolopacidae	*Phalaropus lobatus*	Red-necked Phalarope	TM
Sturnidae	*Sturnus roseus*	Rosy Starling	SM
Sylvidae	*Locustella luscinioides*	Savi`s Warbler	SM
Sylvidae	*Acrocephalus schoenobaenus*	Sedge Warbler	SM
Sylvidae	*Acrocephalus arundinaceus*	Great Reed Warbler	SM
Sylvidae	*Acrocephalus dumetorum*	Blyth's Reed Warbler	SM
Sylvidae	*Acrocephalus palustris*	Marsh Warbler	SM
Sylvidae	*Acrocephalus scirpaceus*	Common Reed Warbler	SM
Sylvidae	*Iduna pallida*	Eastern Olivaceous Warbler	SM
Sylvidae	*Hippolais icterina*	Icterine Warbler	SM
Sylvidae	*Sylvia cantillans*	Subalpine Warbler	TM
Sylvidae	*Sylvia atricapilla*	Eurasian Blackcap	SM
Sylvidae	*Sylvia borin*	Garden Warbler	SM
Sylvidae	*Sylvia nisoria*	Barred Warbler	TM
Sylvidae	*Sylvia communis*	Common Whitethroat	SM
Sylvidae	*Sylvia curruca*	Lesser Whitethroat	SM
Sylvidae	*Sylvia rüppelli*	Rüppell`s Warbler	SM
Sylvidae	*Phylloscopus trochilus*	Willow Warbler	TM
Sylvidae	*Phylloscopus bonelli*	Eastern Bonelli`s Warbler	SM
Sylvidae	*Phylloscopus sibilatrix*	Wood Warbler	SM
Turdidae	*Turdus pilaris*	Fieldfare	WM
Turdidae	*Turdus iliacus*	Redwing	WM

*WM: Winter Migrant; **SM: Summer Migrant; ***TM: Transit Migrant; ****R: Resident