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RESEARCH ARTICLE

Ethnobotanical Usages of the Turkish *Rumex* Taxa

Fatma Sarı[1], Mine Koçyiğit[2]

Abstract

Objective: The genus *Rumex* is represented by 183 taxa across the world, with 48 taxa in Turkey. The most common species are *R. acetosella* L., *R. acetosa* L., *R. alpinus* L., *R. crispus* L., *R. nepalensis* Spreng., *R. patientia* L., *R. pulcher* L., *R. tuberosus* L. and they are known by local names such as Kuzukulağı, Şortah, Taşturşusu, Ekşikulak, Labada, Dibikızıl, Efelek, Ekşilik, Kuzuoğlağı, Kuzukırdağı, Ak labada, Ekşi yemiş. In this study, those *Rumex* species used for medical and food purposes by people in Turkey were compiled. The aim of this study is to provide a basis for chemical, physiological, molecular or agricultural studies and to support them in easily accessing the bibliography without wasting time.

Materials and Methods: Approximately 250 ethnobotanical articles were examined from Turkey and other countries around the world about the local usages of the genus *Rumex*. The data were listed as a table and according to the data compiled from these articles, the Use-Value (UV) index among species was calculated.

Results: In the ethnobotanical studies compiled, it was determined that the species most used by people were *R. crispus*, *R. acetocella* and *R. acetosa*. 174 ethnobotanical usages in Turkey, 152 ethnobotanical usages from different countries for 27 Turkish *Rumex* taxa have been recorded. When the parts used were compared, it was seen that the leaves and roots are mostly used. Considering the usage purposes of the Rumex genus, it was revealed that there are many different uses, however, the most common uses are for food purposes. In the compiled study, the species with the highest UV values were calculated as *R. crispus*, *R. acetosella*, *R. acetosa, R. patienta*, and *R. scutatus*.

Conclusion: *Rumex* taxa are used widely by people for reasons such as having a wide distribution area, growth around agricultural areas and being in areas where people can easily reach them. Also, they do not need special conditions for germination and growth. However, since they have a sourish flavour, consuming them raw as a salad can trigger some health problems. Although there are studies reporting that levels of oxalic acid, which is the source of this sour taste, decrease in cooking, there are also clinical studies that show that it can accumulate in the body and have some long-term toxic effects.

Keywords: *Rumex*, Kuzukulağı, Labada, Ethnobotany, Turkey

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Introduction

Resources from plants found in local environments play an important role in providing food and medical care for people in many parts of the world. The most important factor in people's interest in wild plants is their use as food in times of famine or food shortages. Also, eating wild products has become fashionable in modern society (Vasas, *et al.,* 2015). The genus *Rumex* L., which is in the family Polygonaceae, is frequently encountered in meadow pasture areas and is consumed as food and used for treatment purposes among the people in Turkey (Turan, *et al.*, 2003; Töngel & Ayan, 2005; Tanker, *et al*., 1993). There are 183 taxa of the genus *Rumex* in the world

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(ThePlantlist 2021). In Turkey, 48 species, 8 of which are endemic, grow widely (Güner, *et al*., 2012).

The genus *Rumex* is used in Greek 'lápato' Turkish sources to mean 'a vegetable whose leaves are used as a salad' from the word 'lebeta/lebeta'. Another view is that the name *Rumex* derives from the Latin word dart, referring to the shape of the leaves (Saleh, *et al*., 1993).

In Turkey, Kuzukulağı, Şortah, Taşturşusu, Ekşikulak, Labada, Dibikızıl, Efelek, Ekşilik, Kuzuoğlağı, Kuzukıkırdağı, Aklabada, Ekşiyemiş are used as local names. It is known that the use of herbs for both nutrition and folk medicine in our country has a rich history. Especially in the Aegean and Black Sea regions, we should mention that there is a widespread "Herb Culture" with the contribution of natural floristic wealth (Faydaoğlu & Sürücüoğlu, 2011; Tuzlacı, 2016).

In this study, those *Rumex* species used for medical and food by the people in Turkey were compiled. The aim of this study is to provide a basis for chemical, physiological, molecular or agricultural studies and to support them in easily accessing the bibliography without wasting time.

Material and Methods

In the compilation of data to determine the ethnobotanical use of *Rumex* species both among the people of Turkey and worldwide, 250 scientific articles were reviewed. According to the data compiled from these articles, significance comparison (UV) values between species were calculated according to the formula UV = U / N. U type refers to the number of times it has been used, and N represents the number of articles it appears in. The parts of *Rumex* species used in ethnobotanical studies, the preparation method and the details of the purpose of use are also listed in Table 1.

Results and Discussions

In Turkey, 48 taxa and 38 species grow naturally, however, within the scope of this research, according to the results of the literature review on *Rumex* species grown in our country, the ethnobotanical use of 26 *Rumex* taxa was obtained. In the world 152 different usages are recorded, while in Turkey this figure is 174. Most records of usage were collected from the following provinces respectively Izmir, Hakkari, Van and Mersin in Turkey. The species which had the highest UV values were *R. crispus, R. acetosella, R. acetosa, R. patienta* and *R. scutatus*. Ethnobotanical data was not found for some taxa such as *R. amanus* Rech.f. (Çimen turşusu), *R. angustifolius* Campd (Taş turşusu), *R.* × *autranianus* Freyn & Sint.ex Dinsm. (At kulağı), *R. palustris* Sm. (Tosbağakulağı), *R. olympicus* Boiss. (Uluefelek), *R. bithnynicus* Rech.f. (Yılkı kulak), *R.* × *subtrilobus* Boiss. (Şeytan Kulağı), *R.* × *subtranianus* Freyn & Sint (Kedi Kuzulası), *R.* × *gemlikensis* Rech.f. (Gemlik labadası), *R. tmoleus* Boiss. (Özge Labada), *R.* × *prusianus* Rech.f. (Ilemondoru), *R.* × *muelleri* Meisn. (Eşek Kuzulası) and *R. bucephalophorus* L. (Çipir), they are known only by their Turkish names (Güner, *et al*., 2012).

Leaves of some *Rumex* species (*R. acetosa, R. acetosella, R. abyssinicus, R. crispus, R. sanguineus, R. tuberosus ve R. thyrsiflorus, R. vesicarius)* are used in the preparation of salads (Pardo-de-Santayana, *et al.,* 2007; Çakılcioğlu & Türkoğlu, 2010).

The roots of many species belonging to the *Rumex* genus have been used in traditional medicine since ancient times due to their mild laxative effect. *R. acetosa* is officially listed as one of the main food ingredients in the Korean Food Code (Korean Food and Drug Administration). It has been used in folk medicine both as a mild laxative and for the treatment of cutaneous diseases (inflammation of skin vessels) (Lee, *et al.,* 2005). Some species such as *R. acetosa* and *R. vesicarius* are cultivated (Bélanger, *et al*., 2010). In addition, there are invasive species such as *R. obtusifolius* and *R. crispus* that grow widely in agricultural areas within this genus (Watanabe, *et al.,* 2011).

Worldwide, the countries with the highest rate of use of *Rumex* species are Ireland, England, Iran, North America, and India, respectively.

Some *Rumex* species have been used in Traditional Chinese Medicine (TCM) to treat different ailments. Fresh young leaves of *R. nepalensis* have been shown to be of benefit when applied to the affected areas after injuries from nettles (Gautam, *et al.,* 2010).

The dried roots of *R. crispus* find usage in our country against constipation and as a blood cleanser. It has been used in other parts of the world against skin diseases, jaundice and gastrointestinal system ailments. The fruits of the plant are used against dysentery, and the leaves are eaten as vegetables (Shiwani, *et al*., 2012). In some parts of India, almost all parts of *R. crispus* are used either as food or medicine. Very young leaves of the plant are added to salads and soups, the stems are peeled and the inside is eaten, and finally the seeds are ground and powdered and used as flour for pancakes. Roasted seeds have been used as coffee (Pareek & Kumar, 2014).

R. conglomeratus has been used as a blood cleanser to relieve bathing rashes and sunburn. It has also been used

Table 1. Ethnobotanical Usages and Use-Values of the Turkish Rumex

Plant species	UV	Local Name	Country / City	Plant Part	Dosage, application	Traditional uses	References
R. acetosa L.	0.9	Sour dock, red sorrel, Kişlek	Turkey, Edirne	Leaf	Salad or fresh	Foodstuff	Güneş (2017)
				Stem			
			Kore	Leaf	-	Jaundice treatment	Vasas, et al. (2015), Bello, et al. (2019)
					-	Mild purgative	
					-	Cutaneous diseases	
					-	Throat diseases	
					-	Warts	
			Switzerland	Aerial part	-	Diarrhea treatment	
			Britain, Ireland	Leaf	Decoction	Diarrhea treatment	
					-	Dysentery	
					-	Gonorrhea	
					-	Fever	
					-	Ulcer	
					-	Scabies problem	
					-	Skin diseases	
					-	Kidney diseases	
			Czech Republic	Leaf	Decoction	Lumps	Bello, et al. (2019)
			North America	Leaf	Extract	Diarrhea treatment	
			Yemen	Whole	-	Gastrointestinal disorders	
			Pakistan	Aerial part	-	Acne	Korpelainen &Pietiläinen (2020)
			Pakistan	Aerial part	-	Lowering high blood pressure	Korpelainen &Pietiläinen (2020)
			Yemen	Whole	-	Dermatological infections	Bello, et al. (2019)
			Hungary	Leaf	-	Fever	Vasas, et al. (2015)
			South Africa	Leaf	-	Abscesses	Watt and Breyer, Brandwijk (1932)
		-	Bulgaria	Leaf	Salad or fresh	Foodstuff	Nedelcheva (2013)
		-	India	Leaf	Decoction	Diarrhea treatment	Allen & Hatfield (2004)
		Sheep sorrel	North America	Leaf	Decoction	Diarrhea treatment	Bello, et al. (2019)

Table 1. Continue

Plant species	UV	Local Name	Country / City	Plant Part	Dosage, application	Traditional uses	References
R. acetosella L.	1.14	Field sorrel, red sorrel, sour dock, juhsóska	Malatya	Leaf	Salad or fresh	Foodstuff	Yeşil & Akalın (2011)
			North America	Leaf	Poultice	Warts	Moerman, (2003); Vasas, et al. (2015)
			Romania	Leaf	Poultice	Warts	
			North America	Seed	Chewed	Diarrhea treatment	
			Hungary	Aerial part	Chewed	Diarrhea treatment	
			North America	Seed	Chewed	Stomach problems	
			Hungary	Aerial part	Chewed	Stomach problems	
			Iran	Aerial part	Decoction	Jaundice treatment	Amiri, et al. (2014)
			Iran	Aerial part	Decoction	Fever	Amiri, et al. (2014)
			Turkey, Balıkesir	Leaf	-	Nausea treatment	Çelik, et al. (2008)
			Turkey, Balıkesir	Leaf	-	Pituitary extractor	Çelik, et al. (2008)
		Sheep sorrel	Turkey, Manisa	Leaf	-	Diarrhea treatment	Güler, et al. (2015)
			Turkey	Leaf	Decoction	Diabetes	Çakilcioglu, et al. (2011)
			Turkey, Bilecik	Root	Decoction	Diuretic	Güler, et al. (2015)
			Turkey, Bilecik	Leaf	Decoction	Diuretic	Güler, et al. (2015)
			Turkey, Ordu	Leaf	-	Diabetes	Zengin Kurt, et al. (2018)
			Turkey, Ordu	Leaf	-	Foodstuff	Zengin Kurt, et al. (2018)
			Turkey, Ordu	Leaf	-	Blood pressure-lowering	Zengin Kurt, et al. (2018)
			Turkey	Leaf	-	Blood pressure-lowering	Polat, et al. (2013)
			Turkey	Leaf	-	Diuretic	Polat, et al. (2013)
			Turkey	Leaf	Decoction	Heart diseases	Kılıç & Bağcı(2013)
			Turkey, Erzincan	Leaf	-	Diabetes	Korkmaz & Karakuş (2015)
			Turkey	Leaf	Decoction	Analgesic	Çakılcıoğlu & Türkoğlu (2010)
			Turkey	Leaf	Infusion	Constipation	Fakir, et al. (2009)
			Turkey, Manisa	Leaf	-	Gallstone	Fakir, et al. (2009); Sargin, et al. (2013); Sargin, et al. (2015)
			Turkey, Manisa	Leaf	-	Kidney diseases	Fakir, et al 2009; Sargin, et al (2013); Sargin, et al. (2015)

Table 1. Continue

Plant species	UV	Local Name	Country / City	Plant Part	Dosage, application	Traditional uses	References
R. acetosella L.	1.14		Turkey, Manisa	Leaf	-	-	Fakir, et al. (2009); Sargin, et al. (2013); Sargin, et al. (2015)
			Turkey	Leaf	Infusion	Human intestinal parasites	Fakir, et al. (2009)
			Turkey	Leaf	Infusion	Gallstone	Fakir, et al. (2009)
			Turkey	Leaf	Decoction	Diuretic	Çakılcıoğlu & Türkoğlu (2010)
			Turkey, Ankara	Leaf	-	Gallstone	Baytop (1999)
			Turkey, Ankara	Leaf	-	Antipyretic	Baytop (1999)
			Turkey, Kırklareli	Leaf	Cooked	Asthma	Kültür (2008)
			Mersin, Turkey	Leaf	-	Foodstuff	Elçi & Erik (2006)
		Sheep sorrel	Turkey	Leaf	-	Foodstuff	Dogan, et al. (2004); Dogan (2012); Arı, et al. (2015)
			Kosovo	Leaf	-	Foodstuff	Keskin, et.al. (2012)
			Turkey	Leaf	Poultice	Fistula	Akbulut & Bayramoğlu (2013)
			Turkey	Leaf	Pounded/ External	Acne	Altundag & Özturk (2011)
			Turkey	Leaf	External	Acne	Altundag &Özturk (2011)
			Turkey, Manisa	Leaf	Eaten	Acne	Güler, et al. (2015)
			Turkey	Aerial part	Eaten	Stomach problems	Altundag & Özturk (2011)
			Turkey, Kastamonu	Leaf	Eaten	Foodstuff	Tuttu, et al. (2019)
			Turkey, Mersin	Leaf	Decoction	Diabetes	Bağcı (2013)
R. alpestris Jacg.	0.024	Kırturşusu	Armenia	Leaf	-	Foodstuff	Hovsepyan, et al. (2016)
R. alpinus L.	0.36	Şortah	Armenia	Leaf	-	Foodstuff	Hovsepyan, et al. (2016)
			Turkey, Balıkesir	Leaf	Eaten	Foodstuff	Kaval, et al. (2014)
			Turkey	Leaf	Decoction	Laxative	Mishra, et al. (2018)
						Constipation	
						Diarrhea treatment	
						Jaundice treatment	
				Root		Laxative	
						Constipation	
						Diarrhea treatment	
						Jaundice treatment	
						Antibacterial	
		Şortah		Leaf	-	Antibacterial	
		Dırşo, sılkok	Turkey,Erzurum	Leaf	Cooked	Foodstuff	Karakaya, et al. (2019); Özgen, et al. (2012)
R. caucasicus Rech.f.	0.121	Trişov	Turkey, Van	Leaf	-	Teeth Treatment	Baytop (1999); Öztürk & Öztürk (2007)
						Constipation	Aksakal & Kaya (2008); Erarslan, et al. (2018)
						Diuretic	
						Diuretic	
						Foodstuff	

Table 1. Continue

Plant species	UV	Local Name	Country / City	Plant Part	Dosage, application	Traditional uses	References
R. chalepensis Mill.	0.07	Ekşiot	Pakistan	Root	-	Cutaneous diseases	Shinwari & Khan (2000)
			Turkey	Root	-	Laxative	Özturk, et al.(2013)
					-	Eczema	
R.conglomeratus Murray.	0.22	Ekşikulak	Turkey, Balıkesir	Aerial part	-	Foodstuff	Uysal, et al. (2010); Çelik, et al. (2008); Akaydın, et al. (2013)
			Turkey	Stem	-	Blood purifier	Ahmadi, et al. (2016)
				Root	Maceration	Laxative	Özturk, et al. (2013)
				Root	-	Eczema	
R. crispus L.	1.58	Labada, Curled dock, sour dock, row dock, yellow dock, curled dock, sour dock, fodros lórom	Turkey, Edirne	Leaf	-	Haemorrhoid	Ugulu (2011)
			Turkey, Edirne	Leaf	Crushed	Rheumatism	
			Turkey, Denizli	Leaf	Crushed	Headache	Bulut ,et al. (2017)
			Turkey, Denizli	Leaf	Decoction	Diabetes	
			Turkey, Edirne	Leaf	Eaten	Foodstuff	Güneş (2017)
			Turkey, Edirne	Stem	Eaten	Foodstuff	Güneş (2017)
			Turkey, Kars	Aerial part	-	Foodstuff	Güneş & Özhatay (2011)
			Turkey, Afyonkarahisar	Whole	-	Foodstuff	Kargıoğlu, et al. (2008), Arı, et al. (2015), Dogan (2012), Dogan, et al. (2004)
			Turkey, Erzincan	Leaf	Cooked	Anticancer	Korkmaz & Karakuş (2015)
			Turkey, Erzincan	Seed	-	Eczema	
			Turkey, Erzincan	Leaf	-	Diabetes	
			Turkey	Aerial part	-	Foodstuff	Kargıoğlu, et al. (2008)
			Iran	Fruit	-	Cholesterol-lowering	Ahmadi, et al. (2016)
			Turkey, Ordu	Leaf	-	For scabies	Zengin Kurt, et al. (2018)
			Turkey, Ordu	Leaf	-	Foodstuff	
			Iran	Leaf	-	Blood pressure-lowering	Ahmadi, et al. (2016)
			Turkey, Ankara	Seed	-	Diarrhea treatment	Sarper, et al. (2009)
			India	Aerial part	-	Homeopath	Pareek & Kumar (2014)
			Turkey	Leaf	-	Antipyretic	Özgökçe & Özçelik (2004)
			Turkey	Leaf	-	Haemorrhoid	

Table 1. Continue

Plant species	UV	Local Name	Country / City	Plant Part	Dosage, application	Traditional uses	References
R. crispus L.	1.58	Labada, Curled dock, sour dock, row dock, yellow dock, curled dock, sour dock, fodros lórom	Turkey, Niğde	Leaf	-	For worm	Paksoy, et al. (2016)
			Iran	Root	-	Antipyretic	Rajaei & Mohamadi (2012)
			Iran	Root	-	Laxative	
			Iran	Rhizome	-	Antipyretic	
			Iran	Rhizome	-	Laxative	
			Iran	Rhizome	-	Diarrhea treatment	
			Turkey, İzmir	Leaf	-	For the biliary system	Ugulu, et al. (2009)
			Turkey, İzmir	Leaf	-	Diuretic	
			Turkey, İzmir	Leaf	-	Rheumatism	
			Turkey, Manisa	Leaf	-	Rheumatism	Uğurlu (2011)
			Turkey, Manisa	Leaf	-	Haemorrhoid	Ugulu, et al. (2009)
			Iran	Root	-	Diarrhea treatment	Rajaei & Mohamadi (2012)
			Turkey,Malatya	Leaf	-	Heart diseases	Tetik, et al. (2013)
			Turkey, Ankara	Seed	-	Diarrhea treatment	Akaydın, et al. (2009)
			Turkey	Leaf	-	Antiphlogistic	Özgökçe & Özçelik (2004); Altundag & Özturk (2011)
			Pakistan	Leaf	-	Infections	Shuaib, et al. (2014)
			Pakistan	Fruit	-	Infections	
			Turkey,Uşak	Fruit	-	Urinary system	Bulut, et al. (2017)
			Turkey,Uşak	Fruit	Decoction	Diuretic	
			Turkey	Root	Decoction	Laxative	Özturk, et al. (2013)
			Turkey, Kırklareli	Leaf	-	Foodstuff	Kültür (2007)
			Turkey	Leaf	-	Cold	Altundag & Özturk (2011); Genç & Özhatay (2006); Doğru Koca, & Yıldırımlı (2010)
			Turkey	Leaf	Decoction	Cough	
			Turkey	Leaf	Decoction	Asthma	
			Turkey	Leaf	Decoction	Haemorrhoid	
			Turkey	Leaf	Decoction	Gynecologically diseases	
			Turkey, Kırklareli	Leaf	Decoction	Inflamed wounds	Kültür (2007)
			Turkey	Fruit	Eaten	Goiter	Altundag & Özturk (2011)
			Turkey	Leaf	Decoction	Rheumatism	Altundag & Özturk (2011); Bulut, et al. (2017)
			Turkey	Root	Decoction	Eczema	Özturk, et al. (2013); Erarslan, et al. (2018)
			Britain	Root	-	Laxative	Vasas, et al 2015)
			North America	Root	-	Laxative	Özturk, et al (2013); Vasas, et al (2015)
			South Africa	-	Eaten	Purgative	Watt & Breyer-Brandwijk (1932)
			North America	-	-	Dysentery	Moerman (2003)
			Taiwan	Leaf	Infusion	Infections	Shiwani, et al. (2012)
			Taiwan	Fruit	-	Dysentery	
			Turkey, Kırklareli	Leaf	-	Foodstuff	Karakaya, et al. (2019); Özgen, et al. (2004)
			Switzerland	Root	Cooked	Diabetes	Sandra, et al. (2021)

Table 1. Continue

Plant species	UV	Local Name	Country / City	Plant Part	Dosage, application	Traditional uses	References
R. crispus L.	1.58	Labada, Curled dock, sour dock, row dock, yellow dock, curled dock, sour dock, fodros lórom	Pakistan	-	-	Skin diseases	Ahmad, et al. (2009); Eraslan, et al. (2018)
			Turkey, Kastamonu	Leaf	-	Foodstuff	Tuttu, et al. (2019)
			Italy	Leaf	Infusion	For obesity	Pierroni & Cattero (2019)
			Iran	Fruit	Boiled	Reduction in blood fat	Baharvand, et al. (2015)
R. cristatus DC.	0.1	Lapuşa	Turkey	Flower	-	Laxative	Özturk, et al. (2013)
				Root	-	Laxative	
				Flower	-	Eczema	
				Root	-	Eczema	Özturk, et al. (2013), Eraslan, et al. (2018)
R. dentatus L.	0.2	Kıvırtak	Turkey, Antakya	Leaf	-	Foodstuff	Altay, et al. (2012)
		Kıvırtak	Turkey	Leaf	-	Anticancer	Mishra, et al. (2018)
		toothed dock	India	Root	-	Astringent	Khare (2007)
		toothed dock	China	Root	-	İnfections	Zhu, et al. (2010); Zhang, et al. (2012)
		Kıvırtak	Iran	Leaf	-	Child food	Rajaei & Mohamadi (2012)
R. gracilescens Rech.f.	0.024	Güyreyik	Turkey, Ankara	Leaf	-	Laxative	Elçi &Erik (2006)
R. hydrolapathum Huds.	0.32	Water dock	Britain, Ireland	Root		Astringent	Allen & Hatfield (2004)
						Scurvy	
						Laxative	
						Eczema, Foodstuff	
						Blood purifier	
R. maritimus L.	0.121	Kum eveleği	Bangladesh	Seed	-	Aphorizes	Uddin & Mahbubur Rahman (2014)
						Tonic	
						Analgesic	
				Root	-	Skin diseases	Mahbubur Rahman (2013)
			India	Seed	-	Tonic	Rouf, et al. (2003); Khare (2007)
R. nepalensis Spreng.	0.41	Dibikızıl	Turkey	Seed	-	Constipation	Mishra, et al. (2018)
					-	infectious	
					-	Tumour	
					-	Analgesic	
			Ethiopia	Root	-	Pain	Giday, et al. (2009)
			China	Root	-	Stomach problems	
			South Africa	Root	-	Purgative	Watt & Breyer-Brandwijk (1932); Khare (2007)
				Leaf	Infusion	Bilharziasis	
				Root	-	Purgative	
			North India, Afghanistan, India	Leaf	-	Colic treatment	Khare(2007); Gautam, et al. (2010)

Table 1. Continue

Plant species	UV	Local Name	Country / City	Plant Part	Dosage, application	Traditional uses	References
R. nepalensis Spreng.	0.41	-	India	Aerial part	Decoction	Stomach problems	Jain & Parkhe (2018)
		-	India	Leaf	Infusion	Dysmenorrhoea	
		-	India	Leaf	Infusion	Antiallergic	
		-	Ethiopia	Leaf	Crushed	Abortifacient activities	Dabe, et al. (2020)
		Dibikızıl	India	Leaf	Extract	Colic treatment	Rana & Datt (1997)
R. obtusifolius L.	0.31	Blunt leaf	Ireland	-	-	Laxative	Allen & Hatfield (2004)
						Tonic	
						Anticancer	
						Tumour	
						Burn	
						Astringent	
			North America	Root		Skin diseases	
			Ireland	Root		Skin diseases	
			Ireland	Seed		Cough	
			Britain	Root		Skin diseases	
			Britain	Seed		Cough	
			Hungary	Aerial part		Constipation	Haraszti (1985)
		Kökükızıl	Turkey	Leaf		Foodstuff	Dogan, et al. (2004); Dogan (2012)
R. obtusifolius L. subsp. *subalpinus* Schur.	0.05	Kökükızıl	Turkey, Trabzon	Leaf	Cooked	Animal nutrition	Sağiroğlu, et al. (2012)
R. patienta L.	0.8	Efelek, Tırşıka karan lórom	Turkey, Denizli	Leaf	-	Wound healing	Bulut, et al. (2017)
			Turkey	Leaf	-	Foodstuff	Baytop (1999), Dogan, et al. (2004); Dogan (2012); Kocabaş & Gedik (2016)
			Turkey, Malatya	Leaf	Cooked	Foodstuff	Yeşil & Akalın (2011); Arı, et al. (2015)
			Turkey, Mersin	Root	Eaten	Internal medicine	Altundag & Özturk (2011)
			Turkey, Kars		-	Haemorrhoid	Altundag & Özturk (2011)
					-	Cold	Güneş & Özhatay (2011)
			Turkey, Mersin		Eaten, Cooked	Asthma	Altundag & Özturk (2011)
			Turkey, Mersin Turkey, Balıkesir		-	Kidney diseases	Altundag & Özturk (2011)
					-	Diarrhea treatment	Uysal (2010)
			Turkey, Mersin		-	Eczema	Baytop (1999); Kocabaş & Gedik (2016); Erarslan, et al. (2018)
			Bulgaria			Dysentery	Uysal ,et al. (2006); Dogan & Nedelcheva (2015)
			Turkey			Cytotoxic	Mishra, et al. (2018)
			Turkey			Antiphlogistic	Mishra, et al. (2018)
						Antipyretic	Baytop (1999); Kocabaş & Gedik (2016)
						Blood pressure-lowering	

Table 1. Continue

Plant species	UV	Local Name	Country / City	Plant Part	Dosage, application	Traditional uses	References
R. patienta L.	0.8	Efelek, Tırşıka karan lórom	Hungary, Afghanistan, North India, North America	Root Leaf	-	Constipation Dysentery	Haraszti (1985); Moerman (2003)
			Hungary, Afghanistan, North India, North America		Infusion	Constipation Dysentery	Haraszti (1985); Moerman (2003); Eraslan, et al. (2018)
					Infusion		
					-	Skin diseases	
					-		
			Hungary		Crushed	Wound healing	Dénes, et al. (2013)
			Serbia	Leaf	Infusion	Anaemia	Zlatković, et al. (2014)
			Afghanistan	Leaf	Infusion	Fever	Moernman (2003); Gairola, et al. (2014)
			Turkey	Leaf	-	Internal medicine	Altundag & Özturk (2011)
		At eveliği	Turkey	Leaf	Infusion	Haemorrhoid	Altundag & Özturk (2011)
			Turkey	Leaf	Infusion	Kidney diseases	Altundag & Özturk (2011)
			Turkey	Leaf	Infusion	Laxative	Baytop (1999); Silig, et al. (2004); Suleyman, et al. (2004); Dogan & Ugulu (2013)
		Dock Patience dock	India	Leaf	-	Goiter	Malık, et al. (2018)
		-	Turkey, Mersin Turkey, İzmir	Root	-	Laxative	Dogan &Ugulu (2013)
		Efelek	Hakkari, Turkey	Aerial part	-	Goiter	Oguz & Tepe (2017)
R.ponticus E.H.L.Krause	0.024	Boçu	Turkey, İzmir	Fruit	-	Cough	Kızılarslan& Özhatay (2012)
R. pulcher L.	0.24	Ekşilik Efelik, Labada, Lapaza, Mancar,	Turkey, İzmir Turkey, Kırklareli	Fruit Leaf	Decoction	Cold	Kızılarslan & Özhatay (2012)
					Decoction	Haemorrhoid	Kızılarslan & Özhatay (2012)
					Decoction	Foodstuff	Kültür (2008)
			Turkey, İzmit	Leaf	-	Foodstuff	Kızılarslan & Özhatay (2012)
		Çarşaf, Efelek,	Turkey, Yalova	Aerial part	Eaten	Foodstuff	Koçyiğit & Özhatay (2008)
		Dibikızıl	Iran	Aerial part	Eaten	Diarrhea treatment	Anbari, et al. (2019)
		Torshak	Iran	stem	-	Foodstuff	Ghanadi, et al. (2019)
		Torshak	Iran	Leaf	-	Foodstuff	Ghanadi, et al. (2019)
		Torshak	Turkey, Muğla	Leaf	-	Foodstuff	Gürdal & Kültür (2014)
		Ekşilik	Bangladesh	Seed	Externally	The pain of lumber region	Rahman & Khatun (2020)
R. sangiuneus L.	0.05	Kuzuoğlağı Bon Palong	Ethiopia	Leaf	Salad or fresh	Foodstuff	Nigussie (2020)
			Turkey	Leaf	-	Vitamin needs	Arı, et al. (2011)

Table 1. Continue

Plant species	UV	Local Name	Country / City	Plant Part	Dosage, application	Traditional uses	References
R. scutatus L.	0.46	Kuşkulağı, oğlak kulağı,şeker otu Tırşoktırş French sorrel, Ekşimen Taş turşusu	Turkey, Elazığ	Leaf	Eaten	Diabetes	Hayta, et al. (2014)
			Turkey, Niğde	Aerial part	Eaten	Diabetes	Özdemir & Alpınar (2015)
			Turkey	Leaf		Appetizing	Altundag & Özturk (2011)
			Turkey	Root	-	Diuretic	Altundag & Özturk (2011)
			Turkey, Malatya	Leaf	-	Foodstuff	Yeşil & Akalın 2011
			Turkey	Root	-	Antipyretic	Kargıoğlu, et al. (2008)
			Turkey	Aerial part	-	Foodstuff	
			Turkey, Van	Leaf	-	Foodstuff	Mükemre, et al. (2016)
			Turkey, Afyonkarahisar	Leaf	Eaten	Foodstuff	Kargıoglu, et al. (2013)
			Turkey, Hakkari	Aerial part	Cooked	Blood pressure-lowering	Bulut, et al. (2016)
			India	-	-	Antipyretic	Khare (2007)
			India	Leaf	-	Refrigerant	
			Turkey, Malatya	Leaf	Juice	Blood pressure-lowering	Tetik, et al. (2013)
			Turkey	Leaf	-	Orexigenic	Altundag & Özturk (2011)
			Turkey	Root	Eaten	Antipyretic	Altundag & Özturk (2011)
				Root	Eaten	Diuretic	Altundag & Özturk (2011)
				Aerial part	Eaten	Foodstuff	Akaydın, et al. (2013)
				Leaf	Cooked	Blood pressure-lowering	Uysal, et al. (2010)
R. tuberosus L.	0.12	Kuzu Kıkırdağı	Turkey, Balıkesir	Leaf	-	Kidney diseases	Uysal, et al. (2010)
			Turkey, Isparta Turkey, Hatay	Leaf	Cooked	Foodstuff	Akaydın, et al. (2013)
			Turkey, Muğla	Leaf	-	Foodstuff	Gürdal & Kültür (2014)
R. tuberosus L. subsp. *creticus* (Boiss.) Rech.	0.024	Kuzukulağı	Turkey, Elazığ	Aerial part	Cooked	Constipation	Çakılcıoğlu, et al. (2010); Altundag & Özturk (2011)
R. tuberosus subsp. *tuberosus* L.	0.073	Kuzu Kıkırdağı	Turkey, Ankara	Leaf	Infusion	Blood pressure-lowering	Akyol & Altan (2013); Özturk, et al. (2013)
		Kuzu Kıkırdağı	Turkey, Ankara	Leaf	Infusion	Antipyretic, Kidney diseases	Özturk, et al. (2013), Akyol & Altan (2013)
		Kuzu Kıkırdağı	Turkey	Root	Infusion	Diuretic	Özturk, et al. (2013)
R. tuberosus subsp. *horizontalis* (Koch) Rech.f	0.34	Kuzu Kıkırdağı, Tırşo, Tırşıka mariyan	Turkey	Seed	-	Diuretic	Özturk, et al. (2013) Kaval, et al. (2014)
			Turkey	Seed	Infusion	Antipyretic	
				Root	Infusion	Antipyretic	
				Root		Kidney diseases	
			Turkey	Seed	-	Kidney diseases	
			Turkey, Hakkari	Leaf	-	Wound healing	

Table 1. Continue

Plant species	UV	Local Name	Country / City	Plant Part	Dosage, application	Traditional uses	References
					Maceration	Diabetes	
R. tuberosus subsp. *horizontalis* (Koch) Rech.f	0.34	Kuzu Kıkırdağı, Tırşo, Tırşıka mariyan	Turkey, Hakkari Turkey, Malatya	Leaf	Maceration Infusion	Blood pressure-lowering Diuretic Antipyretic Constipation	Kaval, et al. (2014) Yeşil & Akalın (2011)
					Maceration	Foodstuff	
			Turkey, Van	Leaf	-	Foodstuff	Mükemre, et al. (2016)

in cancer treatment (Allen & Hatfield, 2004). In the Alpine regions, fresh leaves of *R. alpinus* are used as an alternative to sauerkraut or spinach, the stems are peeled and eaten, and added to cakes, biscuits and puddings (Stastna, *et al.,* 2010). *Rumex* species are also used to make wraps, a traditional Middle Eastern and South-eastern dish (Dogan, *et al.,* 2015).

Rumex species are mostly used as food, as well as their use as diarrhoea treatment, laxative and antipyretic, respectively. According to the literature review, it was determined that the leaf, root, above ground and fruit parts of *Rumex* species were mostly used. The ethnobotanical information of the Turkish *Rumex* species is presented in detail in table. Plants have been important natural resources for humans, both therapeutic and protective, since ancient times (Giday, *et al*., 2016).

According to the estimates of the World Health Organization, the populations of 80 developing countries rely more on plants than modern health resources to cure various diseases (WHO 2010). Compilation of traditional uses of medicinal herbs sheds light on pharmacological phytochemical studies. It increases the possibilities to identify new molecules instead of randomly scanning (Akalın, *et al.,* 2020).

In the ethnobotanical studies compiled, it was determined that the most used species among people worldwide were *R.crispus, R. acetocella* and *R. acetosa* (Figure 1). When the parts used are compared, it is seen that leaves and roots are mostly used (Figure 2). Considering the usage purposes of the *Rumex* genus, it has been revealed that there are many different uses, however, the most common uses are as food (Figure 3).

Rumex species contain high levels of oxalic acid, this is the substance that gives the leaves of many species of the genus an acid-lemon flavor. Leaves should not be consumed fresh in large quantities, as oxalic acid can bind other nutrients in foods, especially calcium, causing mineral deficiencies.

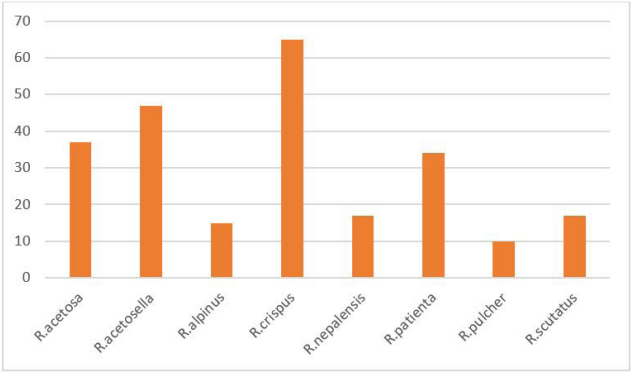

Figure 1. The most commonly used Turkish *Rumex* species in the world.

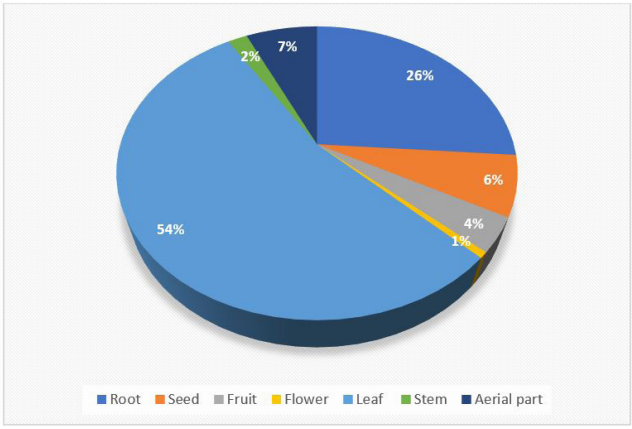

Figure 2. The usage rates of the most used parts of Turkish *Rumex* species

If the plant is cooked, its oxalic acid content may decrease. People with a tendency to rheumatism, arthritis, gout, kidney stones or hyperactivity should be very careful when including this herb in their diet as it may worsen their condition (Bown, 1995).

The *Rumex* species, which are widely used in Ireland, England, Iran and India (Figure 4).

The *Rumex* species, which are widely used in Mersin, Ankara, Van and Manisa in our country (Figure 5).

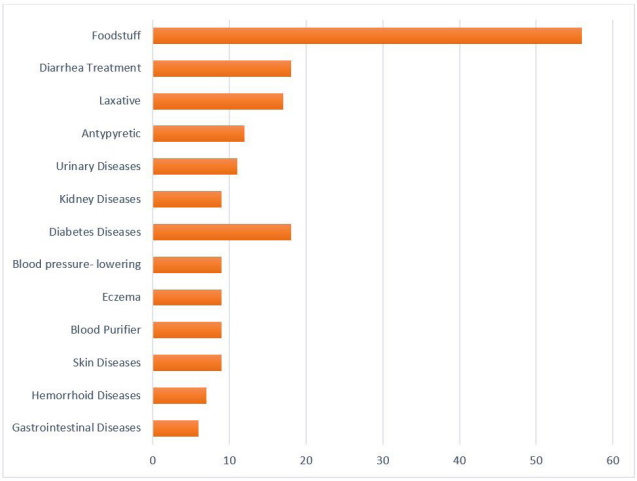

Figure 3. Intended use of *Rumex* taxa

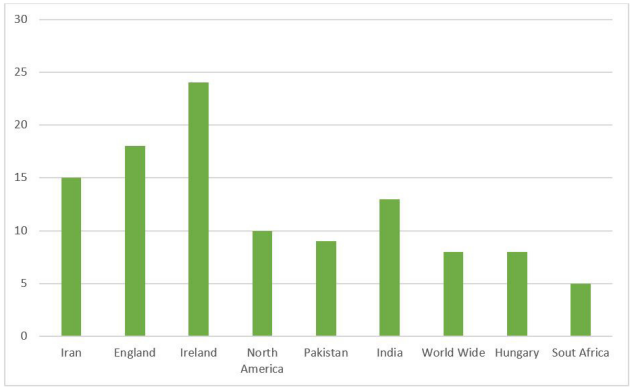

Figure 4. The countries of the world where *Rumex* species are used most ethnobotanically

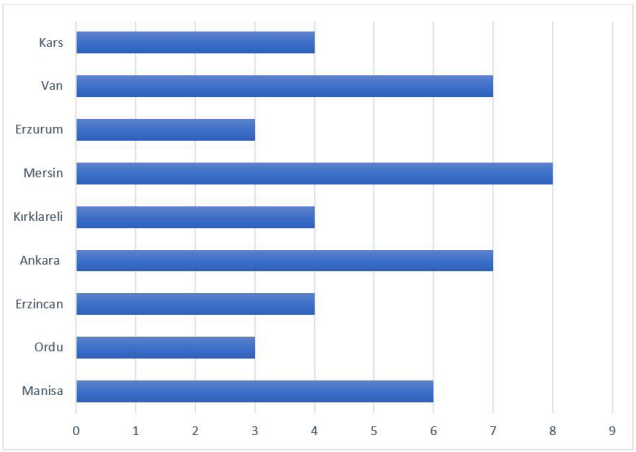

Figure 5. The provinces with the highest ethnobotanical usages of the genus *Rumex* in Turkey

The most important disadvantage of *Rumex* species in food use is that they contain oxalic acid. It is reported that they contain 6.6 to 11.1% oxalic acid on a dry weight basis. This is a very high rate, it has been shown to cause oxalate toxicosis in sheep when consumed as food (Panciera, *et al*., 1990). The lethal dose in humans is 15-30 g and it has been reported that cooking does not make the plant edible (Silberhorn, 2005). However, it is mostly consumed by people after cooking. (Figure 6).

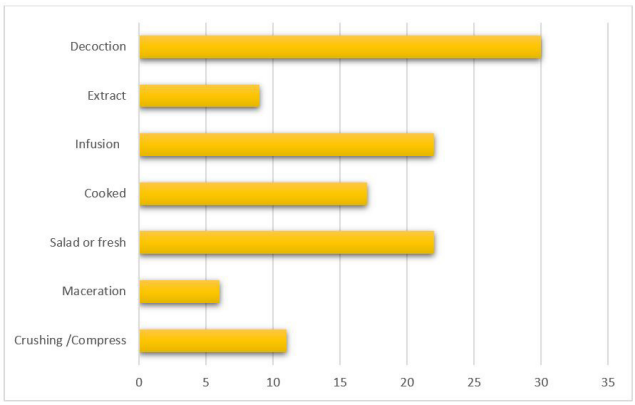

Figure 6. The preparation methods of *Rumex* taxa in ethnobotanical usages

The Use-Value (UV) is an ethnobotanical index commonly used to measure the relative importance of useful plants. In particular, it has been widely used in recent years to base ethnobotanical data on a measurable method (Yeşil & İnal 2019; Yeşil, *et al*., 2019). In the compiled study, the species with the highest UV values were calculated as *R. crispus, R. acetosella, R.acetosa, R. patienta, R. scutatus*. *Rumex* taxa are widely used by people for reasons such as having a wide distribution area, growth around agricultural areas and being in areas where people can easily reach them, and they do not need special conditions for germination and growth. However, since they have a sourish flavor, consuming them raw as a salad can trigger some health problems. Although there are studies reporting that levels of oxalic acid, which is the source of this sour taste, decrease in cooking, there are also clinical studies that show that it can accumulate in the body and have some long-term toxic effects.

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RESEARCH ARTICLE

New locality record of the critically endangered and endemic species, *Lyciasalamandra billae* (Franzen & Klewen, 1987) (Amphibia: Salamandridae) from Turkey

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Abstract

Objective: The Bille's Lycian Salamander, *Lyciasalamandra billae* is an endemic salamander species of Turkey and it has a very narrow distribution area in the Antalya province of the country. A limited number of the reported populations of this critically endangered species are known. The present study aims to show that the distribution of the species extends towards the northeast of Antalya province.

Materials and Methods: Two adult individuals (1 ♂ and 1 ♀) were caught from the Sarısu (Antalya, Turkey) population. The morphometric features of the individuals were measured using a digital caliper. After morphometric measurements of the individuals were taken without performing any anesthetic procedure and killing any animals, the salamanders were released back to the habitat where they were caught.

Results: We recorded a new locality of the species located about 11 km northeast of Gedeller village. The habitat of the individuals from Sarısu consisted of a forested area. Vegetation of the habitat generally comprised pine trees and dwarf scrub plants. Rostrum–Anus length (RA) was 59.68 mm in the female individual and 59.03 mm in the male. The tail length (TL) was 50.14 mm in the female and 47.12 mm in the male.

Conclusion: The morphometric characters and color-pattern features of the specimens were compared with the specimens reported in the literature. We found that the morphometric proportions and ratios of the Sarısu population were similar to the results of the specimens in literature, except a slightly higher HW/HL ratio of the Sarısu population. Based on our morphological findings, we concluded that our specimens belonged to the *L. b. billae*. However, our conclusion was not dependent on molecular data.

Keywords: Bille's Lycian Salamander; Distribution; Sarısu; Antalya

Introduction

The Lycian Salamanders (Amphibia: Salamandridae) are distributed in Turkey and Greece. One species (*Lyciasalamandra helversini*) of the group is endemic to Greece, while other five taxa [*Lyciasalamandra billae* (Franzen & Klewen, 1987); *Lyciasalamandra atifi* (Başoğlu, 1967); *Lyciasalamandra antalyana* (Başoğlu & Baran, 1976); *Lyciasalamandra fazilae* (Başoğlu & Atatür, 1974); *Lyciasalamandra flavimembris* (Mutz & Steinfartz, 1995)] are consisted of endemic species of Turkey. Only one species, *Lyciasalamandra luschani* (Steindachner, 1891) is native to both Greece and Turkey.

The Bille's Lycian Salamander, *Lyciasalamandra billae* is an endemic species of Turkey and it has been classified as CR (Critically Endangered) in the IUCN Red List of Threatened Animals (Kaska *et al.*, 2017). It is present at altitudes of 15-1090 m a.s.l. The specimens of the species are found on the calcareous rocks, in maquis and pine forests (Baran *et al.*, 2021). *L. billae* is only distributed in Antalya Province of Turkey. Range of the nominate

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subspecies (*Lyciasalamandra billae billae*) covers only an area of 15 km from the Gedeller (Hisarçandır) neighborhood of Konyaaltı district to Beldibi neighborhood of Kemer district in the nort-south direction (Kaska *et al.*, 2017; Baran *et al.*, 2021). Although there are studies in the literature reporting different taxa of this species until recently, the validity of these taxa is controversial and the systematic uncertainty of the subspecies of *Lyciasalamandra billae* continues.

The present study provides information indicating the occurrence of this endemic species in a new locality (Sarısu Neighborhood of Konyaaltı District) and shows that the distribution of the species extends towards the northeast of Antalya province.

Material and Methods

The present study includes some morphometric characters and color-pattern features of *L. billae* specimens captured from a locality about 11 km northward of the known distribution areas of the species. During the field studies, two adult individuals (1 ♂ and 1 ♀) were caught from the Sarısu population (10 February 2021, 36°49′52.6″ N, 30°34′56.8″ E, 54 m a.s.l.). The locality is shown in Fig. 1.

After morphometric measurements of the individuals were taken without performing any anesthetic procedure and killing any animals, the salamanders were released back to the habitat where they were caught. The morphometric features of the individuals were measured using a digital caliper (0.01 mm precision). Measurements of body proportions and ratios were applied according to the study of Godmann *et al.* (2016) who described a new subspecies, *Lyciasalamandra billae eikeae* from Geyikbayırı (Konyaaltı, Antalya). We followed the measurements as below:

Mensural (metric) characters: Total Body Length (TBL): length of the whole body including the tail, Rostrum-Anus Length (RA): length from the snout to the anterior tip of the cloacal opening, Length of Trunk (LT): length from the gular fold to the anterior edge of the cloacal opening, Tail Length (TL), Nostril-Eye Distance (NED), Distance Between Nostrils (DBN), Eye Diameter (ED), Head Length (HL): distance from the snout to the posterior end of the parotoid gland, Head Width (HW), Parotoid Length (PL), Parotoid Width (PW), Fore Limb Length (FLL), Hind Limb Length (HLL), Distance between Fore and Hind Limbs (DFHL), Height of Dorsal Protuberance on Base of the Tail in males (HDPBT).

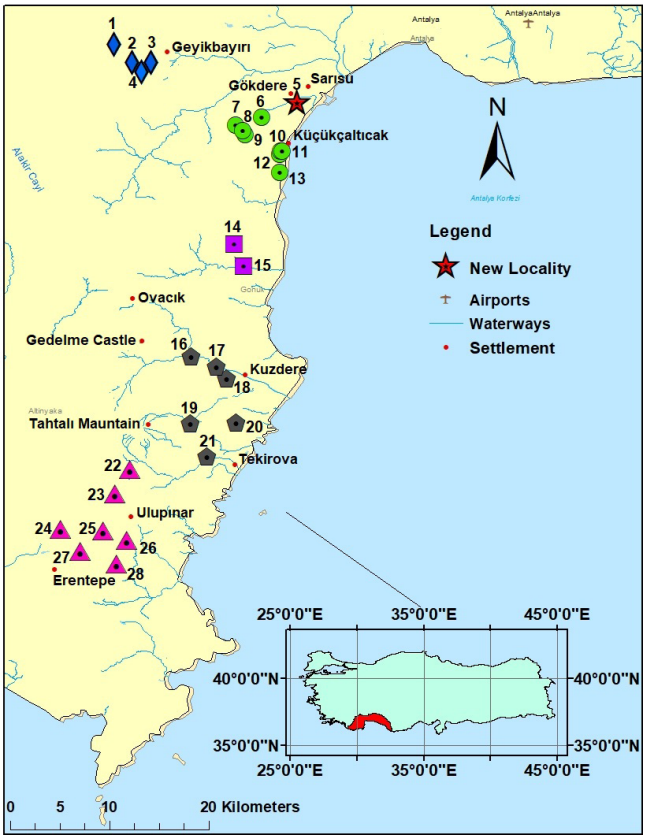

Figure 1. The map showing the distribution area of *Lyciasalamandra billae* in Turkey. Blue dimonds represent distribution area of *L. b. ekiae* according to Godmann *et al.* (2016). The green circles show the localities of *L. b. billae* according to Godmann *et al.* (2016); Johannesen *et al.* (2006); Veith *et al.* (2013); Veith & Stenfartz (2004) and the red star shows the new locality (Sarısu). The purple squares reflect the locations of *L. b. irfani* according to Göçmen *et al.* (2013), while gray pentagons show the localities of *L. b. yehudahi* and lilac triangles points the localities of *L. b. arıkani* according to Akman & Göçmen (2012).

Computed characters (Ratios): Ratios of the characters; HW/HL, TL/TBL, PW/PL, and NED/HL were computed. The habitat of the individuals from Sarısu consists of a forested area. Vegetation of the habitat generally comprises pine trees and dwarf scrub plants (Fig. 2). The individuals were found during a day excursion between 9 and 11 a.m. The air temperature was about 12 °C.

Results

Morphometric measurements

Rostrum–Anus length (RA) was 59.68 mm in the female individual and 59.03 mm in the male. The tail length (TL) was 50.14 mm in the female and 47.12 mm in the male. Head length was 15.84 m in the female while it was 15.56

Figure 2. The habitat of *Lyciasalamandra billae* in Sarısu.

mm in the male. Head width was 11.97 mm in the female and 11.83 mm in the male. All morphometric measurements of the individuals collected from the population are given in Table 1.

Figure 3. A general view of a female individual of *Lyciasalamandra billae* from Sarısu population.

Color-pattern

The dorsal color was salmon pink in both individuals. On the middle of the body, there were dark brown spots in two rows. These spots extended to the end of the hindlimbs. There were also these spots on the tail. The color of the paratoid glands was dirty yellow. There were almost twenty dark brown spots on both paratoid glands. The lateral sides of the body were silvery-white colored. The coloration of the ventral side was creamy white (Fig. 3).

Table 1. Comparison of measurements of body proportions (in mm) and ratios of Sarısu specimens of *L. billae* with those given by Godmann *et al.* (2016). For abbreviations, see text.

	This study (Sarısu specimens)		**Godmann *et al.* (2016) (Gökdere and Küçükçaltıcak specimens of *L. b. billae*)**	
Character	**1 ♂**	**1 ♀**	**Mean values of 8 ♂♂**	**Mean values of 8 ♀♀**
TBL	106.15	109.82	114.38	120.50
RA	59.03	59.68	62.25	63.50
LT	43.41	41.31	47.27	47.45
TL	47.12	50.14	52.13	57.00
NED	2.98	3.02	2.91	2.93
DBN	4.36	4.41	4.38	4.52
ED	4.43	4.42	4.64	4.63
HL	15.56	15.84	14.98	16.05
HW	11.83	11.97	10.71	11.37
PL	7.02	7.10	7.31	8.05
PW	2.12	2.31	2.01	2.20
FLL	18.91	19.55	18.87	19.53
HLL	22.43	24.49	21.96	23.57
DFHL	31.32	31.60	32.68	34.28
HDPBT	2.32	-	2.41	-
HW/HL	0.76	0.75	0.72	0.71
TL/TBL	0.44	0.45	0.46	0.47
PW/PL	0.30	0.32	0.28	0.27
NED/HL	0.19	0.19	0.19	0.18

Discussion

The systematic evaluations reporting new species or subspecies of the genus *Lyciasalamandra* were performed in previous studies (Veith *et al.*, 2001; Göçmen *et al*., 2011; Göçmen & Akman, 2012; Göçmen *et al.*, 2013; Akman & Godmann, 2014; Yıldız & Akman, 2015; Godmann *et al.*, 2016). Populations of the same taxon, which occur only a few kilometers apart, often show distinct color and pattern differences (Veith & Steinfartz, 2004). The new species, *Lyciasalamandra irfani* was reported by Göçmen *et al.* (2011) from Göynük Canyon (Antalya) in southwestern Anatolia. It was characterized by having a rather darkly colored head part and also an aubergine reddish-brown ground color on the dorsum with irregularly scattered white flecks. According to the coloration of the individuals, the new species, *Lyciasalamandra arikani* was described by Göçmen & Akman (2012) in Antalya province from the southern mountainous parts of Tahtalı Mountain between Beycik and Kumlucayazı, and across the elevations (slopes and plains) of Ulupınar. They also reported the second new species, *Lyciasalamandra yehudahi* according to some morphological features [e.g. the ground color of the dorsum of both sexes and of juveniles (being darker) is brown with irregularly scattered yellowish-white flecks or spots of varying sizes, having tiny brown dots inside the light flecks] around Kemer, including Gedelme (an inland locality) between the Kemer stream at the north and Tekirova at the south within the coastal strip.

However, Veith *et al.* (2016) suggested that the recently described species *L. arikani*, *L. irfani* and *L. yehudahi* to be treated as subspecies of *Lyciasalamandra billae* based on levels of molecular differentiation. In addition, a new subspecies, *Lyciasalamandra billae eikeae* was described according to its coloration and pattern by Godmann *et al.* (2016) from Geyikbayırı (Konyaaltı, Antalya). As it can be understood from the studies in the literature reporting different taxa of this species until recently, the validity of these taxa is controversial and the systematic uncertainty of the subspecies of *Lyciasalamandra billae* continues. The systematic status of *Lyciasalamamandra billae* was given as *Lyciasalamandra billae* ssp. *billae* in the web page of IUCN by Kaska *et al.* (2017). This taxon was originally assessed at species-level, but is now demoted to being the nominate subspecies, hence the need for this amended assessment. Finally, Baran *et al.* (2021) reported that the range of the *Lyciasalamandra billae* covers only an area of 15 km from Gedeller (Kedetler) village of Konyaaltı district to Beldibi neighborhood of the Kemer district in the north-south direction.

In the present study, we provided the new locality record (Sarısu, Konyaaltı-Antalya) of *Lyciasalamandra billae* and based on the systematic reviews detailed above we marked this new population in Fig. 1 and showed the populations of other subspecies given in the literature on the same Figure. When we compared our results from the Sarısu population to the records of Godmann *et al.* (2016) related to specimens of Gökdere and Küçükçaltıcak populations of *L. b. billae*, we determined the morphometric proportions and ratios of the Sarısu population were similar to the results of the specimens in the study of Godmann *et al.* (2016) except for a slightly higher HW/HL ratio of the Sarısu population.

The color pattern characteristics of the individuals of Sarısu population were similar to the specimens of *L. b. billae* collected by Godmann *et al.* (2016). The individuals of Sarısu population had continuous lateral white band on both flanks. Dorsum, head and tail were salmon colored. Although the results of the Sarısu population were similar to the specimens of *L. b. billae* in the current literature, the number of specimens in our study was very low. More specimens should be investigated to evaluate the similarity of the Sarısu population with the other populations of *L. b. billae*. Based on our morphological findings, we concluded that our specimens belonged to the *L. b. billae*. However, our conclusion is not dependent on molecular data.

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RESEARCH ARTICLE/ARAŞTIRMA MAKALESİ

Karasu Deresi'nde (İstanbul) Yaşayan *Barbus cyclolepis* Heckel, 1837 ve *Gobio bulgaricus* Drensky, 1926 (Teleostei) Türlerinin Bazı Büyüme Özellikleri

Çiğdem Çelik[1], Müfit Özuluğ[2]

Öz

Amaç: Bu çalışmada Karasu Deresi'nde yaşayan *Barbus cyclolepis* Heckel, 1837 ve *Gobio bulgaricus* Drensky, 1926 türlerinin bazı büyüme özellikleri mevsimsel olarak incelenmiştir.

Materyal ve Yöntem: Örnekleme mevsimlik olarak (Ağustos 2017, Kasım 2017, Ocak 2018, Şubat 2018, Nisan 2018) elektroşok aracılığıyla gerçekleştirilmiştir. Her mevsimi temsil edecek örneklemeler arka arkaya 3 gün tekrarlanmıştır. Elde edilen B. *cyclolepis* ve G. *bulgaricus* bireylerinin boy, ağırlık, yaş, eşey dağılımları, yaş-boy, yaş-ağırlık, boy-ağırlık ilişkileri ve Fulton kondisyon faktörü değerleri incelenmiştir.

Bulgular: İncelenen B. cyclolepis bireyleri 0-III yaş gruplarındadır. Standart boy değerleri 3,5-13,5 cm; ağırlık değerleri ise 1,2232-50,8213 g arasında değişmiştir. Dişi:erkek oranı 1:0,94 olarak saptanmıştır. Tüm bireylerde; boy-ağırlık ilişkisi W= 0,0253*SL2,9226 olarak belirlenmiştir. Yaşa göre en düşük kondisyon faktörü değeri, III yaş grubunda (1,982) dişi bireylerde, en yüksek kondisyon faktörü değeri I yaş grubunda (2,288) erkek bireylerde bulunmuştur. G. bulgaricus türünün yaş dağılımı ise I-IV yaş grupları arasında değişmektedir. Standart boy değerleri 2,5-9,6 cm; ağırlık değerleri ise 0,2989-18,3014 g arasında değişmiştir. Dişi:erkek oranı 1:1,56 olarak saptanmıştır. Tüm bireylerde; boy-ağırlık ilişkisi W= 0,0209*SL3,0081 olarak belirlenmiştir. Yaşa göre en düşük kondisyon faktörü değeri, II yaş grubunda (1,950) erkek bireylerde, en yüksek kondisyon faktörü değeri IV yaş grubunda (2,191) dişi bireylerde bulunmuştur.

Sonuç: Bu çalışma sonucunda Karasu deresinde yaşayan *Barbus cyclolepis* ve *Gobio bulgaricus* türlerinin kimi büyüme özellikleri ilk defa incelenmiştir.

Anahtar Kelimeler: Boy-ağırlık ilişkisi, büyüme, yaş, Cyprinidae, Gobionidae

Some Growth Characteristics of *Barbus cyclolepis* Heckel, 1837 and *Gobio bulgaricus* Drensky, 1926 (Teleostei) Species Living in Karasu Stream (Istanbul)

Abstract

Objective: In this study, some growth characteristics of *Barbus cyclolepis Heckel,* 1837 and *Gobio bulgaricus Drensky*, 1926 species living in Karasu Stream, were investigated.

Materials and Methods: Sampling was carried out seasonal (August 2017, November 2017, January 2018, February 2018, April 2018) via electroshock. Samplings representing each season were repeated for 3 consecutive days. Lenght, weight, age, sex distributions and ratios, age-length, age-weight, length-weight relationships, Von Bertalanffy parameters, Fulton condition factor values of the obtained B. cyclolepis and G. bulgaricus individuals were analyzed.

Results: The examined *B.cyclolepis* individuals are in the 0-III age groups. Standard length values are 3.5-13.5 cm; The weight values varied between 1.2232-50.8213 g. The female:

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male ratio was determined as 1: 0.94. In all individuals; Length-weight relationship was determined as W= 0.0253*SL2.9226. According to age, the lowest condition factor value was found in female individuals in the III age group (1.982), and the highest condition factor value was found in male individuals in the I age group (2.288).
The age distribution of *G. bulgaricus* species varies between I-IV age groups. Standard length values are 2.5-9.6 cm; The weight values varied between 0.2989-18.3014 g. The female: male ratio was determined as 1:1.56. In all individuals; Length-weight relationship was determined as W= 0.0209* SL3.0081. According to age, the lowest condition factor value was found in male individuals in the II age group (1.950), and the highest condition factor value was found in female individuals in the IV age group (2.191).
Conclusion: As a result of this study, some growth characteristics of *Barbus cyclolepis* and *Gobio bulgaricus* species living in Karasu stream were investigated for the first time.
Keywords: Length-weight relationship, growth, age, Cyprinidae, Gobionidae

Giriş

Çok sayıdaki benzer türle temsil edilen coğrafik bölgeler söz konusu canlıların köken merkezi olarak kabul görmektedir. Cypriniformes takımının köken merkezinin Asya kıtası olduğu, çok sayıda türle temsil edildiği ve bu evrim merkezinden diğer coğrafi bölgelere dağılmış olduğu kabul edilmektedir (Winfield & Nelson, 1991). *Barbus* ve *Gobio* cinsleri de çok sayıda temsilcisi olan Cypriniformes takımına aittir.

Barbus Cuvier, 1816 Cyprinidae familyasına ait orta ve büyük boylu türleri barındıran bir gruptur. *Barbus* cinsi; göl, geniş ve orta büyüklüklerdeki nehirlerden dağ sularına kadar çeşitli habitatlara adapte olmuş zemine yakın yaşamaya meyilli türleri içerir. *B. cyclolepis* türünün dağılım alanları; Yunanistan'ın doğusu, Bulgaristan'ın güneyi ve Türkiye'nin kuzeybatısındaki Arda, Tunca ve Ergene nehirleri gibi birçok büyük ve küçük kolun bağlandığı Meriç Nehri Havzası ile Marmara Havzası'nın kuzey kısımlarıdır (Korkmaz, 2017).

Gobionidae familyasına ait *Gobio* Cuvier, 1816 cinsi fenotipik çeşitlilik göstermesi nedeniyle özellikle taksonomi açısından zengin ve karmaşık bir gruptur ve bu nedenle de Avrupa'daki en değişken balık cinslerinden biri olarak kabul edilir (Bănărescu *vd*., 1999). Avrupa ve Asya'da tespit edilen 48 türü bulunmaktadır. Bu türlerden 15'i Anadolu coğrafyasında dağılım göstermektedir (Aksu, 2020). *Gobio* cinsinin üyeleri kısa ömürlü türlerdir ve en fazla 8 yıla kadar yaşadıkları rapor edilmiştir (Maitland & Campbell, 1992; Kottelat & Freyhof, 2007). Ilıman özellik gösteren zemini taş ve çakıllarla kaplı hızlı akan nehir sistemlerinde yaşamaktadır (Kottelat & Freyhof, 2007). *G. bulgaricus* bireyleri küçük gruplar halinde su kolonunun üst ve orta bölümlerinde yaşamaktadır. Türkiye, Bulgaristan, Yunanistan ve Makedonya'daki Meriç ve Aliakmon nehirleri ve kollarında dağılım göstermektedir (Kottelat & Freyhof, 2007).

Aynı türün farklı bölgelerde yaşayan popülasyonlarının büyüme özelliklerinin ortaya konulması balıkçılık biyolojisi açısından önemli bir konudur. Çalışmanın konusunu oluşturan *B. cyclolepis* ve *G. bulgaricus* türlerinin büyüme özellikleri hakkında az sayıda araştırma bulunmaktadır (Rozdina *vd*., 2008; Rozdina & Raikova-Petrova, 2014; Saç & Özuluğ, 2020). Her iki balık türü de dibe yakın yaşayarak çoğunlukla sedimandaki makroomurgasızlar ile beslenmektedir. Bu türler nehirlerin barbus zonu olarak bilinen kısımlarında yaşamını sürdürmektedirler. Çalışmanın yapıldığı Karasu Deresi'nde bu iki balık türünün büyüme özellikleri ile ilgili bir çalışma mevcut değildir. Bu çalışma Karasu Deresi'nde yaşayan *B. cyclolepis* ve *G. bulgaricus* türlerinin kimi büyüme özelliklerinin mevsimlik olarak incelenmesi amacıyla yapılmıştır.

Materyal ve Yöntem

Çalışma kapsamında Büyükçekmece Baraj-Gölü'ne dökülen derelerden biri olan Karasu Deresi'nde belirlenmiş bölgelerde mevsimlik olarak bir yıl boyunca arazi çalışması gerçekleştirilmiştir. Karasu Deresi, Çatalca-Silivri sınırında, İhsaniye Köyü doğusundan çıkar. Kuzeydoğudan güneybatıya doğru Kabakça ve İnceğiz köylerini batıda bırakıp küçük dereleri sularına katarak Büyükçekmece Baraj Gölü'ne dökülür. Karasu Deresi'nin uzunluğu 35 km'dir (Barutçu, 1995).

Balık örneklemeleri Karasu Deresi'nde İnceğiz piknik alanında belirlenen bir istasyonda her mevsim için seçilen ay içerisinde (Ağustos 2017, Kasım 2017, Ocak 2018, Şubat 2018 ve Nisan 2018) yapılmıştır. Seçilen bölgenin balıklarının daha iyi örneklenebilmesi için 3 gün arka arkaya aynı istasyona gidilerek avcılık tekrarlanmıştır. Dere, farklı zemin yapısına sahip (kum, taş, çamur) olmasına dikkat edilerek sığ (derinlik 10-15 cm)-orta (derinlik 25-30 cm)

ve derin (derinlik 55-60 cm) bölgelere ayrılmış ve avcılık bu şekilde gerçekleştirilmiştir. Kış mevsiminde yapılan arazide elde edilen balık sayısı yetersiz olduğu için bu mevsimde 2 defa örnekleme yapılmıştır. Balık örneklerinin yakalanmasında portatif elektroşok cihazı kullanılmıştır. Yakalanan balıklar yüksek oranda anestezik madde (karanfil yağı) kullanılarak öldürülmüş ve buz kutusu içerisinde İstanbul Üniversitesi Biyoloji Bölümü Hidrobiyoloji Anabilim Dalı Laboratuvarı'na getirilerek incelenecekleri güne kadar -18^{0}C'lik derin dondurucuda muhafaza edilmiştir. İncelenecekleri gün derin dondurucudan çıkarılarak oda sıcaklığında çözdürüldükten sonra total, çatal ve standart boyları 1 mm duyarlıklı boy ölçüm tahtası ile ölçülmüş, total vücut ağırlıkları 0,0001 g hassasiyetindeki elektronik terazide tartılmıştır. Çalışmada kullanılan analizler için balığın standart boy değerleri kullanılmıştır.

Dişi ve erkek bireylerin oranında istatistiksel açıdan farkın yorumlanabilmesi için ki-kare testi yapılmıştır. Yaş tayini için balığın pullarından yararlanılmıştır. Balıklardan alındıktan sonra zarflarda muhafaza edilen pullar, su yardımıyla yumuşatılıp temizlenmiştir. Temizlenen pullar suyu alınıp tam kurumadan önce 2 lam arasında sıkıştırılarak preparat haline getirilerek mikrofiş okuma cihazında incelenmiştir. Pullar gerçek ve yalancı yaş halkalarının ayırt edilmesine özen gösterilerek 2 farklı büyütmede (24X, 42X) iki farklı okuyucu tarafından farklı zamanlarda incelenmiş, iki okuyucunun ortak kararı ile balıkların yaşları belirlenmiştir (Duman & Şen, 2002).

Boy-Ağırlık ilişkisi incelemesinde $W= aL^n$ şeklinde verilen allometrik büyüme denkleminden yararlanılmıştır (Le Cren, 1951). Bu formülde; **W:** Total vücut ağırlığı (g) ve **L:** Standart boy (cm) değerlerini ve **n:** Boy-ağırlık ilişkisindeki regresyon sabitini göstermektedir. Boy ve ağırlık verileri, doğal logaritmaları (ln) kullanılarak $lnW= lna+blnL$ şeklindeki doğrusal forma dönüştürülmüş ve *a* (eğimin y eksenini kestiği noktayı gösteren regresyon sabiti) ve *b* (eğrinin eğimini gösteren regresyon katsayısı) değerleri hesaplanmıştır (King, 2007).

Total boy-çatal boy, total boy-standart boy, çatal boy-standart boy arasındaki ilişkiyi göstermek için

$SL= aTL\pm b$, $SL= aFL\pm b$, $FL= aTL\pm b$ denklemleri kullanılmıştır [**TL:** Total boy (cm), **FL:** Çatal boy (cm), **SL:** Standart boy (cm)].

Balık örneklerinin Fulton kondisyon faktörü (K) değerinin hesaplanmasında;

$K= (W/L^3)100$ eşitliğinden yararlanılmıştır (Bagenal, 1978). Bu eşitlikte **W:** Total vücut ağırlığı (g) ve **L:** Standart boy (cm) değerlerini göstermektedir.

Bulgular

Barbus cyclolepis

Arazi çalışmaları sonucunda toplam 36 tanesi dişi (% 51,43), 34 tanesi ise erkek (% 48,57) toplam 70 adet *B. cyclolepis* bireyi elde edilmiştir. Dişi:erkek oranı 1:0,94 olarak bulunmuştur. Yapılan khi-kare testi sonucunda dişi ve erkek bireylerin oranında istatistiksel açıdan fark anlamlı bulunmamıştır (X^2 : 0,057; p: 0,81 p >0,05). 67 bireyin pullarından yaş tayini yapılabilmiştir. Yaş tayini sonucunda balıkların 0-III yaş grupları arasında dağılım gösterdiği belirlenmiştir (Tablo 1).

Tablo 1. Karasu Deresi'nden elde edilen *B. cyclolepis* bireylerinde yaş-eşey dağılımı.

Yaş Grubu	Dişi		Erkek		Tüm Bireyler	
	n	% n	n	% n	n	% n
0	-	-	4	5,97	4	5,97
I	6	8,96	13	19,40	19	28,36
II	24	35,82	12	17,91	36	53,73
III	6	8,96	2	2,99	8	11,94
Toplam	36	53,73	31	46,27	67	100

Tablo 2. Karasu Deresi'nden elde edilen *B. cyclolepis* bireylerinde yaş gruplarına göre, ortalama, en küçük ve en büyük boy değerleri.

	Dişi			Erkek			Tüm Bireyler		
Yaş	**n**	**SL±SD**	**Min.-Mak. SL**	**n**	**SL±SD**	**Min.-Mak. SL**	**n**	**SL±SD**	**Min.-Mak. SL**
0	-	-	-	4	4,05±0,53	3,5-4,5	4	4,05±0,53	3,5-4,5
I	6	8,48±0,68	7,5-9,4	13	7,29±0,93	5,4-8,5	19	7,58±1,05	5,4-9,4
II	24	11,22±1,22	8,0-13,1	12	8,15±0,5	7,3-9,0	36	10,18±1,8	7,3-13,1
III	6	11,75±1,51	9,5-13,5	2	8,55±0,49	8,2-8,9	8	10,95±1,96	8,2-13,5
Toplam	36	10,85±1,60	7,5-13,5	31	7,22±1,50	3,5-8,9	67	9,17±2,39	3,5-13,5

SL: Standart Boy (cm), SD: Standart Sapma

Standart boy dağılımları incelendiğinde, dişi bireylerin 7,5-13,5 cm; erkek bireylerin 3,5-8,9 cm arasında; total vücut ağırlıkları incelendiğinde, dişi bireylerin 9,58-50,82 g; erkek bireylerin 1,22-14,75 g; arasında değerlere sahip oldukları tespit edilmiştir. Yaşları okunan 67 bireyin yaş gruplarına göre boy değerleri Tablo 2'deki gibidir.

Yaşları okunan 67 adet bireyin yaş gruplarına göre vücut ağırlığı değerleri ve standart sapmaları Tablo 3'te, 70 bireylere ait boy-ağırlık ilişkisi ve denklemlerine ait değerler Tablo 4 de verilmiştir.

B. cyclolepis bireyleri için total boy-çatal boy, total boy-standart boy ve çatal boy-standart boy ilişkilerini gösteren denklemler FL= 0,941TL-0,1719 (r^2 = 0,9989), SL= 0,8808FL-0,0772 (r^2 = 0,9948), SL= 0,829TL-0,2287 (r^2 = 0,9938) olarak hesaplanmıştır. İncelenen *B. cyclolepis* bireylerinin standart boy ve ağırlık değerleri kullanılarak Fulton kondisyon faktörü hesaplanmıştır. Tüm bireylerde yaşlara göre kondisyon faktörü değerleri incelendiğinde en düşük değere (1,99) III yaş grubunda, en yüksek değere ise (2,24) 0 yaş grubunda rastlanmıştır (Tablo 5).

Gobio bulgaricus

Arazi çalışmaları sonucunda toplam 90 adet *G. bulgaricus* türü elde edilmiştir. Bunların içerisinde 34 tanesi dişi (% 37,78), 53 tanesi erkek (% 58,89), 3 tanesi ise genç (% 3,33) bireyden (juvenil) oluşmaktadır. Dişi:erkek oranı 1:1,56 olarak bulunmuştur. Yapılan khi-kare testi sonucunda dişi ve erkek bireylerin oranında istatistiksel açıdan fark anlamlı bulunmuştur (X^2 : 4,149; p: 0,042 p < 0,05). Yaş tayini 90 bireyin pulları incelenerek yapılmıştır. Yaş tayini sonucunda balıkların I-IV yaş grupları arasında dağılım gösterdiği belirlenmiştir (Tablo 6).

Standart boy dağılımları incelendiğinde, dişi bireylerin 4,9-9,6 cm; erkek bireylerin 5,4-9,2 cm, genç bireylerin ise 2,5-4,5 cm arasında; total vücut ağırlıkları

Tablo 3. Karasu Deresi'nden elde edilen *B. cyclolepis* bireylerinde yaş gruplarına göre, en küçük ve en büyük ağırlık değerleri.

YAŞ	Dişi			Erkek			Tüm Bireyler		
	n	W±SD	Min.-Mak. W	n	W±SD	Min.-Mak. W	n	W±SD	Min.-Mak. W
0	-	-	-	4	1,43±0,25	1,22-1,78	4	1,43±0,25	1,22-1,78
I	6	12,19±2,31	9,58-15,27	13	9,20±3,17	3,49-13,58	19	10,00±3,25	3,49-15,27
II	24	31,70±10,11	9,83-50,82	12	11,62±2,41	7,97-14,75	36	24,99±12,71	7,97-50,82
III	6	33,65±12,77	15,69-49,64	2	12,66±2,89	10,61-14,70	8	28,40±14,56	10,61-49,64
Toplam	36	28,77±12,18	9,58-50,82	31	9,25±4,19	1,22-14,75	67	19,74±13,52	1,22-50,82

W: Vücut ağırlığı/g, SD: Standart Sapma

Tablo 4. Karasu Deresi'nden elde edilen *B. cyclolepis*'in dişi, erkek ve tüm bireyleri için hesaplanan standart boy-vücut ağırlığı ilişkisi değerleri.

Eşey	n	a	% 95 GA	b	% 95 GA	r
Dişi	36	0,019	0,009-0,038	3,0429	2,746-3,340	0,963
Erkek	34	0,026	0,018-0,038	2,9033	2,714-3,093	0,984
Tüm Bireyler	70	0,025	0,020-0,322	2,9226	2,813-3,032	0,988

n: birey sayısı, a: kesişim noktası, b: eğim, %95 GA: a ve b'nin %95 güven aralığı değeri, r: korelasyon katsayısı

Tablo 5. Karasu Deresi'nden elde edilen *B. cyclolepis* bireylerinde yaşlara göre ortalama kondisyon değerleri.

Yaş	Diş	Erkek	Tüm bireyler
0	-	2,24±0,63	2,24±0,63
I	1,99±0,25	2,29±0,22	2,23±0,28
II	2,18±0,29	2,13±0,21	2,17±0,26
III	1,98±0,17	2,01±0,11	1,99±0,15

Tablo 6. Karasu Deresi'nden elde edilen *G. bulgaricus* bireylerinde yaş-eşey dağılımı.

Yaş Grubu	Dişi		Erkek		Genç Birey		Tüm Bireyler	
	n	% n	n	% n	n	% n	n	% n
I	-	-	-	-	3	3,33	3	3,33
II	5	5,56	8	8,89	-	-	13	14,45
III	21	23,33	32	35,56	-	-	53	58,89
IV	8	8,89	13	14,44	-	-	21	23,33
Toplam	34	37,78	53	58,89	3	3,33	90	100

Tablo 7. Karasu Deresi'nden elde edilen *G. bulgaricus* bireylerinde yaş gruplarına bağlı ortalama, en küçük ve en büyük boy değerleri.

	Dişi			Erkek			Tüm Bireyler		
Yaş	**n**	**SL±SD**	**Min.-Mak. SL**	**n**	**SL±SD**	**Min.-Mak. SL**	**n**	**SL±SD**	**Min.-Mak. SL**
I	-	-	-	-	-	-	3	3,43±1,01	2,5-4,5
II	5	5,92±0,66	4,9-6,5	8	6,29±0,8	5,4-7,5	13	6,15±0,75	4,9-7,5
III	21	7,25±0,67	6,2-8,7	32	7,68±0,59	6,5-9,2	53	7,51±0,65	6,2-9,2
IV	8	8±0,9	6,9-9,6	13	8,27±0,55	7,5-9,2	21	8,17±0,69	6,9-9,6
Toplam	34	7,23±0,95	4,9-9,6	53	7,61±0,86	5,4-9,2	90	7,33±1,16	2,5-9,6

SL: Standart Boy/cm, SD: Standart Sapma

Tablo 8. Karasu Deresi'nden elde edilen *G. bulgaricus* bireylerinde yaş gruplarına bağlı ortalama, en küçük ve en büyük ağırlık değerleri.

	Dişi			Erkek			Tüm Bireyler		
Yaş	**n**	**W±SD**	**Min.-Mak. W**	**n**	**W±SD**	**Min.-Mak. W**	**n**	**W±SD**	**Min.-Mak. W**
I	-	-	-	-	-	-	3	0,97 ±0,78	0,30-1,82
II	5	4,45 ±1,01	2,71-5,29	8	4,90 ±1,5	3,13-7,55	13	4,73 ±1,3	2,71-7,55
III	21	8,16 ±2,05	4,98-12,14	32	9,97 ±2,36	6,14-17,49	53	9,25 ±2,4	4,98-17,49
IV	8	11,57 ±3,95	6,64-18,30	13	12,34 ±2,51	9,02-17,22	21	12,05 ±3,06	6,64-18,30
Toplam	34	8,42±3,29	2,71-18,30	53	9,78±3,23	3,13-17,49	90	8,97±3,57	0,30-18,30

W: Vücut ağırlığı/g, SD: Standart Sapma

Tablo 9. Dişi, erkek ve tüm *G. bulgaricus* bireyleri için hesaplanan standart boy-vücut ağırlığı ilişkisi değerleri.

Eşey	**n**	**a**	**% 95 GA**	**b**	**% 95 GA**	**r**
Dişi	34	0,0324	0,017-0,060	2,7867	2,474-3,100	0,955
Erkek	53	0,0195	0,012-0,032	3,0424	2,791-3,2940	0,959
Tüm Bireyler	90	0,0209	0,016-0,026	3,0081	2,889-3,128	0,983

n: birey sayısı, a: kesişim noktası, b: eğim, %95 GA: a ve b'nin %95 güven aralığı değeri, r: korelasyon katsayısı

incelendiğinde, dişi bireylerin 2,71-18,30 g; erkek bireylerin 3,13-17,49 g; genç bireylerin ise 0,30-1,82 g arasında değerlere sahip oldukları tespit edilmiştir. Yaşları okunan 90 bireyin yaş gruplarına göre boy ve ağırlık Tablo 7 ve 8'de verilmiştir.

İncelenen bireylere ait boy-ağırlık ilişkisi ve denklemlerine ait değerler Tablo 9 da verilmiştir.

G. bulgaricus bireyleri için total boy-çatal boy, total boy-standart boy ve çatal boy-standart boy ilişkilerini gösteren denklemler FL= 0,9451TL-0,0941 (r^2= 0,9951), SL= 0,8247TL-0,0602 (r^2= 0,9784), SL= 0,8723FL+0,024 (r^2= 0,9827) olarak hesaplanmıştır.

İncelenen tüm *G. bulgaricus* bireylerinin standart boy ve ağırlık değerleri kullanılarak Fulton kondisyon faktörü hesaplanmıştır. Tüm bireylerde yaşlara göre kondisyon faktörü değerleri incelendiğinde en düşük değere (2,03) II yaş grubunda, en yüksek değere ise (2,17) IV yaş grubunda rastlanmıştır (Tablo 10).

Tablo 10. Karasu Deresi'nden elde edilen tüm *G. bulgaricus* bireylerinde yaşlara göre ortalama kondisyon değerleri.

Yaş	**Dişi**	**Erkek**	**Tüm Bireyler**
I	-	-	2,03±0,13
II	2,15±0,35	1,95±0,28	2,03±0,31
III	2,12±0,25	2,18±0,21	2,15±0,23
IV	2,19±0,23	2,16±0,13	2,17±0,17

Tartışma ve Sonuç

Küçük boylu balıklarla ilgili çalışmalar genellikle ihmal edilmektedir. Bunun başlıca nedeni ticari önemlerinin olmamasıdır (Mastrorillo *vd*., 1997). Çalışma konusunu oluşturan *B. cyclolepis* ve özellikle *G. bulgaricus* bu türler arasında bulunmaktadır. Oysa ki, *B. cyclolepis* türü 25 cm, *G. bulgaricus* ise 9,5 cm boya kadar rapor edilmiştir (Kottelat & Freyhof, 2007, Saç & Özuluğ 2020).

B. cyclolepis in Yunanistan'da (Makedonya'da bulunan iki dere üzerinde) yaşayan bir populasyonunda yapılan çalışmada erkek bireylerde 6 yaş grubu (0+ dan 5+ ya), dişilerde ise 10 yaş grubu (0+ dan 9+ ya) na rastlanmıştır. Maksimum total boy erkeklerde 163 mm (5+ yaş), dişilerde ise 244 mm (9+) ölçülmüş; dişi:erkek oranı 1:1,28 olarak tespit edilmiştir (X^2= 5,04; p< 0,05). Populasyonda erkek bireyler baskındır ve dişi: erkek oranında istatistiksel açıdan fark anlamlıdır. Kondisyon Faktörü değerleri ise ilkbaharda artmış ve aşamalı olarak yaz boyunca azalmış, kış sonunda ise tekrar giderek artmaya başlamıştır (Vasiliou & Economidis, 2005).

Meriç Nehri'nde besin çeşitliliği üzerinde yapılmış bir çalışmada Nisan-Kasım 2006 ayları boyunca 43'ü erkek, 51'i dişi, 2'si juvenil, 5'i de cinsiyeti tespit edilemeyen bireyler olmak üzere toplam 101 birey incelenmiştir (Rozdina *vd*., 2008). Yine Meriç Nehri'nde büyüme özellikleri ilgili yapılmış bir diğer çalışmaya göre, Eylül 2005-Haziran 2007 tarihleri arasında 847 birey yakalanmış ve 8 yaş grubuna (1-8) rastlanmıştır. Boy-ağırlık ilişkisi formülü W= 0,0144*$L^{3,0588}$ olarak verilmiştir (Rozdina & Raikova-Petrova, 2014).

Struma Nehri üzerinde yaş, büyüme oranları ve kondisyon faktörü hakkında yapılmış bir çalışmaya göre 2006'dan 2011'e kadar elektroşok ile avcılık yapılmış ve 537 birey yakalanmıştır. Populasyonun 6 yaş grubundan (1'den 6'ya) oluştuğu, 3. yaş grubunun ve 61-70 mm aralığındaki (SL) boy grubunun baskın olduğu bildirilmiştir. Avlanan en uzun birey 245 mm, en ağır birey ise 146 g (5 yaş grubunda) dır. Boy-ağırlık ilişkisi formülü W= 0,0002*$L^{2,896}$ olarak belirlenmiştir (Raikova & Kolev, 2015).

Yaptığımız çalışmada khi-kare testi sonucunda dişi ve erkek bireylerin oranındaki fark istatistiksel açıdan anlamlı bulunmamıştır (X^2= 0,057; p: 0,81 p >0,05), bu yönden bulgularımız Vasiliou & Economidis, 2005'in yaptığı çalışmadan farklılık göstermektedir.

Bu çalışmada incelenen bireylerde yaş dağılımı 0-III (4 yaş grubu) aralığındadır. Baskın grup II. yaş grubudur. III. yaş grubundan daha yaşlı bireylere rastlanmamış olmasını çalışma yapılan bölgenin çok derin olmayan bir dere olmasına dayanabilir. Önceki çalışmalar ile bu çalışmadaki kimi bulguların farklı olmasının nedenini ise incelediğimiz balıkların yaşça küçük olmaları ile ilgili olduğuna bağlanabilir.

Boy-ağırlık ilişkisi tüm bireyler için W= 0,0253*$SL^{2,9226}$ olarak belirlenmiştir, izometrik büyüme tespit edilmiştir. Yakın bölgelerdeki popülasyonlara ait verilerle karşılaştırması Tablo 11 de verilmiştir.

Yaşlara göre kondisyon faktörü değerleri en düşük III yaş grubunda en yüksek ise 0 yaş grubunda hesaplanmıştır. Kondisyon faktörü değerleri; çalışma yapılan tarihe, çalışma alanının ekolojik özelliklerine, çalışılan mevsime, balığın yaşadığı alanda beslendiği besin tipine bağlı olarak değişkenlik gösterebilir. Kondisyon faktörü değerlerinin küçük boylu bireylerde en düşük olması, artan yaşla birlikte artması beklenir. Fakat yapılan bu çalışmada birey sayılarının az olması ve yaşa göre dengesiz dağılım sebebiyle bulunan değerler beklenen değerlerden farklılık göstermiştir. Ayrıca bu duruma artan yaşla birlikte yavaşlayan metabolizma hızının da sebep olabileceği düşünülmektedir (Saç, 2017).

Tablo 11. Farklı habitatlardaki *B.cyclolepis* ve *G. bulgaricus* ta boy-ağırlık ilişkisi parametreleri.

Tür	n	a	b	Kaynak
Barbus cyclolepis	847	0,0144	3,0588	Rozdina & Raikova-Petrova, 2014
	537	0,0002	2,896	Raikova & Kolev, 2015
	70	0,0253	2,9226	Bu çalışma
Gobio bulgaricus	883	0,0174	3,1179	Saç, 2017
	90	0,0209	3,0081	Bu çalışma

G. bulgaricus ile ilgili yapılmış çalışmalar incelendiğinde ise sonuçlar şu şekildedir:

Istranca Deresi (İstanbul)'nde biyoekolojik özellikleri üzerine yapılan bir çalışmada Mart 2012- Haziran 2013 tarihleri arasında 883 adet birey yakalanmıştır. Dişi:erkek oranı 1:1,18 olarak bulunmuştur. Dişi ve erkek bireylerin oranında istatistiksel olarak anlamlı bir fark bulunmuştur (X^2= 4,88; p<0,05) ve erkek bireyler baskındır. Standart boy değerleri 2,0 ile 9,8 cm arasında iken, ağırlık değerleri 0,1365 ile 22,4292 g arasındadır. Türün yaş dağılımı 0 ve V yaş olarak bulunmuştur. III. yaş grubu baskındır. Boy-ağırlık ilişkisi W= 0,0174*$L^{3,1179}$ şeklinde hesaplanmıştır. Tüm bireyler için en düşük ve en yüksek kondisyon

faktörü değerleri sırasıyla 0 ve V yaş grubunda olarak belirlenmiştir. Artan yaş ile birlikte kondisyon faktörü değerinin de arttığı gözlenmiştir (Saç, 2017).

Bu çalışmada 90 adet birey elde edilmiş olup bunlardan 34'ü dişi, 53'ü erkek ve 3'ü de genç bireydir. Dişi:erkek oranı 1:1,56 olarak tespit edilmiştir. Dişi ve erkek bireylerin oranında istatistiksel açıdan fark anlamlı bulunmuştur (X^2= 4,149; p: 0,042 p < 0,05). Erkek bireyler baskındır. Dişi-erkek oranının doğada 1:1 olması beklenir. Bu oranda meydana gelecek değişimler ilgili türün bulunduğu ortamda üreme stratejisi açısından bir adaptasyon gösterdiği şeklinde yorumlanabilir (Gaygusuz, 2012).

I-IV aralığında 4 yaş grubu saptanmıştır; baskın olan III. yaş grubudur. Bu yönden Istranca Deresi'nde Saç, 2017 tarafından yapılan çalışma ile benzer sonuçlar göstermektedir. IV yaş grubundan daha yaşlı bireylere rastlanmamış olması *Gobio* cinsi üyelerinin kısa ömürlü balıklar olmalarından kaynaklanmaktadır.

Boy-ağırlık ilişkisi tüm bireyler için $W= 0{,}0209*SL^{3{,}0081}$ olarak belirlenmiştir, izometrik büyüme tespit edilmiştir. Yaşlara göre en düşük ve en yüksek kondisyon faktörü değerleri II. ve IV. yaş grubunda bulunmuştur. Bu da balığın yaşının büyüdükçe iyi beslenip boy ve ağırlığını geliştirmesiyle yani besililik durumuyla alakalıdır.

Ticari değeri olmayan küçük boylu ve kısa yaşam döngüsüne sahip bu tür balıklarla ilgili ülkemiz iç sularında yapılmış çok fazla bir çalışmaya rastlanmamıştır. Mevcut çalışmanın literatüre katkı sağlaması umulmaktadır.

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RESEARCH ARTICLE

Invasive freshwater jellyfish has become established in artificial impoundments of Anatolian Peninsula

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Abstract

Objective: A freshwater jellyfish *Craspedacusta sowerbii* is frequently found in disturbed or artificial bodies of water, e.g. quarry ponds and gravel pits, reservoirs, aquaria and even wastewater treatment facilities, it can also thrive in natural lentic and lotic habitats. In the present study, we present two new records for *C. sowerbii* which is non-native to Turkey and provide the distribution data of the species in Turkey and Europe.

Materials and Methods: The jellyfish samples were obtained from two localities by fishing nets and hand net. Temperature, pH and dissolved oxygen values of the two sampling areas were measured in both of the sampling areas.

Results: Non-native freshwater jellyfish *Craspedacusta sowerbii* is recorded from two different localities namely Akdeğirmen Reservoir (Afyon) and Atabey Reservoir (Isparta) in Turkey. Twelve individuals and two individuals of *C. sowerbii* were sampled in Akdeğirmen Reservoir (Afyon) and Atabey Reservoir (Isparta), respectively. Temperature, pH and dissolved oxygen values of the two sampling areas were 18.7ºC, 7.9, 6.34 mg/l in Akdeğirmen Reservoir, and 10.9ºC, 7.94, 9.36 mg/l in Atabey Reservoir.

Conclusion: Many studies suggested that it could tolerate a wide range of temperatures from 10°C to 28°C and spread by fish stocking activities as well as by migratory birds in Turkey. It may have been possible for *Craspedacusta sowerbii* to be introduced to Akdeğirmen Reservoir where there are many actively moving cormorants colonies. Also, spread of this species may have been facilitated by fish stocking activities in Turkish inland waters.

Keywords: *Craspedacusta sowerbii*, reservoir, invasiveness potential, Akdeğirmen, Atabey

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Introduction

Craspedacusta sowerbii is a freshwater jellyfish belonging to the Olindiidae family (Classis: Hydrozoa). The origin of *C. sowerbii* is Yangtze-Kiang River System in China (Kramp, 1950) but it is now found all over the world. It was firstly observed out of its native range in a lily tank in Regent's Park in England, 1880 (Allman, 1880; Lankester, 1880a; Lankester, 1880b). The non-native ranges of this species have been reported to expand in Europe, North America, and Australia for more than two decades now (Marchessaux & Bejean, 2020).

Although *C. sowerbii* is frequently found in disturbed or artificial bodies of water, e.g. quarry ponds and gravel pits, reservoirs, aquaria and even wastewater treatment facilities, it can also thrive in natural lentic and lotic habitats (Deevey & Brooks, 1943; Dexter *et al*., 1949; Beckett & Turanchik, 1980; Rayner & Appleton, 1992; Lundberg & Svensson, 2003; Fritz *et al*., 2007).

Its chitin-covered drought resistant resting stage enables it to withstand long periods of food shortage and tolerate extreme environmental conditions, as well as serve as a convenient life-stage for anthropogenic transport (Jankowski, 2000). The life cycle of *C. sowerbii* includes both polyp and medusa stages. The species reproduces asexually, via a budding polyp and a motile frustule, and produces sexually reproducing free swimming medusae, which bud off from the polyp (Reisinger, 1957). About 50 tentacles of medusae are provided with nematocysts, which are used for capturing food and defense for predators (Sarkar & Mude, 2010).

Increasing number of reports on *C. sowerbii* in the last two decades in both Turkey (Table 2) and the world suggested that it has been spreading to new areas due to fishing and recreational activities, migratory birds, through newly constructed reservoirs, pools and ponds (Fritz *et al*., 2007). In the present study, we present two new records of *C. sowerbii* in Turkey and provide inventory for the distribution of the species in Turkey and Europe. We suggest that new findings of the species with the distribution data given in the present study is indicative of its invasiveness potential and that two additional records reported in the present study are important, as these new locations are in different regions that are far from each other and both are artificial man-made reservoirs.

Material and Methods

Data Collection

The study was carried out in two localities, namely Atabey Reservoir (Isparta, 37°56'50"N 30°36'39"E) and Akdeğirmen Reservoir (Afyon, 38°49'04"N 30°11'15"E) (Fig. 1). Atabey Reservoir with an area of 345 km² is used for recreational and irrigation purposes. There are several cages in the reservoir for trout farming. Also, amateur fishing activities are carried out in the reservoir. Akdeğirmen Reservoir (Afyon), which has an area of 5.60 km² area is used for irrigation and drinking water.

Sampling was carried out in October, 2020 in Akdeğirmen reservoir and in November, 2020 in Atabey Reservoir. Fishing nets ranging from 5 to 55 mm mesh size and small hand nets are used for sampling. Jellyfish individuals were measured and preserved in a plastic jar in Atabey Reservoir.

Figure 1. Locations of the sampling reservoirs in Turkey (1. Akdeğirmen Reservoir, Afyon, 2. Atabey Reservoir, Isparta).

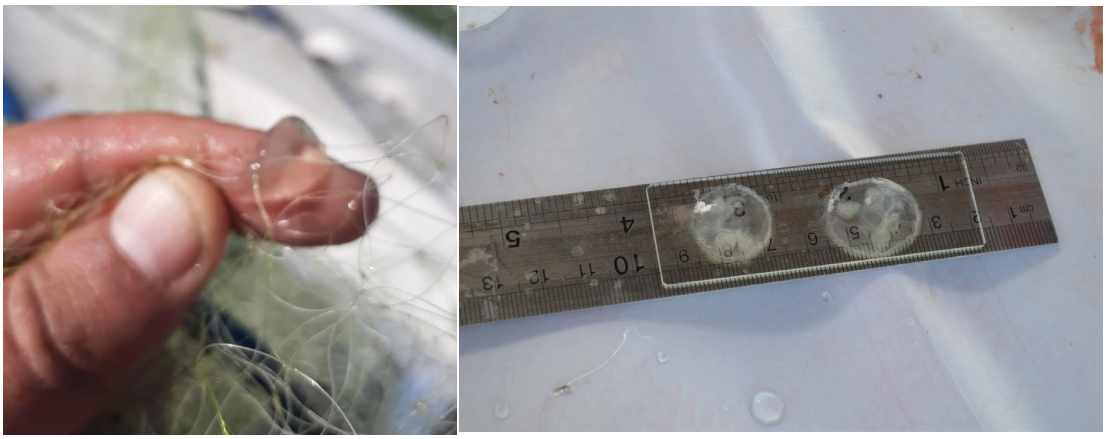

Figure 2. *Craspedacusta sowerbii* samples from Akdeğirmen Reservoir.

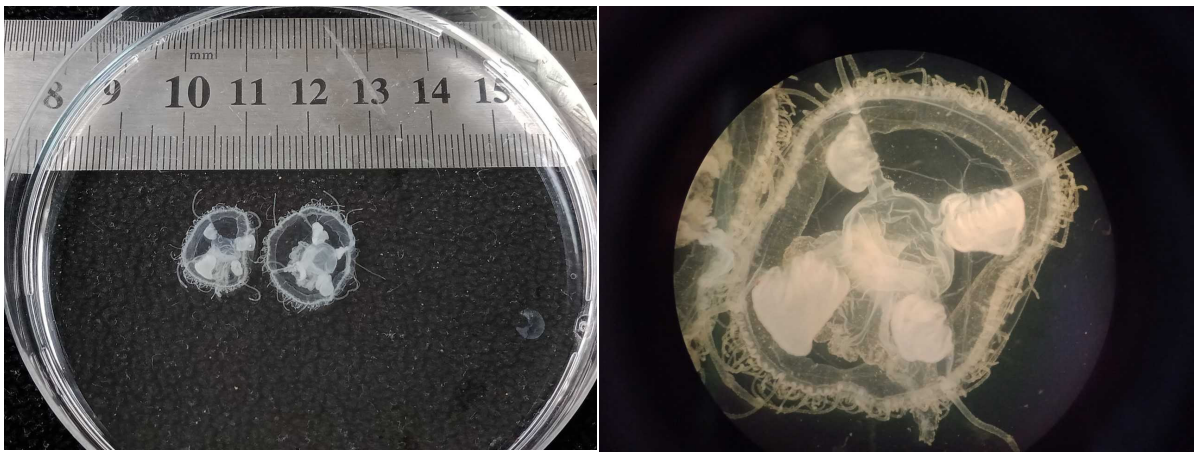

Figure 3. *Craspedacusta sowerbii* samples from Atabey Reservoir.

Results and Discussion

This study provides additional records of *Craspedacusta sowerbii* from Turkish freshwaters with some evidence of its establishment. The first record of *C. sowerbii* was from Akdeğirmen Reservoir in October, 2020 (Fig. 2). Twelve individuals were sampled, measured and preserved in a plastic jar. Bell diameters of the individuals were between 1.3 and 2.4 cm. Temperature, pH and dissolved oxygen values of the sampling area were 18.7ºC, 7.9 and 6.34 mg/l, respectively.

The second record was from Atabey Reservoir in November, 2020. Temperature, pH and dissolved oxygen values of the reservoir were 10.9ºC, 7.94 and 9.36 mg/l, respectively. Four *C. sowerbii* individuals were observed and two of them were sampled from the reservoir (Fig. 3). Bell diameters of the individuals were measured as 2.3 cm and 1.4 cm, respectively.

Some physicochemical parameters of the previous sampling sites in both Europe and Anatolia were presented in Table 1 and Table 2, respectively. According to McClary (1959) and Acker (1976), optimum temperature ranges for this species were 19-25°C. It was reported that medusae occur at temperature of 15-30°C (Milne, 1938) and also could not survive under the temperature 15°C (Dunham, 1941). However, in this study, we found that medusae survived at 10.9°C in Atabey Reservoir. In parallel, previous studies showed that this species could tolerate a wide range of temperature from 10°C to 28°C. Further, *C. sowerbii* was found in European and Turkish lakes between March and November that indicated high environmental tolerance of this species (Table 1-2). Fritz *et al*. (2007) noted that *C. sowerbii* spread rapidly after 1990's in Germany. In Turkey, this species has been recorded since 1983 - this is probably because this tiny jellyfish could not be realized before that time. Balık *et al.* (2001) and Bekleyen *et al*. (2011) suggested that fast spread of this species may have been facilitated by fish stocking activities in Turkish inland waters. Some records of *C. sowerbii* in Turkey revealed that the first appearance of this species was after fish stocking activities (Gülşahin, 2017).

In the Akdeğirmen Reservoir, we found *C. sowerbii* on the fish nets. It has been widely reported that jellyfish

Table 1. Reports of *Craspedacusta sowerbii* from Europe and some physicochemical parameters of the sampling areas.

Locality	Season/year	Temperature (°C)	pH	DO (mg/l)	Secchi depth (m)	Maximum depth (m)	Literature
Iris Pond (Israel) (Natural pool)	September/2011	25	-	8.6	0.84	3	Gasith *et al*., 2011
Germany, 97 lakes, ponds, quarry ponds, gravel pits	1923-2006	-	-	-	-	-	Fritz *et al.*, 2007
Lake Malpaga (Italy) (artificial lake)	July 2009	10.1-28.03	7.2-8.1	2.9-14.4	4	10	Stefani *et al.,* 2010
Water-filled gravel pit located near the Nemunas River (Lithuania)	August 2002	20.3°C	-	-	-	4-5	Arbačiauskas & Lesutienė, 2005
Monte da Rocha Reservoir (Spain)	October 2012	25.3°C	-	-	-	-	Gomes-Pereira & Dionísio, 2013
Pool near Velika Morava river, (Natural shallow pools), Serbia	1958-2004 from July to September	20-26°C	-	-	-	-	Grozdanić & Manojlović, 1958
Sava Lake (Man-made impoundment), Serbia	1958-2004 from July to September	20-26°C					Kalafatić, 1983
Lake Velika Peščara (Artificial water basin), Serbia	1958-2004 from July to September	20-26°C					Kalafatić *et al.,* 1999
Lake Miloševo (Reservoir), Serbia	1958-2004 from July to September	20-26°C					Ludoški *et al.*, 2004
Lake Šumarice (Artificial reservoir), Serbia	1958-2004 from July to September	20-26°C					Jakovčev-Todorović *et al*., 2010
Lake Marathon reservoir, Greece	September 2014	15.6	7.91	7.87	-	54	Karaouzas *et al*., 2015
Cingi-Lingi Lake, Croatia	March 2004	-	-	-	-	19	Stankovi´c & Ternjej 2010
Drenovets Reservoir, Bulgaria	July 2007	26.5	-	9.2	1.2	28	Kozuharov *et al*., 2017
Iskar Reservoir, Bulgaria	August 2011	25.0	-	-	-	76	Kozuharov *et al*., 2017
Studen Kladenets Reservoir, Bulgaria	July 2016	29.0	9.09	7.6	8.5	40	Kozuharov *et al.*, 2017

aggregations cause clogging the fish nets and become a problem for fishermen and fishing activities (Purcell *et al*., 2007). In this reservoir, fishermen admitted that this jellyfish lead to similar problems and become highly nuisance. Also, it has been observed that the density of this species was high in both reservoirs, which would suggest their successful establishment. For instance, *C. sowerbii* is observed every year in Ula Pond (Muğla) since it was recorded for the first time in 2016 (Gülşahin 2017). These records and observations suggested that this species formed established populations in some reservoirs of Anatolia.

The most common foods in stomach contents of sampled individuals from Malpaga Lake (Italy) were copepods and cladocerans (Stefani *et al*., 2010) especially *Bosmina spp*. (Dunham 1941). Cladoceran abundances increase in summer and autumn by parthenogenetic reproduction and

Table 2. Reports of *Craspedacusta sowerbii* from Turkey and some physicochemical parameters of the sampling areas.

Locality	Season/year	Temperature (°C)	pH	DO (mg/l)	Secchi depth (m)	Maximum depth (m)	Literatures
Topçam Reservoir-Aydın	September, October 1999	26-21	-	7.6-5.4	1.6-1.4	-	Balık *et al.*, 2001
Keban Reservoir, Elazığ	-	-	-	-	-	-	Dumont, 1994
Sapanca Lake, Kocaeli	August, September 2009	24.3	-	7.4	5.6	55	Akçaalan, 2011
Kozan Reservoir, Adana	-	-	-	-	-	-	Bozkurt, 2004
Kıralkızı Reservoir, Diyarbakır	August 2008	26.9	8.57	7.3	-	-	Bekleyen *et al.*, 2011
Ula Pond, Muğla	Eylül, 2016	25.5-25.9	-	-	-	20	Gülşahin, 2017
Uzunçayır Reservoir, Tunceli	September 2018	20.3	8.8	8.8	3.6	-	Kutlu, 2020
Ürkmez Reservoir and Küçük Menderes River, İzmir	August and September, 2014	28.7-22.0	8.36-8.45	7.63-8.44	0.3	17	Özbek & Sömek, 2020

it was determined *Daphnia spp.* and *Bosmina spp.* were found with high numbers in the plankton samples from Akdeğirmen Reservoir (unpublished data).

Polyps of *C. sowerbii* become constricted and form dormant podocysts in winter and podocysts transform into new polyps. These podocysts are dispersed by animals, commonly birds that are especially migratory such as cormorants (Sarkar & Mude, 2010). This vector might be important for dispersal of this species in Turkey. Also, it may have been possible for *C. sowerbii* to be introduced to Akdeğirmen reservoir where there are many cormorants distributed.

According to the risk identification tool of non-native aquatic species so called AS-ISK (Aquatic Species Invasiveness Screening Kit) *C. sowerbii* yielded high scores to be potential invasive species (Killi *et al*., 2020) and records from Europe and Turkey (Table 1 and Table 2) support the spreading and establishment potential of this species. Moreover, species distribution models can help understanding the potential distribution of the species under projected climate conditions and this should be taken into consideration against the possibility of the spread of this species in the future.

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Bu Telif Hakkı Anlaşması Formu tüm yazarlar tarafından imzalanmalıdır/onaylanmalıdır. Form farklı kurumlarda bulunan yazarlar tarafından ayrı kopyalar halinde doldurularak sunulabilir. Ancak, tüm imzaların orijinal veya kanıtlanabilir şekilde onaylı olması gerekir.

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