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Directional preferences of Yellow Wagtail (*Motacilla flava*) (Linnaeus, 1758) subspecies migrating through Kızılırmak Delta in spring

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Abstract

The directional preferences of the Yellow Wagtail, *Motacilla flava*, subspecies were studied by orientation cage experiments performed during the spring migration between 2004 – 2006 in Kızılırmak Delta. Spring passage of Yellow Wagtail starts in late March, reaches a peak in mid-April, and then decreases progressively towards the mid-May at Kızılırmak Delta. 369 orientation experiments with Busse cages were conducted with the five *M. flava* subspecies (*M. f. beema, M. f. feldegg, M. f. flava, M. f. melanogrisea*, *M. f. thunbergi*) and two hybrids (*M. f. superciliaris* and *M. f. dombrowskii*). Both our observation and ringing data showed that the Yellow Wagtail subspecies stop-over in mixed flocks during spring migration in Kızılırmak Delta before they cross the Black Sea, which is a large migration barrier, and use this area for resting and feeding. According to the orientation experiments' results, the subspecies showed mean orientation to the north. The predominant migration direction of *M. flava* subspecies were determined as northwest (NW) and northeast (NW). The taxa of this species head for north and thus they head for their breeding areas not before passing over the Black Sea, but after passing over the Black Sea.

Key words: busse cage, Kızılırmak Delta, *Motacilla flava*, orientation, Yellow wagtail

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İlkbaharda Kızılırmak Deltası'ndan göç eden Sarı kuyruksallayan (*Motacilla flava*) (Linnaeus, 1758) alttürlerinin yönelim tercihleri

Özet

Motacilla flava (Sarı kuyruksallayan) taksonlarının yönelim davranışlarını belirlemek amacıyla Kızılırmak Deltası'nda 2004 - 2006 yılları arasında ilkbahar göçü sırasında oriyantasyon kafesi deneyleri yapıldı. Kızılırmak Deltası'nda, Sarı kuyruksallayanların ilkbahar göçü mart ayı sonunda başlar, nisan ayı ortasında en yüksek seviyesine ulaşır ve mayıs ayı ortalarına doğru görece azalır. 2004 – 2006 yılları arasında beş alttür (*M. f. beema, M. f. feldegg, M. f. flava, M. f. melanogrisea*, *M. f. thunbergi*) ve iki hibride (*M. f. superciliaris* and *M. f. dombrowskii*) Busse kafesleri ile 369 oriyantasyon deneyi yapıldı. Oriyantasyon deneyleri ve halkalama çalışmaları sonuçlarına göre *M. flava* taksonuna ait bireyler, ilkbahar göçü sırasında büyük bir göç bariyeri olan Karadeniz'i aşmadan önce Kızılırmak Deltası'nda karışık sürüler halinde konaklamakta ve alanı dinlenme ve beslenme için kullanmaktadır. Oriyantasyon deneylerinden elde edilen sonuçlara göre *M. flava*'ya ait alttürler, kuzeye yönelmişlerdir. *M. flava*'nın ağırlıklı göç yönü, kuzeybatı (KB) ve kuzeydoğu (KD) olarak tespit edilmiştir. *M. flava* taksonları, Karadeniz'i aşmadan önce değil de, Karadeniz'i geçtikten sonra üreme alanlarına doğru yönelmektedirler.

Anahtar kelimeler: busse kafesi**,** Kızılırmak Deltası*, Motacilla flava,* oryantasyon, Sarı kuyruksallayan

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1. Introduction

Billions of migratory birds annually go back and forth the hundreds and even thousands of kilometers between their wintering and breeding grounds [1; 2].

For many long-distance migrants such as geese, swans, raptors, cranes or passerines have to stop at several available stopover sites between wintering and breeding areas [2; 3; 4; 5]. Each bird species follows its own route, with its own departure and arrival dates, its own migration strategy and migratory behaviour [2]. The direction of migration is a heritable characteristic and experiments documented that during migration, birds find their ways according to endogenous factors that are controlled genetically [6].

Migratory songbirds may use several biological compasses such as stars, skylight polarization, geomagnetic field for orientation to find geographic directions and most birds remember and use visual signs such as hills, valleys, even skyscrapers in big cities [7].

The Yellow Wagtail is a common Palearctic passerine that includes thirteen subspecies - all with a parapatric distribution (only limited overlap) of breeding ranges in the Northern Hemisphere [8; 9; 10]. All subspecies breed in the Palearctic and winter in Africa and/or southern Asia. The Yellow Wagtail subspecies leave the wintering grounds in tropical Africa in sequence according to breeding latitude, with more southerly breeding (and northerly wintering) populations migrating earlier [11]. First *M. f. feldegg* (February - March) leave Central Africa, followed by *M. f. flava* (March - April) and lastly *M. f. thunbergi* (April – early May). All these taxa migrate to the north through the Middle East from the middle of March to May. Different subspecies reach the southern part of Israel in different time period: *M. f. feldegg*, generally mid February – late March (they reach the highest number from mid- to late March), *M. f. beema* and *M. f. flava* generally from early April to mid May (they reach the highest number in the second part of April) and *M. f. thunbergi* generally reach this area within the period from mid April to late May [10; 11; 12]. Yellow Wagtails arrive at their breeding grounds between March and April in the southern Europe, from late March to early May in Central Europe, in mid April in South Scandinavia and in mid May in Northern Scandinavia [10 12].

Turkey is placed on the Blacksea/Mediterranean European migratory flyway of the Western Palearctic and most studies on migration have been focused on the Western and Central European Flyways [13, 14]. Like some other wetlands in Turkey, Kızılırmak Delta is visited by a remarkable variety of birds in spring migration [15; 16] however especially passerine migration is little known [17]. Even though Yellow Wagtails are suitable for orientation cage experiments, there are no studies or data on the migratory behavior or directional preferences during the migration period of Yellow Wagtails in Turkey. This study was carried out to determine directional preferences of the Yellow Wagtail subspecies by conducting orientation experiments with Busse cages during spring migration at Kızılırmak Delta in Turkey.

2. Materials and methods

Orientation experiments were conducted in Kızılırmak Delta Wildlife Protection Area (41º 36’ N 36º 05’ E) during the spring migration in 2004, 2005 and 2006 (Figure 1).

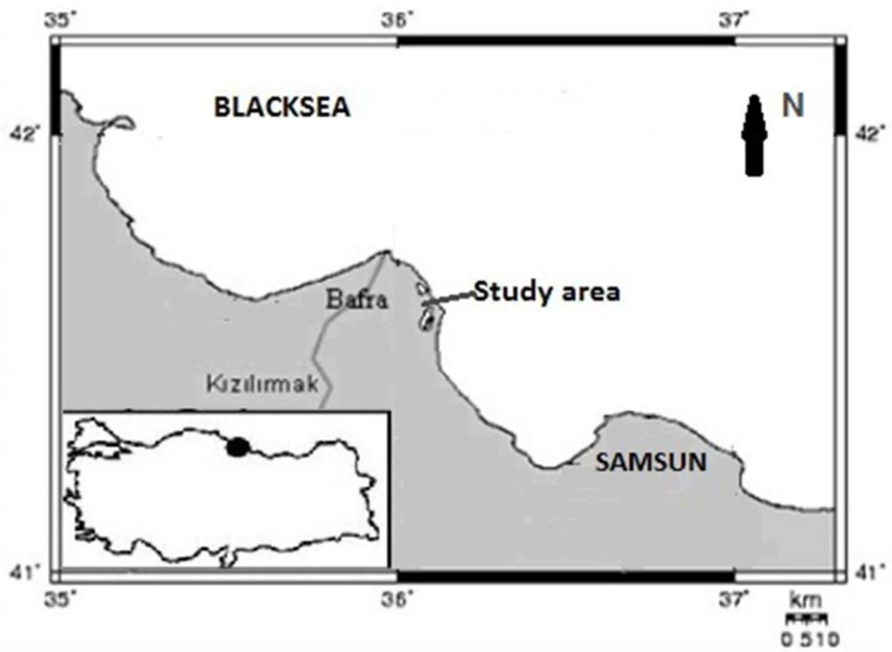

Figure 1. Kızılırmak Delta and the study site

Pinters (one-way entrance crayfish basket) and 7 and 12 m long mist nets were used to catch the birds. The traps and nets were left open all day from dawn to dusk and checked every hour in accordance with SE European Bird Migration Network (SEEN) methodology [18].

Sex and subspecies of each bird was determined based on plumage characteristics [8]. After taking the biometrics (fat score, wing formula, wing and tail length) orientation experiments were carried out with Busse cages on ringed birds cought during their spring migration [19]. "The bird was placed inside Busse flat cage (10 cm height, 36 cm in diameter) made of two circles connected by eight vertical sticks, sides covered with transparent foil, divided into 8 sectors, and top covered with netting that allows tested individuals to see the sky" [20; 21]. The cage was placed on a hexagonal platform, which was made of slat [21]. The cage was placed in the centre of nontransparent, uniformly coloured open cylinder, which had a diameter of 110 cm and a height of 40 cm that prevented a study bird from seeing any landmarks and with one of the vertical sticks oriented to the north. The bird, which was kept waiting in a cotton bag was put inside the cage in a way that it could not see its surroundings. Tested individuals were released after a 10 minute test. The experiments were conducted in the day time and in an area away from objects such as trees and shrubs, where the bird could only see the sky when it was inside the cage. Experiments were not conducted when it was rainy or the wind force was over 6 according to the Beaufort scale.While bird try to escape from the cage, it leaves traces such as pecks, scratches and holes on the stretch film with bill and claws [6; 19]. After the test the scratches and holes left by the bird on the stretch film were counted for each of the 8 sectors. The orientation of the birds was calculated with ORIENTIN 45 computer program, in which multimodal distributions are taken into consideration [22]. The results were drawn in Corel Quattro Pro 8 as 16-sector radar graphs; the headings indicate the distribution of individual vectors of all the birds from the sample [23]. The direction of the compound vector is expressed in degrees.

3. Results

We performed orientation experiments with five *M. flava* subspecies (*M. f. beema*, *M. f. feldegg*, *M. f. flava*, *M. f. melanogrisea*, *M. f. thunbergi*) and two intra-specific hybrids (*M. f. superciliaris* and *M. f. dombrowskii*) of which 369 birds showed orientation significantly different from random (χ^2 -test: p<0.01) (Table 1). Inactive birds and birds that were found to show random distribution by chi-square test were excluded from further analyses.

Table 1. The Number of orientation tests performed per year for each subspecies

	2004	2005	2006	Total
M.f.beema	11	78	13	**102**
M.f.feldegg	11	31	7	**49**
M.f.flava	18	86	26	**130**
M.f.melanogrisea	7	19	4	**30**
M.f.thunbergi	2	8	-	**10**
M.f.dombrowskii	10	13	5	**28**
M.f.superciliaris	-	17	3	**20**
Total	**59**	**252**	**58**	**369**

Table 2. Preferred directions (%) of tested Yellow Wagtail subspecies in Kızılırmak Delta, Turkey

	2004 (%)				2005 (%)				2006 (%)			
	NE	**NW**	**SE**	**SW**	**NE**	**NW**	**SE**	**SW**	**NE**	**NW**	**SE**	**SW**
M.f.beema	27.3	23	24.8	24.8	54.3	34.6	8.1	2.9	46.1	27.8	13.1	13
M. f. feldegg	60	20	-	20	53	32.9	4	10	38.3	48	13.7	-
M. f. flava	46.1	29.9	4.7	19.2	46.2	35.5	9.2	9.1	63	31.7	5.3	-
M.f.melanogrisea	36.3	48.7	5.7	9.3	51.7	36.3	1.9	10	50	-	14.2	35.8
M. f. thunbergi					75.2	12.8	5	7				
M.f.superciliaris					45.5	26.9	11.9	15.7				
M. f.dombrowskii	32.2	59.1	-	8.7	38	48.3	5.4	8.3	75	25	-	-

*NE: northeast, NW: northwest, SE: southeast, SW: southwest

M. f. beema and *M. f. flava* showed dominantly northeast (here after NE) direction for each three years. *M. f. thunbergi* and *M. f. superciliaris* were tested only for 2005 and both of them headed to NE. In the case of *M. f. feldegg* two main directions NE in 2004 and 2005 and also significant northwest (here after NW) direction in 2006 were distinguished. The NW direction was showed also by *M. f. melanogrisea* in 2004, while NE in 2005 and 2006. NW direction was dominant in 2004 and 2005 but NE direction was also significant in 2006 for *M. f. dombrowskii*. The mean orientation of the species was to the north. Dominant direction NE was 41.9% in 2004, 46.6% in 2005 and 48.3% in 2006 while NW were 30.5% in 2004, 59.1% in 2005 and 37.5% in 2006 (Figure 2). The average azimuths were A=2º in 2004 (n = 60), A=15º in 2005 (n = 253) and A=2º in 2006 (n = 58). Headings to the southwest and southeast had the least share of overall percentage (< 20%).

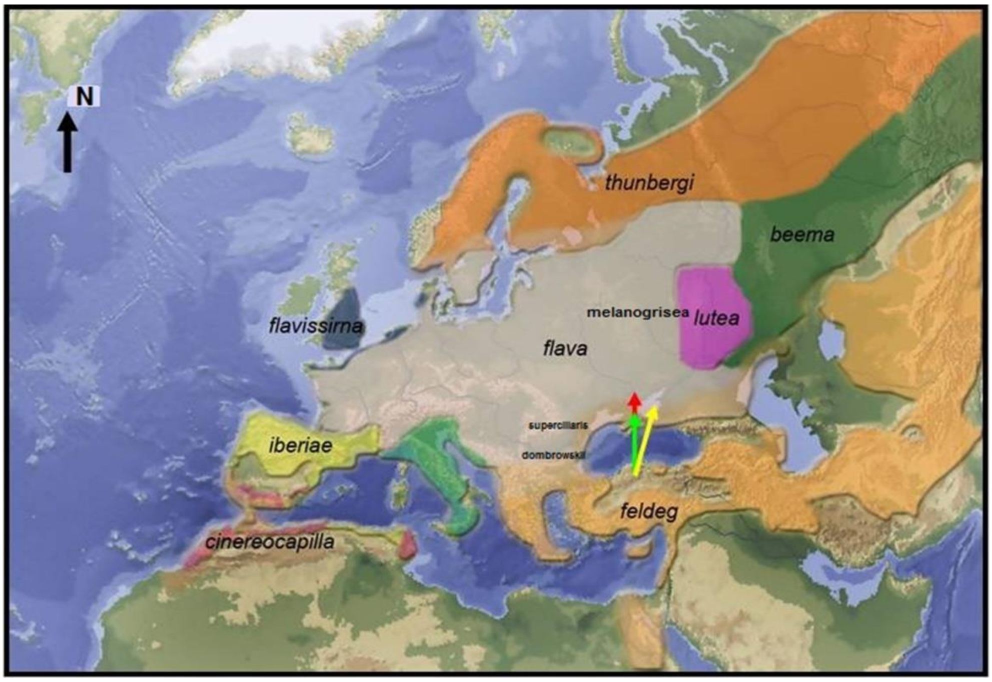

Figure 2. Preferred migratory direction of the Yellow Wagtail to the breeding grounds in spring through the Kızılırmak Delta (Adapted from [8]) (red arrow:2004, yellow arrow:2005; green arrow:2006)

4. Conclusions and discussion

The orientation experiments were conducted using the Busse method to determine the directional preferences of the Yellow Wagtail subspecies during migration peaks in spring migration in the Kızılırmak Delta. According to our ringing data and observations *M. flava* shows two distinct peaks of migration, one in mid-April and second in early May at Kızılırmak Delta.

After refuelling in Kızılırmak Delta, the Yellow Wagtail subspecies crossed the Black Sea and headed toward the breeding areas. It was found that the directional preferences of *M. flava* subspecies were not significantly different from each other and they generally headed for north. The directions preferred by individuals in *M. flava* taxon at Kızılırmak Delta were coincides with the spring migration directions stated by Wood [24] and Bell [11; 25]. Trocinska et al., [21] stated that Busse cage experiments indicate the birds local directional preferences. However, Zehtindjiev et al., [26] found that the Sedge Warblers (*Acrocephalus schoenebaenus*) in the Busse cages showed long-term directional preferences based on the results of their experiments. The dominant headings NE and NW probably showed us the directions of departure and may reflect migration flights to the breeding areas.

Some birds showed also a second, opposite direction or headed exclusively northwest or northeast. At least %20 percentage of the *M. flava* reflected the reverse direction in spring migration. It might happen that under the stress a bird wanted to leave the cage in the opposite direction [27; 28]. Cases of reverse migration were noted also in natural conditions [29; 30]. Researchers have also stated that individuals of different populations which migrate from different areas can make different direction preferences from other individuals [31; 32].

Kızılırmak Delta is an important staging area for *M. flava* and other migrant passerines. The Delta is the last stopover before crossing of the Blacksea to the north. They are oriented until they reach the Black Sea, which is an important migration barrier and after they cross the Black Sea, they realize their navigation. We still do not know much about which compass systems the birds use during migration [33]. Yellow Wagtails must fly at least 350 km without stopping to cross the Black Sea, which is the shortest distance between Kızılırmak Delta and other side of Black Sea. This statement can be supported by the fact that on migration birds prefer to minimize arrival time, distance, energy or predation risk while increasing the chance of finding a nest and finding a mate [34; 35].

No previous orientation experiment data have been found for *M. flava* subspecies and this is the first study to document the directional movements of Yellow Wagtails in the spring in Turkey.

Doing similar studies both at the stopover areas of the *Motacilla* taxa and on the other side of the Black Sea will greatly contribute to the determination of the directional preferences during the migration period. The improvement of larger data sets fom both sexes will allow more presice results of preferences. However, this problem still needs further analyses. The spatio-temporal migration strategies should be studied with geolocator especially for autumn and spring migration.

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