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SHORT COMMUNICATION

Migration timing of Pallas's Grasshopper-warbler *Locustella certhiola* and Lanceolated Warbler *L. lanceolata* at a stopover site in the Russian Far East

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ORNITHOLOGICAL SCIENCE

Abstract The aim of our study was to describe the migration timing of two Siberian *Locustella* species at a breeding site in the Russian Far East. Our results show, that juvenile Lanceolated Warbler *Locustella lanceolata* leave the study site earlier than adults, while juvenile Pallas's Grasshopper Warbler *L. certhiola* start their migration later than adults, which might be caused by juveniles and adults moulting at different times. Both species undertake a fast migration without long-term stopovers at the study site.

Key words East Asian migratory flyway, *Locustella*, Muraviovka Park

Species in the genus *Locustella* live in and move through dense vegetation both during the breeding period and on migration (Snow et al. 1997; Nisbet 1967). At their breeding sites, they are easily identified by their specific songs (Bozó 2015), although it is difficult to see them due to their behaviour and morphological characteristics, but during the rest of the year they are very difficult to find and to identify in the field. Some species, such as Pallas's Grasshopper Warbler *L. certhiola* (Pallas, 1811) and Lanceolated Warbler *L. lanceolata* (Temminck, 1840) occur in Europe as vagrants (Dymond et al. 1989; Snow et al. 1997; Bozó et al. 2016), and breed across extremely large ranges (BirdLife International 2018). We have very limited information about their migration, wintering and breeding grounds (Nisbet 1967; Williams 2000; Harrop 2007; Round & Baral 2013; Round et al. 2014).

Pallas's Grasshopper Warbler is a polytypic species with five subspecies (Kennerley & Pearson 2010). It breeds from east Kazakhstan, in northeast Kyrgyzstan and along the River Irtysh to north and northeast China, southeast Siberia and the area around the Sea of Okhotsk and winters from India to Southeast Asia. Migrants return to their breeding grounds by mid-June (Pearson 2018a) and the first individuals reach their Malaysian wintering grounds in mid-September. Individual birds show both within- and between-year wintering site fidelity (Nisbet 1967).

Lanceolated Warbler is a polytypic species with two subspecies. Its breeding range includes southeast Finland, Russia (Karelia, and from Perm and western Urals east to lower River Kolyma, southern Kamchatka and the Sea of Okhotsk, and south to Altai, Amurland and Ussuriland), northern Mongolia, northeast China and Sakhalin, the Kuril Islands and northern Japan, and winters from northeast India

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to the Southeast Asian islands. They return to their breeding grounds during early June (Pearson 2018b). At Beidaihe (northeast China) it can be observed from August to mid-October with a peak at the end of September (Williams 2000; Harrop 2007) and it arrives to Hong Kong in the northeastern part of their wintering range during October (Harrop 2007).

Here we describe the migration timing of Pallas's Grasshopper Warbler and Lanceolated Warbler at Muraviovka Park in the Russian Far East. Both species are common breeders at this study site (Heim 2014). Following Kennerley and Pearson (2010), Pallas's Grasshopper Warblers breeding at Muraviovka Park belong most likely to nominate *L. c. certhiola* or *L. c. minor*, while *L. c. rubescens* could occur there on migration.

MATERIALS AND METHODS

The study was carried out within the Amur Bird Project (Heim & Smirenski 2013, 2017) during spring (April to mid-June in 2013, 2015, 2016, 2017) and autumn (July to October in 2011, 2012, 2013, 2014, 2017) migration at Muraviovka Park along the middle reaches of the Amur River in the Russian Far East. To define the local population, we also considered the recapture data of birds trapped between mid-June and mid-July. The study site is located 60 km SE of the city of Blagoveshchensk (49°55′08,27″N, 127°40′19,93″E) (Heim et al. 2012). In total, up to 34 Japanese-type mist-nets (Ecotone, Poland) with a total length of up to 250 m were set up in a variety of habitats. Mist-nets were checked hourly from sunrise to sunset.

The data analysis was carried out based on first captures and recaptures of 841 individuals of two species: Pallas's Grasshopper Warbler (first captures: 60 in spring, 476 in autumn; recaptures: 17 in spring, 20 in summer and 111 in autumn), Lanceolated Warbler (first captures: 17 in spring, 118 in autumn; recaptures: three in spring, three in summer and 16 in autumn). Species identification was based on Svensson (1992) and Brazil (2009).

We only processed the data of the first captures to determine the migration timing. We used recaptures to determine how many days the birds spent in the area. Moreover, it was observed how their bodyweight changed during this period and we also considered fat score values following Eck et al. (2011). A fat score of 0 means that the bird did not have any visible fat, while a fat score of 8 means that flight muscles as well as the ventral side of the bird are completely covered by fat. Body weight was measured to the nearest 0.1 g. Birds trapped at least once during the breeding period were considered to be local. We used a t-test to describe the migration timing of juveniles and adults and changes in body mass during the stopover, all the variables followed a normal distribution.

The authors confirm that all experiments were carried out under the current law for scientific bird ringing in Russia, and all necessary permissions were obtained by the Moscow Bird Ringing Centre.

RESULTS

Pallas's Grasshopper Warbler

Eighty-one percent of the migratory birds were juveniles and 19% were adults, with juveniles migrating on average five days later than adults (t-test, $t=6.8612$, $P<0.01$) (see Table 1 for migration phenology).

In spring, local breeding birds arrive in late May and early June. The earliest record of a local bird was on 31st May 2015. In autumn, on average 5.3 days ($SD=6.9$) elapsed between the first and the last capture ($N=82$). According to the recaptures, adults

Table 1. Migration timing of Pallas's Grasshopper Warbler and Lanceolated Warbler (SD=standard deviation, Min=earliest ringed bird, Max=latest ringed bird, N=number of ringed individuals).

Species	Season	Age	Mean	Median	SD	Min	Max	N
Pallas's Grasshopper Warbler	**Spring**	**Adult**	5 Jun	5 Jun	4.4	28 May	15 Jun	39
	Autumn	**Adult**	14 Aug	14 Aug	13	25 Jul	15 Sep	89
	Autumn	**Juvenile**	19 Aug	16 Aug	13	25 Jul	21 Sep	354
Lanceolated Warbler	**Spring**	**Adult**	27 May	26 May	4.2	21 May	3 Jun	17
	Autumn	**Adult**	8 Sep	8 Sep	4.8	30 Aug	16 Sep	8
	Autumn	**Juvenile**	6 Sep	6 Sep	15	27 Jul	10 Oct	94

Table 2. Fat scores and body weight of Pallas's Grasshopper Warbler and Lanceolated Warbler (SD=standard deviation, Min=minimum measured value, Max=maximum measured value, N=number of measured birds).

Species	Age		Median		SD		Min		Max		N	
			Fat	Weight	Fat	Weight	Fat	Weight	Fat	Weight	Fat	Weight
Pallas's Grasshopper Warbler	**Spring**	**Adult**	2.0	14.9	1.3	1.3	0	12.5	4	18.5	39	38
	Autumn	**Adult**	2.0	14.0	1.1	0.9	0	12.1	5	16.6	88	74
	Autumn	**Juvenile**	2.0	13.8	1.1	1.3	0	9.6	5	24.0	359	357
Lanceolated Warbler	**Spring**	**Adult**	2.0	10.7	1.3	0.9	0	9.5	5	13	16	14
	Autumn	**Adult**	1.0	12.1	1.1	1.4	0	9.1	3	13.5	8	8
	Autumn	**Juvenile**	2.0	11.1	1.3	0.9	0	9.7	5	14.5	88	84

of the local population seem to leave the area in the second half of August and early September. There was no significant change in body mass during the stopover (t-test, t=1.8862, P>0.05) (see Table 2, showing fat scores).

Lanceolated Warbler

Most (92.2%) of the birds were juveniles, while 7.8% were adults. Juveniles migrated on average two days earlier than adults (t-test, t=6.8948, P<0.01) (see Table 1 showing migration phenology). One adult bird caught on 9 September 2011 had a visible brood patch.

There were 20 recaptures of 18 different individuals. One bird was re-trapped in the years after it was banded. In autumn, on average 6.7 days (SD=5.5) elapsed between the first and the last capture (N=14), while in spring only one bird was re-trapped three days after ringing. There was no significant change in body mass during the stopover (t-test, t=-1.1218, P>0.05) (see Table 2).

DISCUSSION

Our knowledge of the migration and wintering of Siberian Locustella species is very limited related, therefore, we compared our results with the known migration strategies of the European Locustella species. These species differ in their migration strategies (such as direction, speed, and site fidelity) and moult (Mátrai et al. 2006; Neto & Gosler 2006; Křen 2008; Neto et al. 2008; Spina & Volponi 2008; Bairlein et al. 2014) so we might expect a similarly varied pattern for Siberian species. However, the European species have different wintering sites and several geophysical barriers exist across their migratory flyways including the European Alps and the Mediterranean Sea, whereas the wintering areas of the Siberian species are similar and there are no such major barriers across the East Asian migratory flyway (del Hoyo et al. 2006).

The migration strategies seem similar between the two Siberian species during spring and autumn migration. Their migrations can be described as a single wave, which may indicate that the different populations (and in the case of Pallas's Grasshopper Warbler, potentially different subspecies) migrate through the same area at the same time. In a British population of the Common Grasshopper Warbler *Locustella naevia* the number of broods raised influences migration phenology (birds from different broods migrate at different times; Bayly & Rumsey 2007), but our study species produce only one brood per year.

The number of juveniles captured was remarkably high compared with adults and there are slight differences in the timing of migration of juveniles and adults. Juvenile Lanceolated Warblers leave their natal area earlier than the adults, which might be explained by the fact that adults make a complete moult on their breeding grounds (Svensson 1992), and because of its energy-demand, this process takes time, thus the adults are not able to start their migration earlier. Juveniles undergo only a partial moult hence they leave first (Miholcsa et al. 2009). This also occurs in Savi's Warblers *Locustella luscinioides* (Neto et al. 2008) and Common Grasshopper Warblers (Bayly & Rumsey 2007). However, juvenile Pallas's Grasshopper Warblers start their migration later than adults, which is in agreement with a recent study (Eilts & Heim, in preparation) that found that only one third of the adults moulted their wing feathers, while two thirds of the adults migrated with unmoulted and slightly worn primaries. Additionally, these adults began their migration while still moulting. This strategy allows the adults to migrate earlier after breeding than juveniles. This pattern also occurs in the Common Grasshopper Warbler in Europe (Rumsey 2002).

Juveniles and adults of both species have relatively low fat scores during the spring and autumn migration and spend only a short time in the study area. This is similar to Savi's and Common Grasshopper Warblers in Europe (Mátrai et al. 2006; Bayly & Rumsey 2007; Neto et al. 2008; Bayly et al. 2011). The East Asian migratory flyway does not cross any significant mountain ranges or deserts, as long as birds avoid Central Asia, and therefore it might not be necessary for passerine migrants to accumulate large fat deposits. Most likely, the migration strategies of these species are similar to that of Savi's Warbler, namely fast migration without long-term stopovers (Neto et al. 2008).

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