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Latitudinal Features of Nest Success of Passerine Birds (Passeriformes) in the Ob Forest Tundra and Yamal Peninsula

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Abstract—Success in egg incubation and chick rearing in 18 passerine bird species has been analyzed based on the results of observations on the survival of 12 610 eggs in 2083 nests found in the Ob forest tundra and the southern, central, and northern Yamal peninsula. It has been found that a northward increase in nest success is observed in the direction from the Southern Urals and Kazakhstan to Yamal but not from the Baltic Sea to Yamal. In the total forest tundra–subarctic tundra space, nest success increases to the north in one group of species (the common redpoll, Lapland longspur, and common chiffchaff) but decreases in another group (the horned lark, red-throated pipit, bluethroat, and willow warbler).

Keywords: the Subarctic, passerine birds, nest success, clutch size, brood

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After publication of our data on the clutch size of singing birds in the Lower Ob region [1], we found it expedient to discuss subsequent survival of their nests and compare the parameters of nesting success in species common to the high and temperate latitudes in the space from the Arctic Circle to the southern boundary of arctic tundras (66.5°–71.5° N).

MATERIAL AND METHODS

Bird nests have been systematically searched for since the beginning of our research (1971) at field stations in the Ob forest tundra and Yamal Peninsula. Their location is described in [1]. Nest success was estimated by the traditional method—as the proportion (%) of fledglings from the number of eggs laid—and by the method proposed by Mayfield [2] and modified by Payevsky [3]. A total of 1315 nests with 6497 eggs were monitored since the time of egg laying. The Mayfield–Payevsky method allows nest success to be calculated for the maximum large number of control nests, provided they were examined several times, recording the results. As shown by Shitikov [4], this method has certain drawbacks, and it was proposed to calculate nest success by calculating daily survival of nests by the method used in the nest survival module of program MARK [5]. Unfortunately, parameters of nest success calculated in this way for species common to the moderate and high latitudes are absent in the available literature, while the data obtained by the traditional and Mayfield–Payevsky methods are fairly abundant. Therefore, these two methods were used in this study, where one of the purposes was to compare data from different latitudes.

The data on 2083 nests with 12 624 eggs were included in calculations. The significance of differences between test parameters was estimated by Student's *t*-test for proportions. The data were processed in Statistica v. 6.0 (StatSoft Inc.,1984–2003) and Microsoft Excel 2003.

RESULTS AND DISCUSSION

The nest success of passerine birds in the forest tundra and tundras is usually about 63–89% [6–8], but in some years only 9–10% of chicks fledged from Lapland longspur nests in the tundra zone [7]. Nest success in open-nesting birds at temperate latitudes varies between 20 and 65% [9–11], being sometimes lower. To compare nest success in the forest tundra and tundra zones (the Subarctic) and at temperate latitudes (the southern taiga and broadleaf forest subzones), we used the results of our research and data obtained in the Curonian Spit [3], Southern Urals [10], and northern Kazakhstan [11]. Parameters taken from the study by Payevsky [3] were calculated by both methods, and those from other studies, by the traditional method.

Species common to the high and temperate latitudes are relatively few: the white wagtail Motacilla alba, bluethroat *Luscinia svecica*, fieldfare *Turdus pilaris*, redwing *T. iliacus*, willow warbler *Phylloscopus trochilus*, and rosefinch *Carpodacus erythrinus*. Therefore, the set of species from the temperate latitudes was expanded on account of taxonomically close species with a similar type of nesting, such as the bluethroat/thrush nightingale *L. luscinia* or the brambling *Fringilla montifringilla*/chaffinch *Fringilla coelebs* [3].

Table 1 shows data on the nest success of singing birds calculated by different methods in the Ob forest tundra, Yamal, and temperate latitudes. Parameters estimated by the traditional method are consistently higher than those calculated by the Mayfield–Payevsky method. This excess over the parameters of nest success calculated by the latter method has also been noted by Payevsky himself [3]. In his opinion, the traditional method underestimates chick mortality in the last days before fledging, which may well be increased because of high parents' activity in feeding the fledglings, which attracts predators.

As follows from Table 1, calculations by the traditional method estimated that fledglings emerged from more than half of eggs laid by the birds in the north (except for the brambling). By the second method, nest success over 30% was estimated for the brambling; over 40%, for the horned lark *Eremophila alpestris,* white and citrine wagtails, willow warbler, and rosefinch; and over 50% in the remaining species. On average, the nest success of birds at northern latitudes is 64.0% according to the traditional method and 52.6% according to Mayfield–Payevsky method.

Compared to the Subarctic, nest success at temperate latitudes of the Baltic region (the Curonian Spit) was significantly higher in the yellow wagtail and willow warbler (according to both methods), similar in the redwing, and lower in the bluethroat, chiffchaff *Ph. collybita,* and fieldfare (according to the traditional method). Chaffinches nested more successfully than northern bramblings (birds with a similar type of nesting), while nesting in thrush nightingales was less successful than in northern bluethroats. The average nest success estimated by the traditional and Mayfield–Payevsky methods is 58.9 and 54.2%, respectively.

Parameters of nest success in the Southern Urals and Kazakhstan vary in a wide range [10, 11], but in almost all cases they proved to be significantly lower than in Yamal. This obviously depends on the abundance and species diversity of predatory birds and mammals. However, the nest success of birds in the Curonian Spit was higher than that of the same species in Yamal. The Curonian Spit lies at almost the sale latitude as the Il'men Nature Reserve but has a more favorable (maritime) climate.

Likewise, no general latitudinal trend of nest success was revealed in the total area of Ob forest tundra and Yamal (Table 2). The nest success of some species was found to decrease northward: from the shrub tundra to the arctic tundra in in the horned lark and from the forest tundra to the shrub tundra in the red-throated pipit *Anthus cervinus,* bluethroat, willow warbler, and little bunting *Emberiza pusilla*. An inverse (positive) trend of increase in nest success from the forest tundra to the tundra was observed for the common redpoll *Acanthis flammea*, Lapland longspur *Calcarius lapponicus* (statistically significant), and common chiffchaff (not significant).

With respect to the type of settling at northern latitudes, the birds listed in Table 2 may be divided into two groups: subarctic species (the horned lark, red-throated pipit, common redpoll, and Lapland longspur) and widespread species (willow warbler, common chiffchaff, bluethroat, and little bunting). Each group includes species showing either positive or negative trend in nest success; i.e., their nest success in the north of the Subarctic may be higher or lower than in the south, irrespective of the type of settling.

According to Payevsky [3], nest success depends on both environmental factors (weather conditions, food resources, dates of breeding season, predation, parasitism) and intrapopulation factors (embryonic mortality, the age of parents and constancy of pairs, population density, polygamy, etc.). These factors are relevant at all latitudes, but their effect has certain specific features in each zone.

The nest success of birds in the Subarctic and Arctic is especially dependent on weather conditions. The weather deterioration in the tundra zone may suddenly deteriorate, which is manifested in cold spells with snow falling in summer, which causes embryonic mortality and makes females abandon their nests, especially those with incomplete clutches; in high winds, which blow the nests of redpolls off shrubs and tree branches in the forest tundra and shrub tundras; and in long rains that flood the clutches and broods all over the polar region. These are major factors of bird nest mortality in the Subarctic [6, 7, 15], but they act locally and only in some years. Rains caused the death of all chicks in 19 out of 1650 control nests (1.15%) in central and northern Yamal and in 5 out of 433 nests (1.15%) in the forest tundra. As a rule, females in the north firmly sit on the eggs and young chicks during rains, while fledglings often remain unprotected and get wet.

At temperate latitudes, an important cause of egg and chick mortality (up to 80% of their total loss) is predation by corvid birds, mustelids, squirrels, wildcats, etc. [3, 11]. In the Ob forest tundra, bird nests in the floodplain are ravaged mainly by hooded crows (*Corvus cornix*); in the vicinity of villages, by magpies (*Pica pica*); and also by voles (Arvicolinae), least weasel (*Mustella nivalis*), stoat (*M. erminea*). In the Yamal tundras, Arctic foxes (*Alopex lagopus*) are responsible for the destruction of most nests, especially in the years of their high abundance and population depression in rodents. In central Yamal, the losses of nests to these predators were especially high in 1974, 1986, 1989 [7, 14]. Losses to stoats, voles, and skuas (Stercorariidae) are lower but regular. Among a total of 3176 dead eggs and chicks recorded in the study, their pro-

Table 1. Nest success calculated by the traditional method (TM) and Mayfield–Payevsky method (M-PM) in the Subarctic and temperate latitudes

Species	The Subarctic		Temperate latitudes	Significance of differences *, *t*
	TM	M-PM	TM M-PM	TM M-PM
	Success, % Number of eggs/nests	Success, % Number of eggs/nests	Success, %	
Eremophila alpestris	63.35 ± 3.80 162/42	43.29 ± 1.61 220/85	–	–
Anthus pratensis	60.90 ± 6.10 64/12	59.63 ± 1.80 258/48	*73.7 ± 3.8*** *44.9 ± 2.0***	1.5 **5.4**
Anthus cervinus	67.75 ± 1.76 704/126	52.06 ± 0.79 1454/260	–	–
Motacilla flava	88.80 ± 5.26 36/6	35.30 ± 2.42 167/32	–	–
Motacilla citreola	54.5 ± 15.0 23/6	44.18 ± 6.41 60/23	–	–
Motacilla alba	73.70 ± 4.05 118/21	70.30 ± 2.22 218/39	91.3 ± 2.2** 88.4 ± 0.6**	**4.4** **2.89**
Phylloscopus trochilus	59.26 ± 2.05 572/184	47.90 ± 0.92 1011/184	80.7 ± 2.2** 61.9 ± 1.0**	**3.4** **6.36**
Phylloscopus collybita	58.04 ± 5.45 205/37	51.34 ± 1.45 397/67	42.9**** –	
Phylloscopus borealis	75.70 ± 3.22 177/30	69.09 ± 1.50 250/41	–	–
Oenanthe oenanthe	68.20 ± 5.87 63/11	61.82 ± 2.41 107/18	–	–
Luscinia svecica	58.44 ± 2.29 462/81	52.94 ± 0.80 1383/283	*27.4 ± 4.3**** *43.0 ± 1.6***	**4.9** **5.5**
Turdus pilaris	70.04 ± 3.18 462/81	63.81 ± 1.24 506/98	36.5 ± 9.5*** –	**3.35** –
Turdus iliacus	60.70 ± 4.52 117/22	51.00 ± 1.98 238/43	60.4**** –	–
Fringilla montifringilla	49.70 ± 3.87 167/33	34.24 ± 1.92 204/42	*55.3 ± 0.6*** *41.0 ± 0.2***	0.9 **3.7**
Acanthis flammea	68.20 ± 1.36 1164/244	66.69 ± 0.51 2590/508	– –	
Carpodacus erythrinus	57.77 ± 7.36 45/10	47.81 ± 3.33 57/13	60.6 ± 2.3** 36.6 ± 0.8**	0.3 1.0
Emberiza pusilla	68.0 ± 1.90 600/89	53.22 ± 0.79 1624/314	–	–
Calcarius lapponicus	61.30 ± 3.25 1634/327	53.3 ± 7.7 1975/370	–	–

* Boldface indicates significant differences ($p < 0.05$).
** The Curonian Spit [3]; values in italics refer to the tree pipit, thrush nightingale, chaffinch.
*** Kazakhstan [11].
**** The Southern Urals 10].

Table 2. Latitudinal variation in nest success over the space of Ob forest tundra and Yamal as estimated by the traditional method (above the line) and Mayfield–Payevsky method (below the line)

Species	Forest tundra (66.5° N)		Shrub tundras (69° N)		Arctic tundras (72° N)		Significance of differences*, t	
	number of eggs	$M \pm m$, %	number of eggs	$M \pm m$, %	number of eggs	$M \pm m$, %	forest tundra–tundra	tundra–arctic tundra
Eremophila alpestris	–	–	92	63.90 ± 4.58	69	46.60 ± 6.02		**2.21**
			220	53.23 ± 2.03	133	30.99 ± 2.49		**4.25**
Anthus cervinus	169	84.24 ± 2.80	521	63.14 ± 2.11	–	–	**6.01**	**4.77**
	363	77.11 ± 1.23	1011	46.39 ± 0.96	80	22.78 ± 3.12	**11.34**	
Philloscopus trochilus	266	56.0 ± 3.04	306	62.09 ± 2.77	–	–	1.48	
	579	51.56 ± 1.25	422	44.19 ± 1.35	–	–	**2.31**	
Ph. collybita	38	44.73 ± 8.07	167	61.07 ± 3.77	–	–	1.84	
	128	45.63 ± 2.82	264	53.57 ± 1.69	–	–	1.48	
Luscinia svecica	67	74.6 ± 5.32	377	54.11 ± 2.57	–	–	**3.47**	
	484	65.0 ± 1.32	881	47.54 ± 0.98	–	–	**6.36**	
Acanthis flammea	153	49.0 ± 4.04	1011	71.1 ± 1.43	–	–	**5.16**	
	323	52.74 ± 1.25	2231	68.65 ± 0.53	–	–	**5.40**	
Emberiza pusilla	375	64.26 ± 2.47	225	58.2 ± 0.91	–	–	**3.39**	
	1252	58.02 ± 0.91	432	42.01 ± 1.53	–	–	**5.78**	
Calcarius lapponicus	32	40.62 ± 8.68	1377	58.0 ± 9.20	225	61.33 ± 3.25	1.96	0.91
	52	31.33 ± 3.77	1457	53.7 ± 7.70	516	48.88 ± 1.38	**3.41**	1.91

* Boldface indicates significant differences ($p < 0.05$).

portion lost to predation is 20.7% in the forest tundra, 26.8% in the shrub tundra, and 36.3% in the arctic tundra.

Losses of eggs and chicks in the forest tundra are lower, which is partly explained by almost complete absence of Arctic foxes in this zone and the formation of nesting colonies of fieldfares in the floodplain. These birds usually succeed in defending their nests against magpies and crows (only one out of ten small colonies was ravaged). Redpolls regularly nested in fieldfare colonies, where the total loss of their nests was only 21.4%, compared to 46.2% destroyed by crows and magpies under conditions of solitary nesting [14]. The survival of nests of other species within fieldfare colonies is also higher, but not significantly.

Embryonic mortality in open-nesting birds is determined as the proportion of eggs with dead embryos (addled eggs) and infertile eggs. The proportion of infertile eggs in the forest tundra and tundras was no higher than at temperate latitudes: 1009 out of 12624 eggs, or 7.99%, compared to 5.0–22.9% (on average, 12.7%) in the Curonian Spit [3]. The proportion of addled and infertile eggs was minimum in the horned lark (1 out of 153 eggs laid, 0.6%) and maximum in the redpoll (274 out of 2590 eggs, 10.58%). Nests with a single infertile egg were prevalent, but there were complete clutches consisting of addled or infertile eggs. In the Lapland longspur from central Yamal, a tendency was observed toward increase in the proportion of nests with infertile eggs in young birds, compared to older birds: 45%, $n = 42$ vs. 24%, $n = 21$ [7]. In some years, low temperatures in the period of egg laying contribute to embryonic mortality, particularly in species that start brooding in the middle or at the end of egg laying.

Finally, it should be noted that population abundance depends on the ratio or fecundity and mortality, with nesting density as a reflection of abundance usually remaining relatively constant. The areas of nesting ranges of bird species also remain unchanged in the foreseeable periods of time. Therefore, the annual recruitment of young of the year in individual parts of species populations (micropopulations) should not be significantly higher or lower than the proportion of dead birds. Since the number of clutches per season decreases northward, this should be accompanies by increase in nest success in order to maintain population size. Such an increase is observed in the direction from the Southern Urals and Kazakhstan to Yamal but not from the Baltic Sea to Yamal. In the total forest tundra–subarctic tundra space, nest success increases to the north in one group of species (the common redpoll, Lapland longspur, and common chiffchaff) but decreases in another group (the horned lark, red-throated pipit, bluethroat, and willow warbler). Factors of mortality such as climate and predation in the Subarctic are unstable and hardly predictable, while the level of embryonic mortality is low and stable.

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COMPLIANCE WITH ETHICAL STANDARDS

Statement on the welfare of animals. All applicable international, national, and/or institutional guidelines for the care and use of animals were followed.

Conflict of interest. The authors declare that they have no conflict of interest.

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