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Breeding Biology of the Eurasian Dotterel (*Eudromias morinellus*) on the Putorana Plateau, Central Siberia

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Abstract—Data on the biology and ecology of the Eurasian dotterel *Eudromias morinellus* from the largest mountain range of the Russian Arctic are presented. The data were obtained in the years 1988–2018. It has been established that, during the breeding season, the species covers a wide range of altitudes, settles on flat tops almost everywhere within the alpine belt, locally occurs in some parts of the subalpine belt, and is extremely rarely recorded in the mountain–taiga belt. Its range has a clearly defined three-dimensional character. Its optimal habitats in the alpine belt are confined to dry stony areas of the mountain tundra, which have a hummocky microrelief and are covered with sparse herbaceous vegetation. The abundance of the species during the breeding season varies from 0.4 to 10.0 (mean 1.7) individuals/km^2 in optimal habitats within the alpine belt, gradually decreasing to both the tops (1.3 ind./km^2) and foothills of slopes (3.5 ind./km^2). Thus, 70% of all Eurasian dotterel individuals are concentrated in the central part of the alpine belt (which covers 42% of the vertical living space of this species) during the breeding period. Until the middle of the third ten-day of June, females actively lek in flight and on the ground both singly and in groups of up to 15 individuals. Egg laying begins on June 7–22, when the snow cover is often almost complete. Nests are at altitudes of 850–1036 (mean 935 ± 28) m a.s.l. (n = 8). The local nesting density, determined from the average minimum distance between neighboring nests, can be 1.67 nests/km^2. The earliest estimated date of the appearance of chicks is July 3 and the latest date is July 18 (the average date is July 9 ± 1 day) (n = 13). Chicks of the same brood hatch within one day.

Keywords: Eurasian dotterel, Putorana Plateau, alpine high-altitude belt, mountain tundra, distribution, abundance, breeding season, mating behavior

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INTRODUCTION

The Eurasian dotterel (*Eudromias morinellus* Linnaeus, 1758) has an arctalpine distribution throughout the northern Palearctic (Stepanyan, 2003; Lappo et al., 2012; Ryabitsev, 2014). The features of the distribution and ecology of this sandpiper in a significant part of its range make it possible to classify it as a typical mountain species. Until the 1980s, it was rightly recognized as a poorly studied species (Rogacheva, 1988). Many aspects of its biology in a significant part of its range are still poorly studied. Information about the distribution of the Eurasian dotterel in the Russian Federation, including the Putorana Plateau (where one of the supposed optima of the breeding range is located), is also insufficient (Lappo et al., 2012). At the same time, a decrease in the abundance and range of the species is stated (Tomkovich, 2007); apparently, this results mostly from the death of birds on wintering grounds in North Africa, where pesticides against locusts are used (Hable and Präsent, 1990; Saari, 1995).

The main purpose of this research is to summarize and analyze data on the ecology and biology of the Eurasian dotterel on the Putorana Plateau for monitoring and developing measures to conserve the species. Accordingly, three main tasks were solved: (1) to reveal the patterns of the spatial distribution and indicators of abundance of the species during its breeding season; (2) to reveal the main elements of the behavior of the species, parameters of nest structure, and size of clutches and eggs; (3) to determine the calendar dates of the main phenological phenomena during the breeding season.

MATERIALS AND METHODS

Materials on the biology and ecology of the Eurasian dotterel were collected in the years 1988–2018 on the Putorana Plateau (the extreme northwestern tip

Table 1. Length of routes (km) and the abundance of the Eurasian dotterel (ind./km^2) and its proportion (%) in the total bird community during the breeding season at different sites on the Putorana Plateau

No.	Species registration sites	Alpine belt		Subalpine belt	
		abundance/ route length	proportion	abundance/ route length	proportion
	North of the plateau				
1	Bokovoe Lake (70°10′ N, 94°15′ E)	3.7/25	3.2	–	–
2	Ayan River (69°00′–69°20′ N, 93°30′–94°30′ E)	10.0/86	22.4	–	–
3	Bogatyr and Neralakh lakes (69°35′–69°43′ N, 92°10′–92°35′ E)	0.5/227	0.7	–	–
4	Negu-Iken Lake (69°35′–69°47′ N, 93°05′–93°15′ E)	0.5/141	0.5	–	–
5	Bogatyr-Khuolu Lake (69°42′–69°49′ N, 92°30′–92°45′ E)	6.0/289	2.5	–	–
	Center of the plateau				
6	Ayan Lake (69°00′–69°20′ N, 93°30′–94°30′ E)	1.0/104	4.3	0.6/68	1.3
	West of the plateau				
7	Kutaramakan Lake (68°35′–68°50′ N, 91°30′–92°30′ E)	0.6/60	2.0	8.0/11	9.9
8	Gusinye lakes in the Kureiki River basin (68°22′ N, 93°30′ E)	0.4/113	1.1	0.2/41	0.05
9	Kachuk Lake (69°00′ N, 94°30′ E)*	–	–	–	–
10	Norilsk Lakes (68°41′–68°49′ N, 89°36′–90°26′ E)**	–	–	–	–
	East of the plateau				
11	Kharpicha Lake (68°46′ N, 96°57′ E)	0.7/21	1.9	1.5/17	2.1
12	Dyupkun Kotuiskii Lake (68°00′ N, 98°30′ E)	1.2/21	3.4	–	–
13	Nerangda Lake (69°00′ N, 98°00′ E)***	–	–	–	–
	South of the plateau				
14	Nyakshingda Lake (67°00′ N, 93°30′ E)	1.0/30	2.2	–	–

The bird abundance at each site was calculated based on censuses with the indicated length. Dash, no data. The species was recorded (without determination of its abundance) by * Morozov (1984), ** Krechmar (1966), and *** Zyryanov (1988).

of the Central Siberian Plateau and, at the same time, the middle part of the breeding range of the species). The study area is between 65°00′–71°00′ N and 90°00′–100°00′ E. The area of the study site was about 250000 km^2. The data presented in this paper were based on stationary observations and walking routes, which were conducted from May to August in the above-mentioned seasons and covered the northern, southern, central, western, and eastern areas of the Putorana Plateau (see Table 1). The same geographical area in the Putorana Plateau can have different names on different maps. For example, Neralakh Lake is referred to as Neralak and Negu-Iken Lake as Negu-Ikon in a number of mapping sources. In our research, the names of the rivers and lakes studied correspond to those on a medium-scale topographic map at a scale of 1 : 200000.

The abundance of the species was analyzed using the results of route censuses performed according to the method of Ravkin (1967) at altitudes up to 1412 m a.s.l.; the length of the routes is given in Table 1. The height of the terrain and distance covered were determined by GPS navigators. The total length of the routes was 6921 km: 4063 km in the forest landscapes of the mountain–taiga belt, 238 km in the mountain sparse forests of the subalpine belt, and 1204 km in the mountain tundra areas of the alpine belt. Birds on the routes were recorded visually and by voice. All the indicators of abundance given in this paper were recorded in census areas during the breeding season, including the stages of mating demonstrations, clutch brooding, and raising of chicks at the age of not more than 7–10 days. No differences in the level of occurrence were revealed between the stages of the breeding cycle; therefore, all data were summarized and averaged.

Eurasian dotterel nests were discovered by observing anxious individuals, as well as randomly during bird frightening on the routes. Individuals that were persistently anxious from the second half of July were considered birds that accompanied hidden chicks.

The degree of egg brooding and date of appearance of the first egg in clutches with unknown dates of the formation were determined by the flotation method (according to Liebezeit et al., 2007 for sandpipers), which is generally accepted in studying the biology of bird reproduction (Westerkov, 1950; Rahn, 1974).

PHYSICAL AND GEOGRAPHICAL CHARACTERISTICS OF THE STUDY AREA

The Putorana Plateau is the largest mountain range in the Russian Arctic. The vertical differentiation of vegetation distinguishes altitude landscape belts (mountain north-taiga (forest) belt, subalpine (mountain forest-tundra) belt, and alpine (mountain-tundra) belt (Norin, 1986)). The distribution of the Eurasian dotterel on the Putorana Plateau is almost exclusively ecologically confined to the alpine belt. The physical and geographical description of this belt is given in a number of monographs (Parmuzin, 1964, 1976; Gvozdetskii and Golubchikov, 1987; Golubchikov, 1996; Kuvaev, 2006); therefore, we will only briefly characterize the main habitats of the species below.

The alpine belt lies at altitudes of more than 500–800 m a.s.l. and is characterized by an alternation of areas covered with mountain tundra, which is almost completely free of vegetation (Kuvaev, 2006). The relief is formed by steeply sloping plateau massifs rising above the surrounding space, as well as by heavily destroyed mountain ranges with smoothed dome-shaped tops and gentle terraced slopes and by table mountain plateaus with flat tops with an average elevation of 900–1200 m a.s.l. The current appearance of the low-mountain landscapes surrounding the tops was formed under the influence of Late Pleistocene glaciation.

The mountain tops of the plateau are characterized by extreme climate conditions (Golubchikov, 1996). It regularly snows there even in summer, and a stable cover up to 15–20 cm deep can be formed there for several days even in July. In years with cold summers (when the air temperature does not exceed +5°C), thick ice remains almost unchanged on the lakes all summer (Parmuzin, 1976); only narrow (2–15 m wide) glades are formed along the shores. Moss–lichen–sedge tundra, moss–lichen–dwarf-shrub tundra, and moss–sedge–forb tundra are widespread everywhere. The projective vegetation cover is 25–100% in different parts of the alpine belt.

RESULTS AND DISCUSSION

Distribution of the Species within the Region

Our observations and observations of other researchers show that the Eurasian dotterel is widespread almost everywhere on the Putorana Plateau and has been recorded in most of the sites studied: in 11 of the 15 sites according to our data (Romanov, 1996, 2006a, 2013, 2015; Romanov et al., 2007, 2018, 2019) and 14 of the 18 sites according to the generalized data obtained by us and other researchers (Krechmar, 1966; Morozov, 1984; Zyryanov, 1988). The Eurasian dotterel was not recorded only in the valley of the Mikchangda River and in the depressions of Sobachye, Keta, and Agata Verkhnyaya lakes (Romanov, 2006, 2013; Rupasov and Zhuravlev, 2006). The species steadily breeds in the northern, western, and eastern parts of the plateau. Nesting in its central and southern parts is also beyond doubt; however, this has not been confirmed by facts.

Altitude–Landscape Distribution

The Eurasian dotterel is a typical inhabitant of the mountain tundra landscapes of plateau tops; it is an integral element of the avifauna of the alpine belt and is one of the species forming its core. During the breeding season, it is recorded mostly in the alpine belt at altitudes of 750–1245 m a.s.l. (generally 890–1070 m a.s.l.). The species prefers slightly sloped areas, which have a hummocky microrelief and are covered with sparse herbaceous vegetation. Its optimal habitats are dry stony moss–lichen tundra with different proportions of mountain avens (*Dryas* sp.), cassiope (*Cassiope* sp.), and sedge (*Carex* sp.), abundant stony and crushed stony placers, and frost scars. It tends to stay on the tops of large stony mounds, the surfaces of which are devoid of any vegetation, except lichen groups. It avoids steep mountain slopes, rocks, and rock debris.

The Eurasian dotterel is much less common in the subalpine belt; along with some other species (ptarmigan (*Lagopus muta*), golden plover (*Pluvialis apricaria*), red-throated pipit (*Anthus cervinus*), buff-bellied pipit (*A. rubescens*), and common wheatear (*Oenanthe oenanthe*)), which are ecologically closely confined to alpine landscapes. It can penetrate into these areas if there are sufficiently large areas of dwarfish mountain-tundra vegetation. In such habitats of the subalpine belt, the Eurasian dotterel occurs near Ayan, Kutaramakan, Dyupkun Kureiskii, and Kharpicha lakes. The Eurasian dotterel can descend below the upper boundary of the subalpine belt along the areas of stony mountain tundra zones with patches of permafrost landforms between thickets of dwarf birch (*Betula fruticosa*), alder (*Duschekia fruticosa*), and willows (*Salix glauca* and *S. lanata*) with patches of permafrost landforms; this boundary is at an average altitude of 500 m a.s.l. in the north of the plateau, 800 m a.s.l. in the south, and 750 m a.s.l. in the west and in the center. The Eurasian dotterel and ptarmigan stay strictly in mountain–tundra areas within the subalpine belt. The rest of the above-mentioned species do not show a clear biotopic selectivity and also occur in open larch (*Larix gmelinii*) areas and alder groups and on edges of mountain larch sparse forests.

In the mountain–taiga belt, the Eurasian dotterel literally has a spotted distribution (Krechmar, 1966). The main limiting factors preventing a wider distribution of the species in this belt are the negligibly small area of habitats suitable for nesting and the absence of ecological "channels of penetration," rather than the altitude. However, some birds tend to settle in local isolated centers and successfully nest in areas where suitable biotopes are formed (at altitudes of 100–120 m a.s.l.) (Krechmar, 1966). There are cases of nesting in tundra-like landscapes along the shores of Norilsk lakes within the mountain-taiga zone (Krechmar, 1966). The formation of suitable nesting habitats within northern taiga landscapes, which are ecologically alien to the species, is determined by the temperature and, accordingly, landscape inversion. Under the cooling effect of large lakes with a "polar" hydrological regime, the water has a significantly lower temperature than the air throughout the growing season and has a very strong cooling effect in combination with constant winds on the vegetation of near-shore areas (lakelands) at a distance of up to 1–1.5 km (Vodop'yanova, 1976). Open tundra-like stony landscapes are widespread in lakelands. There are few such places on the Putorana Plateau; however, single Eurasian dotterel pairs probably regularly nest there.

On the whole, the Eurasian dotterel covers a wide range of altitudes on the Putorana Plateau during the breeding season; here, it settles on flat tops of the alpine mountain belt almost everywhere, locally occupies some parts of the subalpine belt, and occurs extremely rarely on the foothills of slopes within the mountain taiga belt during this period. The range of this species, living in all three altitudinal zones, has a clearly defined three-dimensional character. Our data indicate that the altitudinal distribution of the species within the altitude-belt spectrum is determined not so much by the altitude of the area as by the ecological parameters of preferred habitats and by the boundaries of the distribution of the most optimal of these habitats.

Differentiation of the Abundance within the Alpine Belt

Significant differences in the indices of abundance were revealed between different sites studied in different years (Table 1). These differences may be determined both by the interannual dynamics of the abundance (Lappo et al., 2012) and by the ecological features of habitats.

Among the 11 sites of the Putorana Plateau where we recorded the Eurasian dotterel in the years 1988–2018, it was abundant only in one site (the Ayan River), where it was one of the dominant species in the bird community, reaching 22.4% of the total bird abundance, common in five sites, and rare in five sites. In eight sites, it was among the subdominant species (1.1–4.3%). According to census data, the average abundance of the species was 1.7 ind./km^2 throughout the alpine belt and 0.8 ind./km^2 in the subalpine belt. In the alpine belt, the abundance of the Eurasian dotterel varied from 0.4 to 10.0 ind./km^2 during the breeding season, reaching maximum values in the northern parts of the region. Local areas of increased population density of the species were recorded on the tops of the plateau in the middle reaches of the Ayan River in 1989 (10.0 ind./km^2) and in the depression of Bogatyr-Khuolu Lake in 2018 (6.0 ind./km^2). In the subalpine belt, the indices of abundance varied from 0.2 to 8.0 ind./km^2; the highest density (8.0 ind./km^2) was recorded in 1990 on the tops of the plateau at the southwestern tip of Kutaramakan Lake.

A vertical differentiation of indices of the abundance of the Eurasian dotterel was revealed in the northwestern part of the plateau in the depression of Bogatyr-Khuolu Lake within the lower (730–950 m a.s.l.), middle (950–1100 m a.s.l.), and upper (1100–1412 m a.s.l.) parts of the alpine belt; the differentiation is predetermined by differences in the floristic composition, structure and height of the vegetation cover, indicators of projective cover, latitude of distribution of open rocky surfaces, and moisture (Romanov et al., 2019).

The lower part of the belt, where the abundance of the Eurasian dotterel was 3.5 ind./km^2, is represented by wet, small-hummocky moss–willow–sedge mountain tundra with mountain avens. Soddy forb-meadow tundra ecosystems with an abundance of mountain avens, Arctic sweetvetch (*Hedysarum arcticum*), oxytrope (*Oxytropis* sp.), knotweed (*Polygonus* sp.), and Arctic rose (*Novosieversia glacialis*) with a projective cover up to 100% are widespread in the river floodplains and on the gentle slopes of lake depressions. The herb abundance makes the soddy tundra similar to meadow cenoses (Pavlov et al., 1988).

In the middle part, the abundance of the Eurasian dotterel is 11.5 individuals/km^2. The projective cover does not exceed 60% here; moss–lichen, moss–sedge, and forb–sedge tundra ecosystems with Arctic willow (*Salix arctica*), dwarf birch (*Betula nana*), and western blueberry (*Vaccinium uliginosum*) prevail there everywhere. The dry gentle slopes of the lake depressions are rich in frost scars and covered with lichens, cassiope (*Cassiope tetragona*), and mountain avens. Sandy-pebble hills mosaically overgrown with clumps of lichens, mountain avens, grasses, and Alpine forget-me-not (*Eritrichinum* sp.) are widespread here. Hills alternate with vast flat, waterlogged valleys of rivers and streams, in which the soddy, small-hummocky surface is occupied by a dense vegetation cover of mosses, lichens, mountain avens, cassiope, grasses, sedges, and dwarf willows. Snow patches, stony placers (corroms), and boulder accumulations are widespread everywhere.

The upper part of the alpine belt, where the abundance of the Eurasian dotterel was 1.3 ind./km^2, is characterized by extremely low values of the projective cover (up to 40% only in some places). Terraced and steep slopes are occupied by almost lifeless cold alpine deserts (Kuvaev, 2006) with mosaic alternation of numerous mountain scarps, residual rocks, extensive snowfields, patches of frozen heaved ground, and stony placers interspersed with small patches of mosses, lichens, sedges, mountain avens, and Arctic rose.

Quantitative censuses of birds in the depression of Bogatyr-Khuolu Lake that were purposefully carried out at different altitudes showed that, against the background of the decrease in the total density of the bird community from the foothills to the tops, the abundance of the Eurasian dotterel is maximal in the middle part of the alpine belt and gradually decreases towards both the tops and the foothills of the slopes (Romanov et al., 2019). In the middle part of the alpine belt, which makes up 42% of the vertical living space, 70% of all individuals of the species are concentrated during the breeding season. Its abundance decreases much more intensively with an increase in altitude under conditions of a decrease in heat supply, a decrease in the duration of the snowless period, and fragmentation of the vegetation cover.

Similar patterns of vertical differentiation in the abundance of the Eurasian dotterel were established during analysis of the corresponding indicators in the depressions of all alpine lakes studied in 2010, 2013, and 2018: Bogatyr (970 m a.s.l.), Neralakh (920 m a.s.l.), Bogatyr-Khuolu (854 m a.s.l.), and Negu-Iken (760 m a.s.l.). Here, the abundance of the Eurasian dotterel proved to be maximal (6.0 ind./km^2) in the depression of Bogatyr-Khuolu Lake (at medium heights with respect to the other lakes), and its reduction can be traced both towards the upstream Bogatyr Lake (0.5 ind./km^2) and towards the downstream Negu-Iken Lake (0.5 ind./km^2).

Mapping of the discovered nests ($n = 5$) and broods with recently hatched chicks ($n = 3$) in the depression of Bogatyr-Khuolu Lake in 2018 showed a lower abundance value than that according to the results of route censuses. The sites of these finds proved to be confined to the mountain tundra area of 4 km^2 (see Fig. 1). In the case of the total discovery of nests (which is unattainable in practice) and at an equal sex ratio, this corresponds to an abundance of 4.0 ind./km^2 (according to the data of route censuses, 6.0 ind./km^2). The differences in the results based on different methods can be explained either by an imbalance in the sex ratio (according to visual observations, there were really many single females) or by the fact that we found too few nests (no more than one-third of their real number). The second assumption is hardly possible, since we studied the control area for quite a long time and the revealed nests were distributed quite evenly. This allows us to hope that we missed no more than one or two nests. If it is true, the nesting density should be 2–2.5 conventional pairs (nests)/km^2 in this "center" (Romanov et al., 2018). Calculation of the nest density from the average minimum distance between the adjacent nests gives an even lower value. The average distance between the nearest nests and places where broods were found ($n = 14$) was 774 ± 78 (SE) m (from 369 to 1167). If all nests were evenly distributed over the territory at this distance from one another, the density would be 1.67 nests/km^2.

At the same time, a clearly uneven distribution of birds over the territory was also revealed in the depression of Bogatyr-Khuolu Lake. Thus, we found an area of about 1.5 × 2 km with an increased concentration of birds at the foot of high table mountains at the border of the lower and middle parts of the alpine belt, on gentle slopes with altitudes from 870 to 970 m a.s.l. We encountered lekking females much more often at this site than in other places both in the air and on the ground. They gathered in groups up to 15 individuals, moved around this area, and arranged peculiar "wandering leks" like ruff (*Philomachus pugnax*) males (see Ryabitsev et al., 2003; Ryabitsev, 2014). All nests and broods that were found in that season were near this "center of female activity." We assume that these "centers" in the northwestern part of the Putorana Plateau may be several dozens of kilometers from each other.

The Eurasian dotterel is one of the 17 bird species that, despite the extreme environmental conditions in the upper part of the alpine belt, spend their nesting season on almost lifeless tops of the plateau with conditions similar to those in the zonal arctic tundra or polar deserts (Romanov, 2013; Romanov et al., 2019). Most likely, the extremely short (due to much later snow melting than snow melting periods in lower altitudes) nesting terms on plateau tops cannot be considered insurmountable barriers for the habitation of the Eurasian dotterel.

Mating Behavior

In 1989, the most active mating demonstrations in the valley of the Ayan River were recorded on June 20 and very clearly coincided with the completion of the mass passage of wild reindeer (*Rangifer tarandus*) along the plateau tops. Mating demonstrations became significantly weaker by June 25 and ceased by July 3.

More detailed information about the mating behavior of dotterels was obtained in 2018, when all the observations described below in this section were carried out. From the date of our arrival in the depression of Bogatyr-Khuolu Lake (June 18), we observed lekking flights of females (up to two–three individuals were simultaneously in the field of view). They flew separately at a height of 30–50 m in different directions in wide (1–2 km in radius) circles or in an almost straight line, hiding behind the horizon. We recorded them single on the ground; sometimes, two birds pursued each other with "buzzing." Thus, a single female was observed resting and feeding on June 18; when it saw another bird (sex not determined), it began to pursue it in flight.

It is known that Eurasian dotterel individuals form mating pairs during the breeding season, often being still in flight (Cramp and Simmons, 1983; Kålås and Byrkjedal, 1984; Pulliainen and Saari, 1996); how-

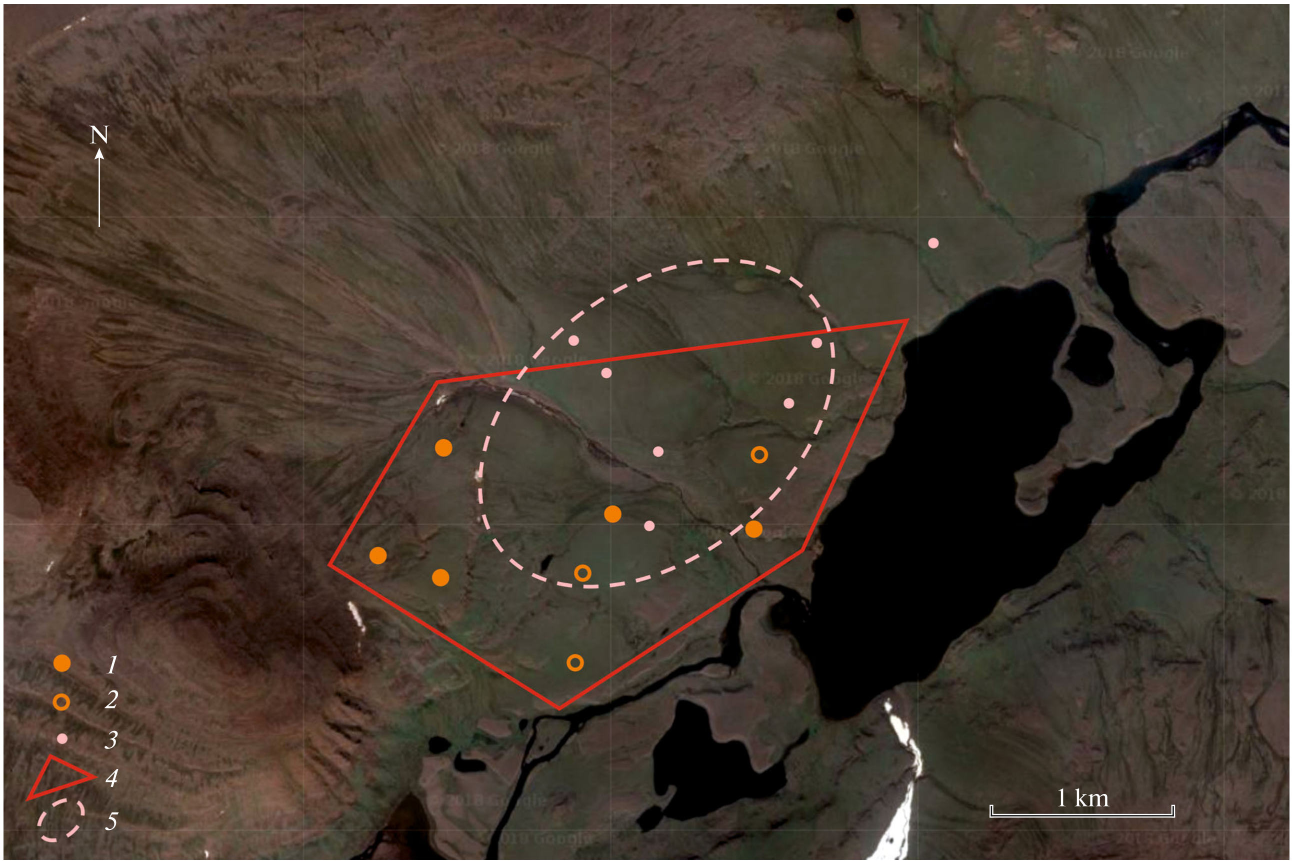

Fig. 1. Scheme of distribution of (*1*) nests, (*2*) broods, and (*3*) flocks of single females in 2018 in the depression of Bogatyr-Khu-olu Lake; (*4*) control site (4 km^2); (*5*) site with the highest lekking activity of females.

ever, we observed almost no pairs. The average estimated period of egg laying in that year was June 10–12. Apparently, a week after the completion of laying, most of the females had already left their males by the time we started our work and there were no longer any pairs.

Active lekking of females in flight continued approximately until the middle of the third ten-day period of June. Groups of lekking birds were also encountered on the ground. Thus, a group of 15 females was found on June 20. They gathered on the slope of the riverine terrace, where they noisily (with "buzzing") ran on the ground, demonstrated threat postures, and periodically attacked each other, with their head lowering down, back raised in a hump, tail fanned, and feathers let out, similarly to the behavior of fighting ring dotterel (*Charadrius hiaticula*) males (see Cramp and Simmons, 1983). We witnessed a female pressing its rival to the ground and pecking it in the back, not letting it go for a long time (from half a minute). From time to time, more or fewer birds flew up and away from the flock; however, they soon returned back. We failed to discern clearly any males in the flock, although it is quite possible that there was a male in the flock (possibly, even in a pair with a female), and it was this male to which single females (or females that left males after they began to incubate egg clutches) flew down, as done, for example, by single river duck males (genus *Anas*), when they pursue mating pairs (see, e.g., Koblik, 2001). The next day, we did not find any lekking females here; apparently, they lekked somewhere else. This behavior of birds was similar to the "wandering lekking" of ruff or black grouse (*Lyrurus tetrix*) males (see Ryabitsev, 2014). Apparently, the joint lekking of Eurasian dotterel females on the ground is not common; we did not find any description of this phenomenon in the literature.

The second time, a group of five lekking birds was encountered on June 24, 1 km from the first place. Their behavior was the same: they ran noisily on the ground, demonstrated threat postures, and periodically attacked each other. Soon, three birds flew away and the other two (probably a male and a female, although it was impossible to discern them clearly by their appearance from a distance of 30 m even by photographs) continued to walk together for a long time, making low thin trills (obviously addressed to each other), and feed. In addition, one of them (a female), kept lekking and the second (obviously, a male) periodically perched, demonstrating nesting pits. This was the only episode when two birds (presumably, a mating pair) were observed together. By the time of our arrival in the study area, most of the males had been incubating clutches for more than a week, and the absence of pairs against the background of fairly frequent encounters of lekking females confirms the data that Eurasian dotterel individuals usually form pairs for a very short time (only a few days) until the clutch completion (Nethersole-Thompson, 1973; Cramp and Simmons, 1983). In turn, judging by the time, the encounter of the assumed pair described above can be explained by the manifestation of consecutive polyandry. It is known that a female can lay a clutch to a second male as early as five days after the completion of the first clutch (Cramp and Simmons, 1983; Pulliainen and Saari, 1992).

Subsequently, we encountered groups of three to nine females that no longer showed mutual aggression five more times (until July 8). They fed together, lekked, flew away together after being frightened, and "buzzed" when they flew up. Soon they also stopped lekking. Sounds of lekking on the ground (monotonously repeated short whistles) were heard the last time on July 1 from a group of three females. We continued to register regular lekking in flight (one to two times a day) until July 10; it completely ceased by July 14. In the mountains of Norway, females actively lek for about a month (Kålås and Byrkjedal, 1984), while their lekking period is significantly lower on the Putorana Plateau, according to our observations.

We recorded most of the encounters of females in an area of 1.5 × 2 km (see Fig. 1) located at the foot of the mountains on gently sloping terraces descending to the river bed, 0.5–1.5 km from the river, at altitudes of 870–970 (mean 905 ± 15) m a.s.l. (SE), $n = 7$. At a distance of 4–12 km from this "center," the number of encounters of the Eurasian dotterel decreased by 5–10 times. Near this "center," we found five nests and three broods with recently hatched (3–5 days ago) chicks in the control site of 4 km^2; i.e., the number of these chicks is probably half of the offspring in this local group (judging by the number of lekking females at an equal sex ratio). Like many bird species that are characterized by joint lekking (capercaillies (genus *Tetrao*), black grouse, etc.), the Eurasian dotterel probably sought to build nests in lek locations or not far from them. For instance, it is known that ruff females build nests at a distance of no more than 400 m from the lekking ground (Hayman et al., 1986). In addition, it is evident that the local group was largely formed in this place as a result of the first thawed patches on the south-facing slopes of the lake depression (see Fig. 1). This is consistent with the data that pairs are usually formed from a flock of five to eight individuals of each sex, which gathers on a flat surface, often near a water stream (Cramp and Simmons, 1983). Apparently, a migrating flock of birds settled in this area, which was cleared from snow earlier than other sites. At the same time, in other years, Eurasian dotterel individuals appeared in spring on the Putorana Plateau mainly in pairs and only occasionally in groups of six to nine individuals (see below).

Reproductive Phenology

In the alpine belt of the Ayan River valley, a nest with one fresh egg was found on June 20, 1989, when the mountain tundra was still 50% covered with snow. In the same year, birds protecting nests with young individuals were often seen on August 4 in the valley of the Nerakachi River near Bokovoe Lake (35 km north of the Ayan River) on the border of the alpine and subalpine belts; by this time, they had reached 1/3 of the size of an adult individual. The length of the beak, wing, and tarsometatarsus of one of them was 13, 60, and 32 mm, respectively; the coverts of its shoulder and back were 3/4 of their length; all flight feathers and upper wing coverts were represented by brushes and only stumps were visible in place of the lower wing coverts and head outlines.

On June 21, 1990, a nest with three nonincubated eggs was found in the mountain tundra at the southwestern tip of Kutaramakan Lake, which was still almost completely covered with snow. Near the middle part of this lake, an adult bird was observed accompanying a nonflying young female on August 5. The latter was almost completely feathered; it had reached the size of an adult individual with incompletely formed wing and tail feathers (10–20 mm long) and beak, wing, and tarsometatarsus lengths of 9, 113, and 40 mm, respectively.

On June 28 and July 1, 2006, two nests were found in the alpine belt near Gusinye Lakes; each of them contained a full clutch of three weakly incubated eggs. The estimated dates of onset of these clutches are June 21 and 22.

On June 18, 2007, a nest with three nonincubated eggs was found in the lower part of the alpine belt at the eastern tip of Kharpicha Lake.

Anxious individuals were periodically recorded near nests or broods in the depressions of Bogatyr and Neralakh lakes from July 6 to August 5, 2010, and in the depression of Negu Iken Lake from June 25 to July 26, 2013. Males accompanying chicks were recorded on July 9 and 14, 2010.

In the depression of Bogatyr-Khuolu Lake, five nests with full clutches of three eggs were found in 2018. Chicks appeared almost simultaneously in these clutches: on July 7 in two nests, on July 8 in two other nests, and on July 11 in another nest. The timing of nesting onset was determined by the reconstructed dates of the onset of clutch incubation. According to the data on the dynamics of variation in the specific weight of eggs (determined by the flotation method), the average period of incubation of one egg was about 24 days; in different nests, its duration differed by 1–2 days. The incubation period was longer in Scotland and Finnish Lapland (about 26 days) (Nethersole-Thompson, 1973; Pulliainen and Saari, 1992). On the chick hatching dates known to us (July 7–8), we encountered three more broods with 3- to 5-day-old chicks (without an egg tooth); each brood contained three chicks. Taking into account the data on these broods, the estimated average date of laying of the first egg in the nests (n = 8) was June 10 ± 1 day (SE) in 2018; the earliest date was June 7 and latest date was June 15.

When we arrived in the depression of Bogatyr-Khuolu Lake on June 18, 2018, the snow had almost completely melted in the river valley and lake depression (there were only snow patches in the mountains). At the same time, according to our observations in the vicinity of the city of Norilsk from June 14 to 17, the spring was cold and very long in that year and snow probably began to melt in the mountains no earlier than June 10. According to our calculations, Eurasian dotterel nests in the study area contained eggs as early as those days. This indicates that they began to nest on the first thawed patches with almost continuous snow cover. In the mountains of northern Scandinavia, the nesting period of the species is longer and falls on phenologically later dates. Thus, in Norway, dotterels arrived in mid-May, occupied nesting sites in late May–early June, when snow covered 75% of the surface, and began to lay eggs after a few days. At the same time, females continued to lek until the second week of July and the egg laying season lasted up to one month (Kålås and Byrkjedal, 1984).

According to the observations of four nests in 2018, the process of chick hatching in each of them lasted less than a day. In northern Europe, this process lasted from 12 hours (Pulliainen and Saari, 1992) or less (Nethersole-Thompson, 1973) to 24 hours (Kålås and Byrkjedal, 1984). In the depression of Bogatyr-Khuolu Lake, video surveillance of one of the nests showed that the period between the appearance of the first and third chicks was 16 hours and the whole family then continued to stay in the nest for 1.5 more days. The male sometimes left the chicks for feeding; however, this lasted no longer than one minute. While it was warming the younger chick, the two older ones also periodically left the nest, walked in its vicinity, pecked at something from the surface of the soil and plants, and then returned back to the nest under the belly of the male.

Thus, according to the generalized data (n = 13) for the years 1988–2018, dotterels began to lay eggs from June 7 to June 22 (on average, June 13 ± 2 days) (SE); the median was June 12. On the days when the first eggs appeared in Eurasian dotterel nests, the mountain tundra was often still completely covered with snow. The earliest estimated date of chick hatching was July 3, and the latest date was July 18 (on average, July 9 ± 1 day (SE)); the median was July 8.

Nest Structure and Size of Clutches and Eggs

Each of all complete clutches of the Eurasian dotterel that were known to us (n = 9) contained three eggs.

The nest that was found in the valley of the Ayan River was in an inconspicuous depression with a diameter of 9 cm and a depth of 5 cm in a tussock of moss, sedge, and mountain avens among frost scars.

The nest discovered near Kutaramakan Lake was a shapeless depression in the ground with a diameter of 13 cm and a depth of 1 cm and located on a melted clayey-stony hillock with a size of 10 × 15 m, covered with mosses, lichens, mountain avens, a creeping dwarf birch thicket, a dwarf willow thicket, and ledum (*Ledum palustre*). The egg size was 29.2 × 41.3, 29.8 × 42.5, and 29.0 × 42.5 mm; their weight was 18.0, 19.15, and 18.1 g, respectively.

In the mountain tundra near Gusinye Lakes, two inspected nests were at altitudes of 875 and 890 m a.s.l. They were on flat surfaces of terraces covered with mountain avens, lichen, moss, cassiope, and sedge. No less than 30% of the area of these habitats was occupied by stony placers and frost scars. Nests looked like pits in a flattened plant patch; their outer diameters were 12 and 14 cm and tray depths were 4 cm and 4.5 mm. The egg size (n = 6) was 39.2–43.8 × 28.9–30.1 (mean 41.3 × 29.4) mm.

The nest that was found near Kharpicha Lake was in the mountain tundra of the lower part of the alpine belt (850 m a.s.l.), 150 m from an impetuous stream and 15 m from solitary suppressed larches 0.5–0.8 m high. It represented a depression on the surface of a wet moss–grass–mountain-avens tussock, located among stony placers, and was lined with dry leaves of willow and bearberry (*Arctous alpina*). The outer nest diameter was 12 cm, and the depth was 6 cm. The egg size was 29.1 × 43.0, 30.2 × 42.8, and 29.3 × 44.1 mm.

In the depression of Bogatyr-Khuolu Lake, the nests discovered (n = 5) were distributed on glacial moraines and gentle terraces with an inclination angle of up to 10° (according to visual estimates) and among stones and sparse vegetation with a projective cover of 30–50%. The lining of five nest cavities consisted of ground plant debris about 1 cm thick. The average tray diameter (n = 3) was 10.3 ± 0.2 (SE) cm and depth was 4.2 ± 0.9 cm. The average egg size (n = 12) was 28.13 ± 0.19 × 41.74 ± 0.34 mm (27.2–29.2 × 40.4–43.6). The average altitude of the area where nests and broods were found was 941 ± 26 m a.s.l. (from 871 to 1036, $n = 8$).

Thus, all the nests discovered in the years 1988–2018 were at an altitude of 850 to 1036 (mean 935 ± 28) m a.s.l. ($n = 8$). They represented depressions in the ground with a diameter of 9 to 14 (mean 11) cm and a depth of 1 to 6 (mean 4) cm ($n = 8$). The average egg size ($n = 25$) was 28.80 ± 0.17 × 41.88 ± 0.25 mm (27.2–30.2 × 39.2–44.1).

Nesting Success

The rate of melting of snow cover and the degree of its mosaicity in spring largely determine the distribution of nests over the territory, as well as the timing of egg laying and the very possibility of nesting. Apparently, heavy snowfalls in early summer may cause the death of clutches (Cramp and Simmons, 1983), which is also indirectly evidenced by our observations of vertical movements of dotterels in late June 1988 and 1989 (see below). Cases of death of clutches or eggs were not recorded in years with favorable weather conditions. Thus, all chicks successfully hatched in all five nests observed in 2018. It should be noted that the nesting success was high in all bird species during that year. Only four of the 39 nests studied proved to be unsuccessful. The number of chicks that successfully hatched from 167 eggs laid by all species and left the nests was 144; therefore, the total breeding success of birds was 86% (Romanov et al., 2018). In addition to favorable weather conditions, this high nesting success was also determined by a low level of predation against the background of abundant small rodents. Here, in the depression of God-tyr-Khuolu Lake, we did not encounter the Arctic fox (*Vulpes lagopus*) or red fox (*V. vulpes*); ermine (*Mustela erminea*) was recorded only once. Among birds, the long-tailed jaeger (*Stercorarius longicaudus*) was the only potential destroyer of nests; however, the numerous individuals of the Middendorff vole (*Microtus middendorffi*) and Arctic lemming (*Dicrostonyx torquatus*) could fully satisfy its food demands. In other years, we failed to trace the fate of the nests discovered.

Response of Incubating Birds to the Disturbance Factor

In 2018, we found only males on clutches during control visits of nests. Females were not involved in incubation, although it is known that this sometimes happens in other parts of the range (Cramp and Simmons, 1983; Lücker et al., 2011; Bassi et al., 2014). Males behaved differently in response to the approach of humans: in 13 of the 31 cases, they hid and flew up from under the feet at the very last moment; in 18 cases, they quietly left the nest in advance. At the same time, four males allowed the observer come close to the nest ten times and left it in advance only five times. The fifth male, which covered half of all observations (owing to the close proximity of its nest to our tent camp), unnoticeably left the nest in advance almost every time (in 13 of the 16 visits). On July 4, this male left the incubated clutch for a short time three times to drive away a ring dotterel from the nest.

Timing of Migrations

During the spring movement of dotterels, they were encountered mainly in pairs and only occasionally in groups of six–nine individuals. The earliest dates of their encounters are June 5, 1988, near Ayan Lake and June 14, 1989, in the middle reaches of the Ayan River (Romanov, 1996). In these areas, birds appeared in the mountain tundra when more than 30% of its surface was covered with unmelted snow. In some years, the Eurasian dotterel arrived phenologically even earlier, when the snow cover was in the winter state and its melting had just begun. We recorded a similar situation on June 16, 1990, near Kutaramakan Lake, and Morozov (1984) observed this phenomenon near Kapchuk Lake in June 25, 1980.

Heavy snowfalls and cooling in June 20–22, 1988, forced the birds that stayed on the tops of the plateau to descend to the intermountain valleys. At this time, dotterels continued to arrive and they could not move to the mountain tundra due to the unfavorable weather conditions. As a result, birds aggregated in swamps among larch forests, in sparse forests, and on the shore pebbles of Ayan Lake, which were overgrown with grasses. Apparently, not all birds could feed themselves even near the water, since birds that died from starvation were found on the shore of the lake ($n = 5$). The poor contents of the stomachs of two dissected specimens consisted of ground plant material, crowberry berries, mosquito larvae, and rangle. In 1989, heavy snowfalls in the valley of the Ayan River on June 24 and 25 stimulated vertical movements and concentrations of birds near the river, similar to those that occurred a year earlier near Ayan Lake (Romanov, 1996).

It is likely that heavy snowfalls also caused Eurasian dotterel migrations on July 23–25, 2010, near the shores of Bogatyr and Neralakh lakes, where the birds actively moved singly or in groups of two to five individuals.

Most dotterels leave the region in autumn, probably around August 20. In 1989, the Eurasian dotterel had disappeared from the Ayan River basin by August 16. In 1980, Morozov (1984) observed the departure of the Eurasian dotterel from the vicinity of Kapchuk Lake on August 16–20. In 1990, intensive autumn migration near Kutaramakan Lake was observed on August 18–19, a period characterized by sharp cooling and heavy snowfalls, which formed a continuous snow cover in the alpine and subalpine belts of the plateau. On these days, dotterel flocks of ten to 30 individuals constantly flew low over the water to the southwest and single individuals, pairs, and groups of three to four individuals were observed gathering food everywhere on the shores of the lake.

CONCLUSIONS

It was revealed that the Eurasian dotterel is widespread almost everywhere throughout the Putorana Plateau and steadily nests in the northern, western, and eastern parts. During the nesting period, it covers a wide range of altitudes; it stays mainly on flat peaks of the alpine mountain belt, locally occurs in some parts of the subalpine belt, and is extremely rarely recorded within the mountain taiga belt. The altitudinal distribution of the species is determined not so much by the altitude as by the ecological parameters of preferred habitats. The range of the species within the Putorana Plateau has a clearly defined three-dimensional character.

The Eurasian dotterel is a typical inhabitant of the mountain-tundra landscapes of plateau tops; it is a characteristic element of the avifauna of the alpine belt and is one of the species forming its core. During the breeding season, it stays mainly in the range of 890–1070 m a.s.l. It prefers slightly sloped areas that have a hummocky microrelief and are covered with sparse herbaceous vegetation. Its optimal habitats are dry stony moss–lichen tundra areas with different proportions of mountain avens, cassiope, and sedges and an abundance of stony and crushed stone placers, as well as permafrost scars. It tends to stay on tops of large crushed stone hillocks, the surface of which is almost completely devoid of any vegetation except lichen clumps.

The spatial distribution of the Eurasian dotterel is uneven. Its abundance varies from 0.4 to 10.0 ind./km^2 in optimal mountain-tundra habitats of the alpine belt during the breeding season, averaging 1.7 ind./km^2. The species abundance is maximal in the middle part of the alpine belt and gradually decreases towards both the tops and foothills of the slopes. In addition, centers of increased density can be observed in relatively small sites of the area, where local centers of female lekking activity are formed. In such cases, the birds tend to stay in a limited area where they not only make single "advertising" flights (which are typical for this species), but also gather on the ground for joint lekking in groups of up to fifteen individuals. The distribution of nests on the ground can also be considered this kind of "center."

The birds arrive in breeding grounds mostly in pairs, which break up shortly after egg laying. After leaving males that had begun to incubate, females continue to lek actively for about two more weeks, trying to attract new males; the activity of their lekking then significantly decreased and completely ceased after two more weeks. During the years of our research, the birds began to lay eggs from June 7 to June 22 (on average, June 13 ± 2 days) (n = 13). Extreme weather and climate conditions during the breeding season are not insurmountable for the Eurasian dotterel. It can start nesting even when the alpine tops of the plateau are still completely covered with snow. On the whole, the timing of Eurasian dotterel breeding is shorter on the Putorana Plateau than in the North European part of the range; in addition, separate phases of this cycle are also shorter on the Putorana Plateau.

The nests discovered were at an altitude of 850 to 1036 (mean 935 ± 28) m a.s.l. (n = 8). They represented depressions in the ground with a diameter of 9 to 14 (mean 11) cm and a depth of 1 to 6 (mean 4) cm (n = 8). Each complete clutch contained three eggs (n = 9). The average egg size (n = 25) was 28.80 ± 0.17 × 41.88 ± 0.25 mm (27.2–30.2 × 39.2–44.1). The earliest estimated date of chick appearance was July 3, and the latest date was July 18; the average date was July 9 ± 1 day (n = 13). Chicks of the same brood hatch within one day. There were no cases of nest destruction by predators or death of eggs due to unfavorable weather conditions. The birds leave their nesting sites around August 20.

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COMPLIANCE WITH ETHICAL STANDARDS

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

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