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Nest site selection and hatching success of Little Ringed Plover *Charadrius dubius* at the coast of Gulf of Riga, eastern Baltic Sea

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Abstract

Nest site selection and hatching success of the Little Ringed Plover *Charadrius dubius* was studied on two sections of sand beaches in the Gulf of Riga (West coast and East coast), Latvia, in 1995 – 1996. The distance from each nest to the sea and to the forest, as well as nest success, was recorded. The measured distances differed significantly between each other only on the East coast in 1996, when the distance to the sea was larger. Survival rates were not lower for nests located closer to the sea or to the forest than in central parts of the beach. Hence, no edge effects on nest success were apparent. Still, Little Ringed Plovers seemed to avoid both edges to an equal degree, apart from at the East coast where they faced more strong onshore winds. The wind may force plovers to place nests on the lee-side of foredunes, closer to the forest, and thus break up the balanced position of nests in relation to habitat edges.

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Introduction

Nest site selection in ground-nesting birds primarily involves physical features of the habitat which provide the nest, eggs and incubating bird protection from floods, heat stress, cooling and predators (Cody 1985). Due to predation risk many bird species nesting in open areas avoid the presence of trees and other potential perches of avian predators (von Haartman 1980, Galbraith 1989, Stroud et al. 1990, Vermeer et al. 1992). Some shorebird species may avoid close proximity to the water, because nests located closer to water are more likely to become flooded (Vermeer et al. 1992, Espie et al. 1996).

The Little Ringed Plover *Charadrius dubius* is a small-size wader nesting on ground, predominantly without vegetation. On the shores of the Gulf of Riga, it breeds on narrow sand beaches lying between the sea and, usually, pine forest. The aim of this study was to analyse how the nest site selection and hatching success of Little Ringed Plovers are determined by the two habitat edges (sea and beach, beach and forest). By selecting two study areas with similar habitat composition, but different geographical orientation, I also considered the wind as a possible factor influencing nest site choice, since this has not been taken into account in most other beach-nesting plover studies (Burger 1987, Dann 1991, Biondi et al. 1992, Flemming et al. 1992, Powell & Cuthbert 1992, Espie et al. 1996; but see Armstrong & Nol 1993).

Methods

The data were collected during the 1995–1996 breeding seasons in two sections of the western and eastern coasts of the Gulf of Riga, Latvia (Figure 1). The sections were 23.9 km and 25.7 km long, respectively. Sand beaches were the dominant habitat on both coasts. Other habitats, salt marshes and temporary gravel patches, constituted less than 10% of the studied coastline. The coastal habitats of the Gulf of Riga have been described in detail by Opermanis (1995).

I systematically searched potential nest sites within plovers' territories or, when this method was not successful, I watched birds returning to their nests after disturbance. A nest was recorded if at least one

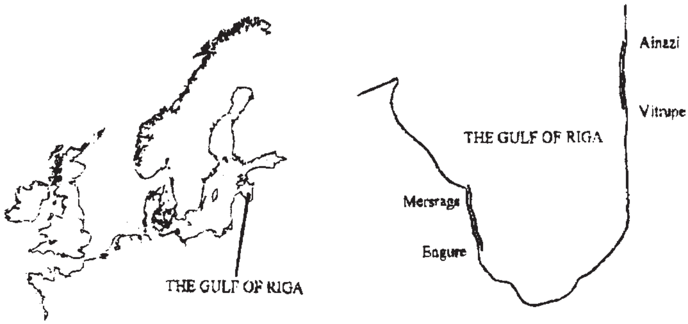

Figure 1. Location of study area in Northern Europe and in the Gulf of Riga. The double lines in the right figure indicate the studied coastal sections.
Studieområdets plats i norra Europa och i Rigabukten. De dubbla linjerna i högra bilden visar de studerade kuststräckorna.

egg was found in a hollow scraped by the bird. I started to search for eggs between 10 and 15 May, corresponding to the egg-laying period for most of the pairs, and continued in 10–15 day intervals until no more eggs were produced. Therefore in each of the two years, five complete nest censuses, covering all of the studied shorelines, were performed. I made additional visits later in the season to get more data on hatching success. The daily nest failure probability was calculated according to Mayfield (1975). For the nests with a complete breeding record, the average number of days for egg-laying and incubation was 29. This figure was used in the Mayfield calculations. To minimize the potential negative effect of my activities on nest survival, no nest markers were used. Instead, nest locations were mapped and described in detail, using the characteristics of the nearest surroundings as reference points.

At all nests, two measurements were taken: 1) the distance from the nest to the sea, and 2) the distance from the nest to the closest vertical element (forest edges, individual trees, bushes higher than 2 metres, poles and buildings). The distance to the sea was measured on calm days. There were no significant tidal differences present in the area. The position of the nest in relation to the foredune (a sand ridge, usually up to 1 m high) was recorded as either seaward (on seaside) or landward (on the forest side). Occasionally, when the foredune was absent, the nests were included in the first category because their exposure was rather similar to the nests located on the seaward side of the foredune.

Table 1. Comparison between the distance (m) from the nest to the sea and to the closest vertical element (v. e.)
Jämförelse mellan avståndet från boet till havet och avståndet till närmaste vertikala struktur (v.s.)

	1995			1996		
	Mean *medel*	n	Wilcoxon Signed Ranks Test	Mean *Medel*	n	Wilcoxon Signed Ranks Test
East coast *Östra kusten*						
Distance to sea *Avstånd till havet*	27.8	17	z=0.31 p=0.76	41.3	19	z=2.05 p=0.04
Distance to v.e. *Avstånd till v.s.*	28.4	17		25.8	19	
West coast *Västra kusten*						
Distance to sea *Avstånd till havet*	21.1	25	z=0.84 p=0.40	26.9	27	z=1.23 p=0.22
Distance to v.e. *Avstånd till v.s.*	22.8	25		25.4	27	

Data on wind speed and direction were recorded at meteorological stations in Mersrags (the West coast) and Ainazi (the East coast), both lying within the study areas, in 6-hour intervals from 1 April till 30 June, in both years.

Other studies have shown that Little Ringed Plovers are quite faithful to their natal areas (Glutz et al. 1975). To avoid including the same birds more than once in the analyses, I analysed nest positions for each year separately. Non-parametric statistics were used throughout (Spearman Rank Correlation, Wilcoxon Signed Ranks Test, Chi-square Test). Statistical tests (two-tailed) were performed using SPSS 8.0.2 package and according to Sokal & Rohlf (1995).

Results

The distances from nest to sea and from nest to vertical elements differed significantly from each other only on the East coast in 1996 (Table 1), when the distances from nest to sea on average were larger than distances to vertical elements. There was a significant positive correlation between the distances from nests to the sea and from nests to vertical elements on the West coast (in 1995: n=25, r_s=0.41, p<0.05; in 1996: n=27, r_s =0.54, p<0.01) but not on the East coast (in 1995: n=17, r_s=0.16, p=0.54; in 1996: n=19, r_s =-0.10, p=0.67).

On the East coast, a significantly greater proportion of nests was located on the forest side of the foredune than on the West coast (East coast 33.3%, West coast 5.8%; Chi-square test with Yates correction, χ^2 = 9.56, df = 1, p<0.01). This can be linked with the fact that the East coast is more exposed to strong onshore winds than the West coast (Figure 2). Overall hatching success probability (all nests pooled) was 17.2% (95% confidence limits: upper 27.6%, lower 10.7%). There were no statistically significant differences in daily nest failure probability, neither between the seaward half of the beach (50% by width) and the landward half of the beach, nor between the coasts (Table 2).

To assess the potential risk of nesting closer to forest and sea edges in comparison with nesting as far as possible from both edges, the nests were also classified by dividing the beach in three equal sections (seaward, middle and landward) each comprising 33.3% of total beach width (the distance from the sea to the closest vertical element at each nest site). However, there were no significant differences in nest failure probability among the three beach sections (Table 2).

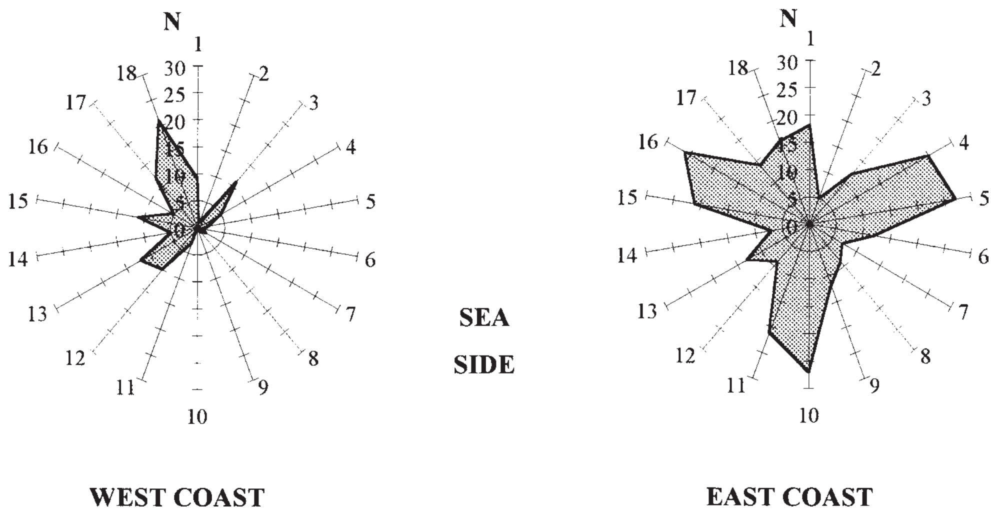

Figure 2. The number of readings of winds exceeding 5 m/sec during the study period on the West and the East shore sections (1995 and 1996 were pooled). Wind directions, the direction the wind is blowing from, were grouped in 20° sections. Section 1 corresponds to the range 345°-5°, north being 0°.

Antalet avläsningar av vindar på mer än 5 m/s för västra respektive östra kusten av Rigabukten (data för 1995 och 1996 är sammanslagna). Vindriktningen (varifrån vinden blåser) är uppdelad i sektorer om 20°. Sektion 1 motsvarar sektorn 345°-5° och norr motsvaras av 0°

Table 2. Daily nest failure probability (pf) of Little Ringed Plover nests calculated according to Mayfield (1975). Standard errors (SE) and z-tests* were calculated according to Johnson (1979) and Hensler & Nichols (1981).
Sannolikheten per dag för att en häckning hos mindre strandpipare skall misslyckas i bostadiet (pf), beräknat efter Mayfield (1975). Standardfelet (SE) och z-test har beräknats enligt Johnson (1979) och Hensler & Nichols (1981).*

Nest location *Boplats*	n	Nest days *Bodagar*	Losses *Förluster*	pf	SE
West coast *Västra kusten*					
1. Seaward half (50% by width) of the beach *På den havsnära halvan av stranden*	33	367	23	0.062	0.012
2. Landward half (50% by width) of the beach *På den landnära halvan av stranden*	16	253.5	9	0.035	0.011
East coast *Östra kusten*					
3. Seaward half (50% by width) of the beach *På den havsnära halvan av stranden*	10	71	9	0.126	0.039
4. Landward half (50% by width) of the beach *På den landnära halvan av stranden*	21	243.5	14	0.057	0.014
Both coasts pooled *Båda kusterna*					
5. Seaward one-third (33% by width) of the beach *På den havsnära tredjedelen av stranden*	19	197.5	14	0.071	0.018
6. Middle one-third (33% by width) of the beach *På den mittre tredjedelen av stranden*	37	426	24	0.056	0.011
7. Landward one-third (33% by width) of the beach *På den landnära tredjedelen av stranden*	24	311.5	17	0.055	0.013

* None of z-tests were significant at $p<0.05$ level: between 1 and 2 z=1.59, 3 and 4 z=1.64, 1 and 3 z=1.54, 2 and 4 z=1.22, 5 and 6 z=0.74, 5 and 7 z=0.73, 6 and 7 z=0.06.

Discussion

The present study was initially designed to test the hypothesis that the probability of depredation of avian nests increases at the edges between adjacent habitat types, and to do it by involving two distinct edges (sea-beach and beach-forest) simultaneously. However, testing this hypothesis with the present data set could raise two major objections: (1) the beach width was unsufficient to distinguish any edge effects, and (2) other nest failure causes in addition to predation were included in analysis.

Paton (1994) reviewed the results of more than 20 studies of edge effects and concluded that future research should focus on smaller scales, about 100–200 m from an edge, at 20–25 m increments. Since no nest classifications had mean distances from the nest to habitat edges less than 20 m (Table 1), I believe this case study meets these requirements.

The second objection is valid only if the edge effect is considered only in terms of predation. In the present case, it was often impossible to determine or even guess about the factors responsible for egg loss (because of the absence of eggshells and other cues), especially at the sea edge. For example, I occasionally observed Red Foxes *Vulpes vulpes* searching for food in the beach zone adjacent to water, but they could equally well have been looking for dead fish, seals and other potential food items, as for plover eggs. At the same time, eggs could be washed off by waves with the same degree of confidence. Therefore, for purposes of this study, the meaning of edge effects was extended to other causes of nest failure, like flooding, since other studies of coastal waders showed that nests located closer to water are more likely to become flooded (Vermeer et al. 1992, Espie et al. 1996). From the point of view of nest success, there seems to be no principal difference if one reports that 'nest depredation rates' increase at habitat edges or 'nest failure rates' increase at habitat edges.

The absence of significant differences of failure rates among the three beach sections (seaward, middle and landward) may be because the beaches were narrow (of 88 nest sites, only 35 were on beaches wider than 50 m, and 9 wider than 100 m) and probably strong overlapping effects of both edges occurred and nest failure rates ‘levelled out’ among the three beach sections. Paton (1994) concluded that the edge effect may extend for at least 50 metres. In the case of the present study, obviously a crow perching on a tree may locate a plovers’ nest on a 50 m wide beach in any of its sections with nearly the same effort and success rate. In some cases, sea waves could reach the nests located closer to the vertical elements as well, especially where the foredune was not present.

Nevertheless, on the West coast a significant positive correlation was found between distances from nest to the sea and from nest to vertical elements, and it was consistent for both study years. This suggests that, at least in some areas, birds balanced the positioning of their nests between two potentially dangerous habitats, that is, they avoided the edges.

Wind can be unfavourable for birds, causing mechanical damage, heat loss and hindrance of flight (Harvey 1971, Stoutjesdijk & Barkman 1992). In addition, wind can act as a generator and director of waves which may destroy nests. In both study areas, such unfavourable conditions can be caused only by onshore winds (blowing from the sea), because the high secondary dunes overgrown with pine forest offer good shelter from other wind directions. On the East coast, where wind activity was remarkably higher (Figure 2), more nests were located on the lee-side of foredune, in comparison with the West coast. This may indicate that avoidance from direct winds is also important in nest site selection. Furthermore, the different wind exposure on the two coasts seems to explain the absence of correlation between the distance from the nest to the sea and from the nest to the vertical elements on the East coast study area since the nests, if situated on the lee-side of the foredune, inevitably tend to be closer to forest, and this brakes up the relationships between the distances. Armstrong & Nol (1993) in a similar study with Semipalmated Plover *Charadrius semipalmatus* on the coast of Hudson’s Bay, Canada, rejected the importance of wind as a factor affecting the spacing pattern of plovers, when comparing coastal and inland breeding sites. But, in their study, all nests at the seacoast were behind foredunes where they did not meet onshore winds directly and this also may indicate that the birds avoided sites exposed to wind.

Other studies of beach-nesting plovers revealed other important factors determining their nest distribution, in particular, recreation and disturbance (Burger 1987, Biondi et al. 1996), nest substrate availability (Burger 1987, Dann 1991, Flemming et al. 1992, Espie et al. 1996) and presence of other species (Burger 1987, Armstrong & Nol 1993). I could not measure the effect of recreation in the study areas, since it had low intensity and greatly depended on weather conditions and public holidays. Similarly I was unable to assess proportions of available shingle and sand covered areas. Shingle occurred patchily, covering about 20% of the total shore length, but its appearance was rather temporary and dynamic: after storms or periods of strong wind activity, the shingle patches frequently disappeared in one area and re-emerged from sand in another. This dynamic environment also affected the plovers: in one case, a deserted nest was found where the eggs were almost completely buried by sand. This could probably happen regularly, since most nest failures were recorded when eggs had disappeared. The presence of other competitive species could not be a significant factor influencing nest site choice of Little Ringed Plovers since it was the only beach-nesting species in more than 90% of the shoreline of the study areas.

This study did not support the theory that nest predation and/or destruction rates increase near the edges (e.g. Paton 1994) and it seems that the whole narrow beach belt – the nesting habitat of Little Ringed Plover – was affected by edges which partly or totally overlapped in most of sites. However, there was evidence that birds, if not disturbed by wind activity, tried to maintain a balanced distance from both edges. In other words, the edge effects appeared as traits in bird behaviour reflected in nest site selection process, but not as higher nest failure rates. The objective for further studies would be to find if these nest site adaptations are targeted to increase safety of eggs or comfort and safety of adult birds during incubation.

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Sammanfattning

Boplatsval och kläckningsframgång hos mindre strandpipare Charadrius dubius *vid Rigabuktens stränder*

Boplatsvalet hos markhäckande fåglar beror ofta på den omgivande fysiska miljön. De bör till exempel ta hänsyn till hur utsatta de är för instrålning, regn och vind. Av risk för predation från flygande predatorer så undviker fåglarna ofta boplatser med träd och andra utkiksposter i närheten. Vissa vadararter undviker närhet till vatten på grund av överspolningsrisken. Det har också föreslagits att det skulle vara speciellt farligt att placera boet nära övergången mellan olika naturtyper ("kanteffekter").

Mindre strandpiparen häckar på marken och föredrar vegetationslösa underlag. I Rigabukten häckar den på sandstränder som ofta avgränsas av tallskog mot land. Jag studerade hur mindre strandpiparens boplatsval och häckningsframgång påverkades av kanteffekter, det vill säga av närheten till hav (överspolningsrisk) respektive skog (predationsrisk). Effekten av vind kunde också studeras genom att jag jämförde två likartade stränder med olika vindexponering.

Metoder

Studien utfördes 1995 och 1996 på två kuststräckor (23,9 och 25,7 km långa) av Rigabukten, Lettland (Figur 1). Sandstrand dominerade, men saltängar och tillfälliga stenskravelytor utgjorde ca. 10% av habitatet. Jag sökte efter bon med start 10–15 maj vart år och sedan med 10–15 dagars intervall fram tills dess att inga fler ägg producerades (fem totalinventeringar per år). Jag gjorde ytterligare besök för att följa upp häckningsframgången.

Sannolikheten per dag att en häckning skulle misslyckas i bostadiet beräknades enligt Mayfield (1975). Det genomsnittliga sammanlagda antalet dagar för värpning och ruvning var 29. För att minimera predationsrisken från mina egna aktiviteter märktes bona inte ut. Istället användes karaktärer i den omgivande miljön för att beskriva boets läge.

För varje bo mätte jag avståndet både till strandkanten och till närmsta vertikala objekt (skogskant, enstaka träd, buskar högre än 2 m, stolpar och byggnader). Avståndet till strandkanten mättes lugna dagar. Det noterades också huruvida boet låg på sjösidan eller landsidan av den ca 1 m höga sanddynsrygg som ofta fanns på stranden.

Vinduppgifter för perioden 1 april till 30 juni, data från var sjätte timme, erhölls från de meteorologiska stationerna vid Mersrags (västra kusten) och Ainazi (östra kusten), som båda finns inom studieområdet.

Resultat

Bona placerades i genomsnitt lika långt från stranden som från skogen, med undantag av östra kusten 1996 (Tabell1). Där lades bona oftast närmare skogen än stranden. På östra kusten låg bona oftare på landsidan av dynerna, troligen därför att det ofta blåser starka vindar från sjösidan där. Den genomsnittliga kläckningsframgången var 17 %. Det fanns ingen skillnad i kläckningsframgång mellan olika delar av stranden, när denna delades upp i två eller tre likbreda delar (Tabell 2).

Diskussion

Bristen på skillnader i kläckningsframgång mellan olika delar av stranden kan bero på att stranden i genomsnitt var så smal att eventuella kanteffekter (hav-strand och strand-skog) helt eller delvis överlappade varandra. Då stranden ofta inte var mer än 50 m bred kan kanske en kråka sittande i skogen se över hela stranden och från andra hållet kan vågorna i värsta fall skölja över hela stranden. Oavsett detta så visade det sig att fåglarna, i alla fall på västra kuststräckan, helst placerade sina bon mitt på stranden med lika avstånd till strand och skog.

På östra stranden placerades bona oftare innanför de yttersta dynerna och i alla fall det ena året mycket närmare skogen än stranden. Detta indikerar att vindförhållandena, med regelbundna starka vindar från sjösidan (från väster) starkt påverkar fåglarnas boplatsval. Vinden kan på flera sätt påverka fåglarna negativt. Äggen kan blåsas över av sand eller vatten och vinden kan både kyla och blåsa sand på de ruvande föräldrarna.

Jag kunde i denna studie inte avgöra betydelsen av andra faktorer för fåglarnas boplatsval och kläckningsframgång, så som störning från rekreation och ändrade markförhållanden. Avsaknaden av andra häckande arter utesluter dock mellanartskonkurrens som någon betydelsefull faktor.