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Feeding behaviour of Ruffs during spring migration at a stopover site of international importance in Eastern Austria

Claudia Schütz & Christian H. Schulze

Abstract

This study tested for effects of potentially important variables (location, vegetation cover, feeding habitat, wind force, date, time of day, flock size, scan rate, stepping rate) on the peck rate of foraging Ruffs *Philomachus pugnax* during spring migration at Seewinkel, an important stopover site for waders in Eastern Austria. Therefore foraging Ruffs were filmed at four salt ponds with 681 film sequences being available for analyses. Peck rate (number of pecks per 30 sec) of Ruffs proved to be mainly affected by wind force (positive effect) and feeding location. Our study emphasized the importance of maintaining a network of different salt pans, complementing each other most likely due to spatio-temporal dynamics in food availability and therefore enabling Ruffs to optimize food intake during their limited stopover time during spring migration.

Keywords

Seewinkel, *Philomachus pugnax*, food intake rate, foraging behaviour, flocking, number of steps, soda ponds

Introduction

Like many other shorebirds Ruffs *Philomachus pugnax* are long-distance migrants (van Gils & Wiersma 1996). They cover up to 11,000 km on migration routes between their wintering areas in Southern Africa and their breeding grounds in Northern Europe and Siberia (Scheufler & Stiefel 1985). In the course of migration long-distance flights are interrupted by filling up fat reserves at suitable stopover sites before continuing migration (Weber et al. 1998). At stopover sites migrants have to cope with varying prey availability, inter- and intraspecific competition for limited resources and predation pressure (Lyons & Haig 1995). Furthermore, their time schedule for spring migration is strongly constrained by selective pressures related to the approaching reproductive period (Lyons & Haig 1995; Muraoka et al. 2009).

How effectively waders adapt their foraging behaviour to the complex interactions of biotic and abiotic factors characteristic for individual stopover sites, determines the success of migration, which is ultimately measured in units of time and condition during passage and upon arrival at the destination (Smith & Moore 2003). This study aimed to analyse if, how and to which extent the variables scan rate, flock size, feeding location, weather conditions, vegetation cover, date, time and habitat patch selection affect food intake behaviour of Ruffs *Philomachus pugnax* during spring migration at Seewinkel, an important stopover site for waders in Eastern Austria (Laber 2003). In contradiction to other studies, which focused mainly on effects of single or a small number of biotic and/or abiotic variables on the foraging behaviour of birds (Beauchamp 1998; Evans 1976; but: Ward & Low 1997), we evaluated effects of a large set of different factors potentially influencing food intake of foraging Ruffs.

Food intake as quantified by birds´ peck rates can be affected by intraspecific competition. In foraging Redshanks *Tringa totanus* an increase of flock size can cause a decline of prey accessibility. Birds compensate for this by a higher mobility, measured as stepping rate, to reach habitat patches with better access to prey (Minderman et al. 2006). Therefore, stepping rate was suggested to be a good indicator of competition in foraging Redshanks. In this study we tested if stepping rate is increasing with flock size, which could indicate a potential decrease of food availability when a habitat patch is (over-)exploited by a larger flock. Then stepping rate might be also negatively related to food intake quantified as peck rate.

Methods

<u>Study area</u>

The Seewinkel (47°82’ N, 16°77’ E, alt. 115m asl) located east of Lake Neusiedl at Burgenland, Eastern Austria is a stopover site of international importance for waders, particularly for Ruffs (Laber 2003). During spring migration Ruffs represent the most abundant wader species in the area with maximum numbers of more than 10,000 birds per day (Kohler & Rauer 2009; Laber 2003).

The study area is characterised by shallow soda ponds. These pools are shallow basins with a depth of about 30-50 cm having extremely high pH values (Wielander 2005) and some of them dry up nearly every year (Wolfram et al. 1999). Among these salt pans four have been chosen for this study: Darscho (D), Illmitzer Zicklacke (IZ), Neubruchlacke (N) and Oberer Stinkersee (OS) (Fig. 1).

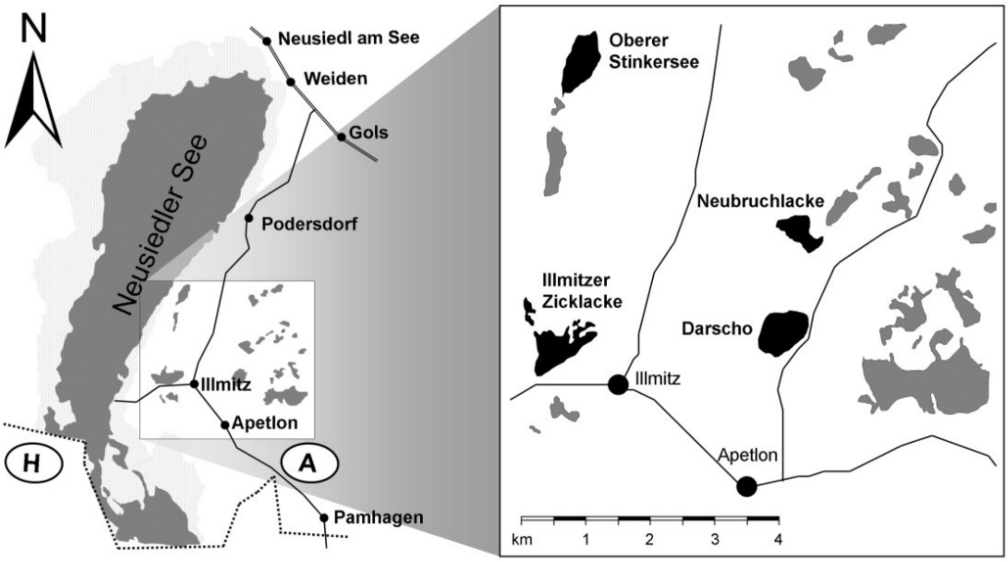

Figure 1: Maps indicating location of study area (left figure) and study sites (right figure). The four study sites, where foraging Ruff were observed (Oberer Stinkersee, Illmitzer Zicklacke, Darscho and Neubruchlacke), are marked by black fillings, other salt pan-areas are grey.

Recording bird behaviour

Foraging behaviour of Ruffs was recorded with a digital hand cam (Panasonic HDC-SX5) from an observation hut or a car to get as close as possible to the birds without affecting their behaviour by the presence of the observer. Filming of individual birds, small flocks or parts of larger flocks lasted for at least one minute. Date and time were recorded automatically during filming by the digital hand cam. Additionally, observation site and wind force (1: windless; 2: weak wind; 3: moderate wind; 4: strong wind) were noted. For bird flocks, additionally total flock size and – for mixed species flocks – the number of individuals per species were recorded. A bird flock was defined as a con- or heterospecific group of waders all within a distance of approximately 20 body lengths to the nearest neighbour.

Due to the large number of present Ruffs an individual was most likely not recorded more than once on consecutive days. In several instances information on foraging behaviour of Ruffs in larger flocks was recorded on more than one focal bird. However, the same individual was never recorded twice during the same session.

Field work was conducted from 1 April until 30 May 2008 (max. 5 days a week; total of 40 observation days). There was no field work on weekends and holidays due to the risk of higher anthropogenic disturbance potentially affecting foraging behaviour and feeding site selection of Ruffs. Furthermore, no field work was done during extremely bad weather conditions (e.g. heavy rain). Each salt pan was visited twice a day at an interval of three to four hours.

Analysis of film sequences

To quantify the frequency of scan and peck rate of foraging Ruffs, one 30 sec film sequence of every film was selected during which the focal bird was not hidden by vegetation structures or other birds. Peck rates (quantified as number of pecks per 30 sec) were used as measurement of food intake. Pecking was defined as touching or investigating the surface of water, soil or vegetation with the tip of the bill. Scan rates (quantified as number of scans per 30 sec) were used as measurement of vigilance. Scanning behaviour was defined as rising of the head from the head-down foraging position (0°) to a bill position of at least 80°.

Two types of feeding habitats were defined: semi-aquatic (foraging in water) and terrestrial (foraging on land). Additionally, vegetation cover of foraging habitats was categorized as no or sparse, low vegetation (A) or dense, high vegetation reaching at least the bird's intertarsal articulation in height (B).

Data analysis

Effects of abiotic and biotic variables on peck rate (as surrogate for food intake) of Ruffs were assessed by a Generalized Linear Model (GLM) using a log-link function. Wald statistics for the GLM were used to detect univariate effects of variables on peck rates of Ruffs. All analyses were carried out in Statistica version 7.1 (Statsoft Inc. 2005).

Results

A total of 681 film sequences of foraging Ruffs were analyzed. The two main components of foraging behaviour, scan rate and peck rate, were not correlated (r = -0.05, N = 681, p = 0.205). Stepping rate did decrease with increasing flock size (r_s = -0.32, N = 681, p < 0.001). Furthermore, peck rate decreased with increasing stepping rate (r = -0.12, N = 681, p = 0.001). However, a GLM testing for effects of biotic and abiotic variables (location, vegetation cover, wind force, date, time, feeding habitat, flock size, stepping rate and scan rate) did neither indicate an important contribution of stepping rate nor flock size in explaining variance of peck rate (multiple R^2 = 0.25, $F_{13,667}$ = 16.74, p < 0.001), whereas wind force (F = 5.13, p < 0.001; Fig. 2) and location (F = 41.56, p < 0.001; Fig. 2) showed a strong effect on the food intake rate. These two variables also proved to strongly affect Ruffs´ pecking rates according to Wald statistics (Table 1).

Table 1: Results of Wald statistics testing for effects of nine predictor variables (included in the GLM) on peck rate of foraging Ruffs (variables with a $P < 0.01$ are printed in bold).

Variable	Df	Wald statistic	*P*
Constant	**1**	**319.83**	**<0.001**
Location	**3**	**41.56**	**<0.001**
Vegetation cover	1	0.48	0.489
Feeding habitat	1	0.37	0.541
Wind force	**3**	**5.13**	**<0.001**
Date	1	0.36	0.551
Time	1	1.91	0.417
Flock size	1	0.00	0.972
Scan rate	1	2.82	0.094
Stepping rate	1	1.65	0.199

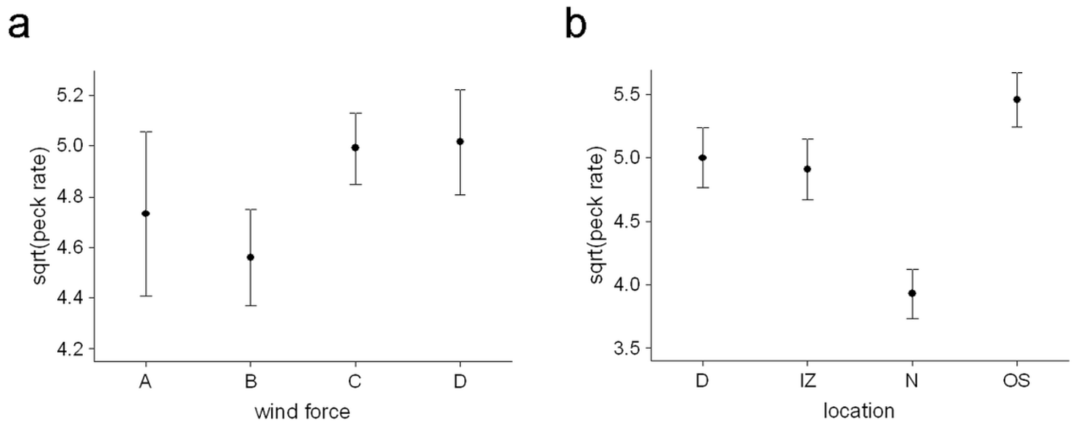

Figure 2: Least square means of peck rate (square root transformed) ± 95% confidence interval for Ruffs exposed to different wind forces (a) and foraging at four different salt pans (D ☐ Darscho, IZ ☐ Illmitzer Zicklacke, N ☐ Neubruchlacke, OS ☐ Oberer Stinkersee) (b).

Discussion

It is often assumed that an increase in vigilance, e.g. in response to increased predation risk, translates into a decrease in food intake (PULLIAM 1973; FRITZ et al. 2002) because a bird cannot peck for food and raises its head to scan for predators at the same time (SLOTOW & ROTHSTEIN 1995). An increase in vigilance can have a direct negative effect on the food intake rate through a reduction in the time available for feeding or through a decrease in foraging efficiency (LIMA & DILL 1990). However, our study demonstrated that pecking and vigilance do not always have to be mutually exclusive. Also others studies showed little evidence supporting a trade-off of peck rate against scan rate (CRESSWELL et al. 2003; SIROT et al. 2012).

In peck rate an influence of flock size is often assumed as birds in larger flocks can spend more time foraging (SANSOM et al. 2008; VAN DIJK et al. 2012). However, this does not appear to translate necessarily into a foraging benefit. For example, in foraging Redshanks food intake was not related to flock size (SANSOM et al. 2008). In general the relationship between mean food intake rate and group size can take on different shapes (BEAUCHAMP 1998). Most commonly mean food intake rate increases with group size (BEAUCHAMP 1998; CEZILLY & KEDDAR 2012; MORAND-FERRON & QUINN 2011). For example, peck rate can increase with group size because time needed to locate food patches can be reduced (BEAUCHAMP et al. 1997) and as a consequence more time can be allocated to foraging. Conversely, mean food intake rate can decrease with group size because of increasing aggressive interactions, which can decrease individuals´ foraging time and lower food intake in larger groups (STILLMAN et al. 1997). Or the relationship can be a combination of the two relationships mentioned before. Then mean food intake first increases to a maximum and then decreases with group size, a relationship that could be found in captive Skylarks *Alauda arvensis* (POWOLNY et al. 2012).

Studies have shown that flock size is an important variable in explaining variance in scan rate of foraging Ruffs (SCHÜTZ & SCHULZE 2011). However, peck rate was not directly related to group size, which was also reported by other studies (VAN DIJK et al. 2012). But our data also show that stepping rate decreased with increasing flock size, which is contrary to the expectation that flock size increases competition and, therefore, increases stepping rate because birds have to search more intensively for food. The decreased stepping rate of Ruffs in larger flocks, as found in our study, indicates better food availability at sites with larger aggregations of feeding birds. This is underlined by the observation that food intake increased with decreasing stepping rate.

Food intake rates recorded in our study differed significantly between salt pans. Peck rate was highest at Oberer Stinkersee, intermediate at Darscho and Illmitzer Zicklacke and lowest at Neubruchlacke. This may reflect different prey availability levels at our four study sites.

As Ruffs are mainly visual foragers (GLUTZ VON BLOTZHEIM et al. 1975) it did not come as a surprise that wind force had an influence on peck rate. Wind can produce strong wave action, especially at the shallow salt pans. This in turn stirs up sediments and clouds the sight for prey (EVANS 1976). Furthermore birds which feed with their heads above the water surface have to overcome the problem of the change in refractive index between air and water, which leads to distortion of the location of potential prey (EVANS 1976). This problem is augmented by wind action, which makes the water surface more turbulent (Evans 1976). Perhaps, Ruffs foraging in salt lakes at Seewinkel showed higher peck rates during periods of stronger wind because they had to compensate for a smaller proportion of successful feeding attempts.

Conclusions

Our results clearly showed that feeding locations and weather conditions strongly affected food intake behaviour of Ruffs foraging at salt pans at Seewinkel. Differences of peck rates between feeding locations may have been the result of salt lake specific differences in food supply. Substrate characteristics and the abundance of macrophytes seem to determine seasonal and spatial differences in abundance of benthic invertebrates in the salt pans at Seewinkel (Wolfram et al. 1999). Due to the spatio-temporal dynamic of food availability different salt pans at Seewinkel are not redundant as stopover sites for migrating waders, but may complement each other. Therefore, the protection of the existing salt pans may be an important precondition for maintaining the high conservation status of the Seewinkel as important stopover site for Ruffs and other waders. While in the year 1850 still around 139 salt pans (3,615 ha) existed, in 1957 only 79 salt pans (1,360 ha) remained with an ongoing decrease leading to a total of only 40 salt pans in the 1990s (Kohler et al. 1994). If the number of salt pans further decreases, the conservation value of Seewinkel as important staging site for migrating waders will most certainly decline.

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Contact

Claudia Schütz
claudia.schuetz@univie.ac.at

Christian H. Schulze
christian.schulze@univie.ac.at

Department of Tropical Ecology and Animal Biodiversity
University Vienna
Rennweg 14
1030 Vienna
Austria