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A comparison of two European breeding habitats of the Water Rail *Rallus aquaticus*

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Abstract. The study was carried out in two sites — fluvial mires (FM) in Netherlands, and at salt marshes (SM) and at the borders of lagoons (BL) in Spain. All 58 nests were found in unmown and ungrazed vegetation. *Carex* species were dominant at the nesting sites FM, but not *Phragmites australis*. *Juncus maritimus* was dominant in the SM and at the BL. The plant communities at and around the nest sites of FM differed from those of SM + BL. At nest height from the side the nest was mostly only poorly visible. Nests at nest height and eggs at observer eye level were invisible among dense clusters of *Juncus maritimus* tussocks. Visibility of eggs in reed stands mixed with *Carex* species and in *Sparganium erectum* stands was mostly poor and moderate respectively. This was in contrast to nests situated among *Juncus maritimus* stems. For the most part, an incubating Water Rail on the nest at eye-level was hardly visible in any of the various stands. The vegetation height of nest sites in SM and BL was considerably less than in FM owed to the absence of *Phragmites australis*. The nest height in tussocks of *Juncus maritimus* was greater. The other nests characteristics (diameter, depth and weight) were not significantly different in FM and SM + BL. The nest material corresponded to the plant species in the immediate vicinity of the nest.

Key words: Water Rail, *Rallus aquaticus*, breeding habitat, vegetation structure, nest site, nest measurements

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INTRODUCTION

The distribution of many bird species is associated with distribution of plant species, particularly in connection with a breeding habitat. Each plant community has its typical physiognomy and vertical and/or horizontal structure (texture) (Beecher 1942, Blondel et al. 1973, Cody 1981, Kinoshita 1997). The density and quality of vegetation at the time of nesting is important for the construction of a nest and the breeding success (e.g. De Kroon 2001).

In handbooks, descriptions of vegetation of the Water Rail breeding habitat, characteristics of the nest site and the hydrological situation are often superficial (Glutz von Blotzheim et al. 1973, Cramp & Simmons 1980, Potapov & Flint 1989, Hagemeijer & Blair 1997, Purroy 1997, Taylor & van Perlo 1998). Detailed quantitative descriptions about these subjects are scarce both for Water Rail (Jenkins & Ormerod 2002, De Kroon & Mommers 2002), as well as for other rail species (Sayre & Rundle 1984, Johnson & Dinsmore 1986, Reid 1989).

The aim of the study was to compare in detail breeding habitats and some characteristics of nests of the Water Rail in two different ecotopes. The species is a terrestrial — and wading bird, living secretly and skulking primarily among densely structured (unmown, ungrazed) vegetation. Therefore it was hypothesised that there will be no difference in density of vegetation and the soil hydrology in all nest habitats studied.

STUDY AREAS

Field studies were carried out in fluvial mires (swamps, tall-herb fens and marshy woodland — abbreviated FM), in The Netherlands during March–July, 1989–1998. The places of study in Holland were two national reserves situated in the municipalities of Lingewaal (51°52’N, 5°04’E) and Brakel (51°49′N, 5°06′E). In Spain study were undertaken during April–May (1999 and 2000) in reclaimed and neglected salt marshes along estuaries and on the coast (abbreviated SM), and borders of lagoons (abbreviated BL). Study were done on six sites situated near Foz (43°34′N, 7°15′W), near Carballo (43°13′N, 8°41′W — Baldaio), near Ponte Ceso (43°15′N, 8°54′W — wet polder) and inside the National Park Coto Dońana.

METHODS

Nest finding

Vocal reactions were important for discovering the status and the nest site of a pair. In order to locate Water Rails by day (10.00–17.00, local time), birds were stimulated with a playback of the 33 seconds long sequence (copied from the gramophone-record (M 45) of Paul Feint, Hildesheim, Germany) of the most common announcement call of an European Water Rail *R. a. aquaticus* (Cramp & Simmons 1980). If necessary, after waiting for some minutes for a reaction, the playback was repeated. A second observer was 25–100 m behind the person with the cassette recorder, also listening for any call of the rails.

In order to find a nest, areas where Water Rails were present were systematically investigated by cautious searching ways between vegetation using small tracks or animal trails. Important signals for direction to the nest were four typical Water Rail calls, particularly: a soft drum or purring, a groan or grunt, the alarm-call "Phith!!"; and the family-call "Pheeh-eeht!" (Glutz von Blotzheim et al. 1973, Cramp & Simmons 1980).

In large areas a visible and transplantable long stick was used on both sides of the area to fix our position.

Nest habitat characteristics

Description of the nest habitat characteristics in each nest site included four parameters.

The quantitative cover of particular plant taxon in nest habitat was estimated in one square-meter (m^2) of substrate with the nest in the plot centre, using five degrees of plant cover: I = 1–5%, II = 6–25%, III = 26–50%, IV = 51–75% and V = 76–100%.

Vegetation height was measured (in metres) from the soil or floating vegetation mat up to the end of the stem including a panicle (inflorescence). At least five measurements were taken per m including the shortest, the tallest, and three stems with the most frequent length at random.

The differential and faithful plant species around the nest over 3 × 3 m (over 5 × 5 m around nests in marshy woodland) was described. This was to identify and classify the vegetation of the breeding habitat into associations or other plant communities according to Schaminée et al. (1995, 1999), Rodwell et al. (1995, 2000), and Rivas-Martinez et al. (1980).

The transparency of the vegetation may affect the visibility of the nest, eggs, and Water Rail in the nest (which could be related to predators pressure). The relative visibility of the above three objects was estimated in four percentage classes: I = 1–25% (i.e. bad, for instance in dense vegetation structure), II = 26–50% (indistinct), III = 51–75% (moderate) and IV = 76–100% (good). Objects were observed at nest height from the side at a distance of c. 50 cm and at the observer's eye-level (c. 1.25 m).

Description of nest

During the egg laying and breeding period several measurements of the nest were also taken: a) water depth was measured from the soil surface or from plant material suspended in water, at least at five locations around the nest (in cm); b) acidity (pH) of the surface water was estimated using universal indicator-strips for pH 0–14; c) nest height from water surface to upper side of the nest and outside diameter of the nest, maximum opening and depth of the nest bowl (in cm to the nearest 0.5 cm).

Nest was weighted with a Pesola spring balance (to the nearest 2 g). If possible, some days after hatching of the chicks, empty nests were collected to weigh nest material wet and wind dry.

Nest material was identified by plant species or by plant family and was estimated in percentages.

Statistical comparisons between averages of samples were done using an F-test and a two-tailed Students t- test. A significance level of 5% was used.

RESULTS AND DISCUSSION

Breeding habitat

Vegetation cover. All nests were found in unmown and ungrazed vegetation. At the nesting sites in fluvial mires (FM) *Carex* species were dominant and presented in almost all nest sites. *Phragmites australis* was in this ecotype less abundant (Table 1).

At the nesting sites in salt marshes (SM) and at the borders of lagoons (BL) *Juncus maritimus* tussocks were dominant and occurred frequently. In

Table 1. Quantititative cover and frequency of occurrence of plant taxa found in nesting habitat. Plant cover: I = 1–5%, II = 6–25%, III = 26–50%, IV = 51–75%, V = 76–100%.

Species	Plant cover	
	Mean (range)	Frequency n (%)
Fluvial mires (FM, N = 43)		
Carex acutiformis	IV	1 (2.3)
Carex riparia	IV (II–V)	32 (74.4)
Carex acuta	III (III–IV)	8 (18.6)
Phragmites australis	III (I–V)	41 (95.4)
Gramineae sp.	II (II–III)	10 (23.3)
Alnus glutinosa	II	1 (2.3)
Rubus sp.	II	1 (2.3)
Solanum dulcamara	I (I–II)	25 (58.1)
Salix sp.	I	2 (4.7)
Urtica dioica	I	1 (2.3)
Crataegus monogyna	I	1 (2.3)
Epilobium hirsutum	I	1 (2.3)
Eupatorium cannabinum	I	1 (2.3)
Caltha palustris	I	1 (2.3)
Typha latifolia	I	2 (4.7)
Symphytum officinale	I	2 (4.7)
Equisetum fluviatile	I	1 (2.3)
Equisetum arvense	I	1 (2.3)
Iris pseudacorus	I	1 (2.3)
Juncus effusus	I	1 (2.3)
Salt marches and borders of lagoons (SM + BL, N = 15)		
Sparganium erectum	V	3 (20)
Juncus maritimus	V (III–V)	12 (80)
Scirpus lacustris	III (I–III)	2 (13.3)
Gramineae sp.	II (II–III)	3 (20)
Typha latifolia	I	3 (20)
Scirpus maritimus	I	1 (6.7)

some nest sites also *Sparganium erectum* dominates (Table 1). The SM and BL nest sites were situated inside vegetation where the mentioned above plant species were dominant over rather large surfaces.

In FM and at the BL the number of plant species found in 1 m² around the nests was larger than in SM (Table 1). The structure of *Juncus maritimus* vegetation in SM and BL is totally different, being tussocks with very stiff stems. FM were a varied small-scale stands with a mosaic of different plant communities. SM was more species-poor. The lagoons, more and less flat hollows that are considered to be vestiges of an old arm of the Guadalquivir (Valverde 1958), had a wide vegetation border with locally species-poor areas around open water.

Plant communities. There were large differences between the associations or other plant communities of FM and those of SM and BL. The distinguishable plant communities around the nest sites of the Water Rail in FM were *Lemna minor* (Alliance Lemnion minoris), *Utricularietum vulgaris* (Alliance Hydrochariton morsus-ranae), *Typho-Phragmitetum* (Alliance Phragmition), *Caricetum ripariae* (Alliance Caricion gracilis), *Salicetum cinereae calamagrostietosum canescentis* (Alliance Salicion cinereae), *Thelypterido-Alnetum caricetosum ripariae* (Alliance Alnion glutinosae). The plant communities of FM are typical of a reclaimed fresh river delta. In SM *Juncetum maritimi* (Class Asteretea tripolii), *Halo-Scirpetum maritimi* (Alliance Halo-Scirpion), and at/on BL *Scirpetum maritime* (Alliance *Phragmition*), *Juncetea maritime (Galio palustri-Juncetum maritimi), Sparganietum erecti* (Class Phragmitetea), and *Typhetum latifoliae* (Class Phragmitetea) were distinguished.

The *Juncetum maritimi* community of SM is typical for Atlantic coastal marshes along estuaries on inter-tidal silts and sands.

The breeding habitats in tidal areas of SM were situated on soils influenced by the top of high tide. They were characterized by a wet, sandy and muddy saline substrate, with or without a layer of shallow water. Locally the *Juncetum maritimi* community forms mosaics with the *Scirpetum maritimi*.

The BL vegetation of *Juncetea maritime* is influenced by high groundwater level and probably by brackish soil. It is characteristic for Mediterranean coasts (Rivas-Martinez et al. 1980).

On soils with a vegetation of the *Galio palustri-Juncetum maritimi* (Rivas-Martinez et al. 1980), in Coto Dońana marshes (BL), rails were absent. These soil substrates were not inundated and at best the soil was moist. The *Sparganietum erecti* in BL generally formed a closed covering of stems and leaves, in standing shallow water. These stands were very species-poor, growing in full sunlight and often bordering open water or woodland. It was unclear whether Water Rails nested in the *Caricetum paniculatae* — or in the *Typhetum latifoliae* vegetation (BL). In FM a nest was never found in such plant communities.

The transparency of breeding habitats. The visibility of the nest in the under storey of vegetation at nest-height from the side was for the greater part bad (Table 2). It was not conspicuous, because it was integrated with surrounding vegetation.

Visibility of the creamy-white eggs at eye-level by the observer in reed stands with *Carex* species (FM) in the under storey as well as in stands dominated by *Sparganium erectum* (BL), was mostly indistinct (degree II) and moderate (degree III) respectively, due to a canopy of shoots and leaves (Table 2). The structure of all stems and leaves together in *Carex*- and *Sparganium* stands forms an impediment to the visibility of the eggs; therefore the visibility was low. This contrasts with the tussock vegetation structure of *Juncus maritimus* (SM/BL) with its stiff stems. Those together have at eye-level an open structure. Consequently the visibility of these clutches at eye-level was good (degree IV). Successful predation of Rail eggs has been determined by findings of fresh eggshell fragments (Carrion Crows *Corvus corone* and Magpies *Pica pica* were the possible predators observed in SM study sites). The nest at nest-height from the side and the clutch at eye-level were invisible (degree I) if the nest site was situated between densely growing clusters of large and high tussocks. Such a position offered a safe protection against flying predators.

In the different stands the visibility of a breeding Water Rail at the nest at eye-level was for the greater part bad due to the bird's dorsal brownish/blackish plumage (Table 2).

Nest sites

The mean vegetation height at the nest site in FM was significantly greater than in SM and at BL (Table 3), because *Phragmites australis* was a taller plant species ($\bar{x} = 2.29 \pm 0.33$ m, n = 18) than *Juncus maritimus* ($\bar{x} = 1.34 \pm 0.02$ m, n = 6) and *Sparganium erectum* ($\bar{x} = 1.62 \pm 0.05$ m, n = 3).

Water depth around the nests in all study sites varied, but the means were not significantly different (Table 3). In FM and at BL, surface water was fresh and eutrophic and in SM it was brackish as a result of fresh water seepage from adjacent hills. Nest habitats in this area were situated more on the hillside and behind the polder dikes, not on the coast or the estuary side. Acidity (pH) varied more in FM (7–10), than in SM and at BL (7–8).

There were significant differences ($t = 6.15$ $df = 12$, $p < 0.05$) in nest height among stems

Table 2. Relative visibility of nests (%), eggs and breeding birds. Visibility from I (bad) to IV (good) — see Methods. N — total number of objects.

Objects	Visibility I	II	III	IV	N
Nests at nest-height among:					
Carex/*Phragmites* vegetation	76	24			45
Sparganium vegetation	67	33			3
dense clusters of *Juncus maritimus* tussocks	100				2
the stiff stems of *Juncus maritimus*	70	30			10
Eggs at eye-level among:					
Carex/*Phragmites* vegetation		76	24		45
Sparganium vegetation			100		2
dense clusters of *Juncus maritimus* tussocks	100				2
the stiff stems of *Juncus maritimus*			10	90	10
Breeding Water Rail at eye-level among:					
Carex/*Phragmites* vegetation	75	25			20
Sparganium vegetation	100				1
the stiff stems of *Juncus maritimus*	67	33			6

of *Juncus maritimus* (SM + BL, $\bar{x}$ = 27.9 ± 7.8 cm, n = 12) and *Phragmites australis* and *Carex* species in FM and among *Sparganium erectum* at BL ($\bar{x}$ = 13.8 ± 3.5 cm, n = 44).

Nest sizes were variable and changed during the breeding period. Therefore there were no differences in nest measurements between study sites (Table 3). At the beginning, the inside diameter of the nest-bowl and the nest-bowl depth were respectively smaller and larger than at the end of breeding period. This can be explained because the parent Water Rail built inside the nest. Later, it increased due to the size of the clutch and the brooding period on eggs (20–21 days).

Table 3. Characteristics of nest sites and nests in different ecotypes. FM — fluvial mires, SM — salt marshes, BL — borders of lagoons, N — sample size. Statistics comparison: t test, * — p < 0.05, ns — p > 0.05.

Parameters	FM $\bar{x}$ ± SD (N)	SM + BL $\bar{x}$ ± SD (N)	
Vegetation height (m)	1.81± 0.69 (32)	1.43 ± 0.23 (9)	*
Water depth (cm)	6.6 ± 4.5 (44)	6.8 ± 5.8 (15)	ns
Nest height (cm)	13.8 ± 3.6 (41)	25.1± 9.2 (15)	*
Nest characteristics (cm)			
Outside diameter	19.7 ± 3.3 (39)	20.6 ± 3.5 (15)	ns
Diameter of nest bowl	11.8 ± 2.2 (40)	10.3 ± 1.3 (15)	ns
Depth of nest bowl	6.1± 2.2 (33)	5.8 ± 1.1 (15)	ns
Weight of nest material (g)			
wet	697 ± 481 (11)	410 ± 262 (4)	ns
wind dry	143 ± 40 (29)	101 ± 45 (7)	ns

There were no significant differences between the mean weights of wet and of wind dry nest material between study sites (Table 3).

The total mass of material from nests built amongst stems (FM, $\bar{x}$ = 165 ± 51, n = 22) was significantly greater than from nests constructed in clumps or tussocks of *Carex* species and *Juncus maritimus* (SM + BL, $\bar{x}$ = 87 ± 35, n = 14) (t = 5.03, p < 0.05) This is related to the nest height. In vegetation without tussocks, rails first have to build a platform reaching above the water surface. Nest mass and moist nest material may help to maintain egg temperature during incubation.

Nest material corresponded to the plant species surrounding the nest site (Table 4). The material from three nests in *Sparganium* vegetation (BL) was built mainly with decaying leaves of *Sparganium* plants.

CONCLUSIONS

Only in unmown and ungrazed vegetation the nests were found. Though *Phragmites australis* was dominant at sight in the vegetation of FM, at the nest sites it were *Carex*-species.

The composition of vegetation of Spanish breeding sites (SM and BL) differed predominantly greatly from Dutch sites (FM).

In all ecotopes nests were mostly situated directly above shallow water and with water all round. It forms a barrier for predators. Nests

Table 4. The mean percentages of determined plant taxon in the vegetable nest material. N — total number of nests, n — number of nests particular.

Species	$\bar{x}$	Min–max (%)	n
Fluvial mires (FM, N = 32)			
Carex acutiformis (leaf)	80		1
Carex riparia (leaf)	78	10–99	27
Carex acuta (leaf)	43		2
Phragmites australis (stalk, leaf, panicle)	23	1–87	24
Gramineae sp. (leaf, root)	8	1–30	10
Alnus glutinosa (leaf, prop)	6	2–15	4
Salix species (leaf, twig)	5	1–39	19
Populus sp. (leaf)	5	1–15	15
Typha species (leaf)	4		2
Quercus robur (leaf)	1		1
Solanum dulcamara (stem)	1		1
Musci species	1		1
Salt marches and borders of lagoons (SM + BL, N = 12)			
Juncus maritimus (stem, panicle)	72	5–100	12
Typha latifolia (leaf)	51	2–100	2
Gramineae sp. (leaf)	34	1–95	7
Scirpus lacustris (stem)	25	2–30	1
Scirpus maritimus (stem)	16	1–2	2
Eucalyptus camaldulensis (leaf)	2		3
Cotula coronopifolia (leaf, flower)	1		1

constructed among stems of *Juncus maritimus* at eye-level had a high rate of visibility. By this the chance of predation of eggs by flying predators (*Corvus corone*, *Pica pica*), in view of the finds of fresh eggshell fragments of Water Rail eggs in SM, will be higher than nests in closed vegetation. Nest building in vegetation with a dense structure is important with respect to protection against predators.

The results of this study indicate that it does not matter which plant species or community occur in the breeding habitat. The density of vegetation (except for nests among the stiff stems of *Juncus maritimus*) and the soil hydrology in all nest habitats were almost equal.

Principal factors for a nest site in connection with the relative invisibility of the breeding Water Rail and the clutch at nest-height from aside as well as at eye-level are: a) a tall (> 1 m high), b) dense vegetation of helophytes, c) in shallow water or floating, and, d) a structure with a low degree of transparency. Cover from view is more important than floristic assemblage of vegetation.

Finally, important is that rails can behave inconspicuously running unobserved amongst and under dense vegetation and can build a nest with old plant material.

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STRESZCZENIE

[Miejsca gniazdowe wodnika w różnych środowiskach]

Badania prowadzono w dwóch różnych biotopach: podmokłych terenach nadrzecznych (FL) w

Holandii oraz słonych bagniskach rozciągających się wzdłuż estuariów (SM) i na brzegach morskich lagun (BL) w Hiszpanii.

Opisano środowisko wokół gniazd — m. in. skład gatunkowy i wysokość roślinności, stopień ukrycia gniazda, głębokość wody oraz jej pH. Wykonano także pomiary samych gniazd — wysokość, głębokość i ciężar oraz oznaczono materiały użyte do ich budowy.

Wszystkie gniazda (n = 58) stwierdzono na terenach nie poddanych antropopresji (koszenie, wypasanie). Na stanowiskach w Holandii wokół gniazd dominowały turzyce i trzcina, zaś na podmokłych słonawych terenach w Hiszpanii — jeżówka gałęzista, sit morski i oczeret jeziorny (Tab. 1). Gniazda były najczęściej dobrze ukryte, a widoczność pustych gniazd, jaj i wysiadujących ptaków — słaba (Tab. 2). Tylko wysokość roślinności wokół gniazd oraz wysokość samego gniazda różniły się istotnie pomiędzy badanymi terenami, pozostałe wymiary gniazd — były podobne (Tab. 3). Materiały użyte do budowy gniazd były podobne do składu gatunkowego roślin stwierdzanego w najbliższej okolicy (Tab. 1 i 4).

Na podstawie zebranych danych wydaje się, że najważniejszymi czynnikami opisującymi środowisko lęgowe wodnika są wysoka, zwarta roślinność i płytka woda.