Diet selection of the Aquatic Warbler *Acrocephalus paludicola* during its post-nuptial migration stopover in NW Spain

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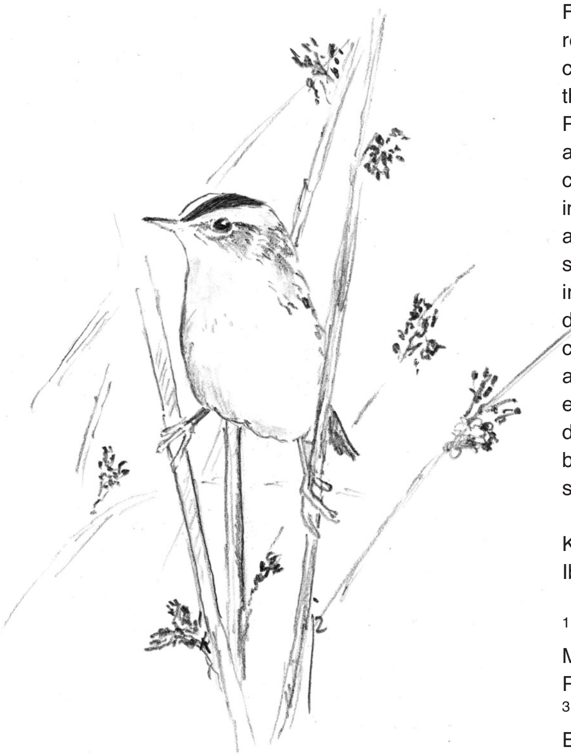

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Food availability and diet are two key issues in understanding the ecological requirements of a migratory species in stopover sites and in taking effective conservation measures. In the case of the globally threatened Aquatic Warbler, there have previously been no studies examining diet selection in the Iberian Peninsula, a key region for their post-nuptial movements. In this context, the availability of arthropods in different habitats (reeds, rushes and grassland), the composition and biomass of prey in faecal samples, and diet selection were all investigated in a wetland in northwest Spain. The results showed a higher total abundance of arthropods in grassland and rushes: habitats which were more similar to each other, in terms of vegetation physiognomy and composition of invertebrates, compared with reeds. In terms of prey abundance, diet was dominated by Araneae, Heteroptera and Homoptera. However, the groups that contributed most to the ingested biomass were Diptera (Tipulidae), Odonata and Orthoptera, followed by Araneae. Prey selection indices showed a preference for these groups, which all contain insects with a large body length. These diet characteristics showed many similarities with studies in other stopover and breeding areas, but differ in that Araneae were the main arthropod prey at this stopover site.

Key words: food preferences, food availability, prey species, inland wetland, Iberian Peninsula

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For many Palearctic birds, the Iberian Peninsula is one of the last opportunities to stock up on the necessary fat reserves before crossing the Mediterranean Sea and the Sahara during southward migration (Moreau 1956). The globally threatened Aquatic Warbler *Acrocephalus paludicola*, is a trans-Sahara migrant that crosses the Iberian Peninsula on its migratory journey from Central and Eastern Europe to Sub-Saharan West Africa (de By 1990). During the last two decades, knowledge of its stopover sites in the Iberian Peninsula has increased significantly, but there still are considerable gaps concerning basic aspects of its ecological needs, which are vital for effective conservation (Schäffer *et al.* 2006).

Birds spend more time in stopover sites than in active migratory flight (Zduniak & Yosef 2012), where they have the opportunity to rest and replace fat reserves; therefore, food availability and diet are fundamental aspects for understanding the ecological needs of any species in a particular habitat (Sutherland 1998). In the case of Aquatic Warblers, studies on these aspects have been carried out in breeding areas in

Poland and Germany (Schulze-Hagen *et al.* 1989, Tanneberger *et al.* 2008) and in stopover sites in France (Provost *et al.* 2010, Kerbiriou *et al.* 2011, Marquet *et al.* 2014, Musseau *et al.* 2014), but not in the Iberian Peninsula. All of these studies underline the importance of large prey, which account for a high percentage of consumed biomass, in the diet of Aquatic Warblers. They also indicate that the availability of arthropod prey is greater in low and medium-height water-logged helophytic communities, and provide useful information for the conservation of the areas where the studies were conducted. However, environmental conditions in these areas differ from those in the stopover sites of the Iberian Peninsula; therefore, it is important to carry out studies on a regional level.

This study was carried out in a wetland in northern Spain used by Aquatic Warblers as a stopover site. Faecal samples were analysed to identify arthropod composition and biomass in the diet of Aquatic Warblers, and results were compared with the arthropod community available in the wetland to assess prey selection.

METHODS

The study area was the El Villar lagoon (NW Spain; 42°18'N, 5°44'W), situated at 789 m altitude in an intensively irrigated farming area. The lagoon covers 5.7 ha and is of natural origin. During summer, water excess from flood irrigation on nearby farms partially waterlogs the grassland and rush areas up to a depth of 20 cm. We distinguished three different habitat types in the wetland: (1) A reed community, covering 29% of the wetland surface, occupied almost exclusively by dense formation of *Schoenoplectus lacustris*, (2) a fringe of rushes bordering the reeds, making up 25% of the surface area, where *Scirpoides holoschoenus* and *Eleocharis palustris* are the two predominant species, and (3) a grassland dominated by *Elytrigia repens*, accounting for 32% of the area. The remaining 14% of the area is mostly open standing water. A full description of the vegetation is available in Table S1.

Bird sampling was carried out in 2013 between 30 July and 10 September, coinciding with the postnuptial passage of Aquatic Warblers through the Iberian Peninsula (de By 1990). We sampled on a daily basis during a four hour period starting from dusk. To obtain more faecal samples, sampling was carried out on a further nine days in 2014, under similar water and vegetation conditions as the previous year. Three recording devices with the sound of a singing male were used to attract birds to the nets during the sampling period. After capturing and ringing, the birds were aged and sexed according to Svensson (1992).

Faecal samples were obtained by placing captured individuals in bags with a plastic container at the bottom for 20–30 minutes, and were individually preserved in 70% alcohol (Kerbiriou *et al.* 2011). Chitinous fragments were identified in each sample to estimate the minimum number of individuals in each taxonomic group and were identified to the lowest taxonomical level possible. Davies (1977a, b) demonstrated a strong correlation between prey remains in faeces and diet composition in other insectivorous passerines. Besides the number of prey per faecal sample and prey occurrence, the biomass of consumed prey was calculated using a predictive model based on the relationship between body length and mass for each group of invertebrates (Ganihar 1997).

To determine potential food availability for Aquatic Warblers, two semi-quantitative sampling methods were combined to capture arthropods in the three main habitats during three sampling periods: two in August and one in September 2013. We used yellow bowl traps to sample flying arthropods, which were placed one meter above ground and filled with a preservative liquid. The liquid did not attract insects. We also walked transects with sweep nets, beating the upper part of the vegetation, mainly to sample vegetation-dwelling arthropods. In each habitat we sampled two yellow bowl traps three times, after five days of operation. At the same time we sampled along two 25-m long transects (a total of six samples per habitat per method). We assume that both methods sampled arthropods effectively, covered the same area and that samples represent the entire community of arthropods of each habitat. Captured arthropods were identified to order level.

To assess if the number of faecal samples collected was representative, we used accumulation curves to show the number of accumulated taxa in respect to the number of faecal samples, and to reveal how many new taxa would appear with a new sample. To assess differences in diet composition and variety between adults and juveniles, we used, respectively, permutational multivariate analysis of variance (PERMANOVA) and multivariate dispersion analysis (see Anderson *et al.* 2006). These analyses were based on Hellinger distances in order to focus on differences in the relative abundances of prey, which was judged to be meaningful when comparing the diet of individuals of different size. To assess food availability, the abundance of the whole assemblage and that of the dominant taxa (more than 50 individuals) were compared between the three sampled habitats with generalised linear models (GLM), using negative binomial or quasi-Poisson error distributions, depending on which one fitted the data best in each case. Further, differences in overall arthropod composition between habitats were tested using PERMANOVA. These analyses were based on modified Gower distances (Anderson *et al.* 2006), which account for changes both in composition and absolute number of individuals (i.e. number of individuals), which was judged to be relevant when studying food availability. When global tests in PERMANOVA or GLM were significant ($P < 0.05$), pairwise comparisons were carried out, and P-values were corrected for multiple comparisons using the Holm procedure. In all permutational tests, 9999 permutations were used. These analyses were performed using R statistical software (R Core Team 2014).

Prey selection or food preference by Aquatic Warblers was analysed using various methods based on comparing faecal content with availability samples throughout the study area. Jacobs' index (Jacobs 1974) relates proportions obtained from each resource with the corresponding proportion in the environment. The degree of selection of the different taxonomic groups was also calculated using Manly's B selectivity index (Manly *et al.* 2002), verifying its statistical significance with a chi-square test and Bonferroni's confidence intervals at 95% probability (Neu *et al.* 1974). We have used two indices because Jacobs' index is a classic test and therefore allows comparison with other studies, while Manly's B index is more innovative and gets more robust results. Data on food availability and prey selection were obtained from the arthropod sampling methods carried out in the three habitats (see Table S2).

Table 1. Abundance of arthropod taxonomic groups found in all collected faecal samples ($n = 12$) of Aquatic Warblers *Acrocephalus paludicola* during autumn migration, including total number of individuals, proportion of total prey number, frequency of occurrence in faecal samples and proportion of total fresh biomass.

(Sub)Order	Number of individuals	Proportion of prey number (%)	Occurrence (%)	Biomass (%)
Araneae	14	21.5	91.7	11.7
Heteroptera	14	21.5	75.0	4.0
Homoptera	12	18.5	83.3	3.1
Diptera	8	12.3	66.7	27.4
Hymenoptera	7	10.8	58.3	1.0
Coleoptera	6	9.2	50.0	2.2
Orthoptera	2	3.1	16.7	23.5
Odonata	1	1.5	8.3	25.8
Lepidoptera	1	1.5	8.3	1.3

RESULTS

Diet

We captured 12 Aquatic Warblers in 2013 and 2014. This represents around a fifth of the mean annual number of Aquatic Warblers captured every year in Spain during autumn migration in the last decade (Spanish ringing data banks). Eleven faecal samples were collected in 2013 (six adult and five young) and one in 2014 (adult): one per captured warbler. A total of 65 prey species were identified. The mean number of prey individuals in each faecal sample was 5.4 ± 3.5 ($n = 12$). Accumulation curves showed that from six faecal samples onwards each additional sample provided less than 5% new taxa. In terms of prey abundance, the warbler's diet was dominated by Araneae, Heteroptera and Homoptera (Table 1), with Araneae found to occur most commonly across samples. Mean length of prey consumed by Aquatic Warblers was 5.5 ± 4.4 mm. Most of the biomass consumed came from Diptera, Odonata, Orthoptera and Araneae, which together represented 86% of the total biomass. No significant differences were observed between young and adults with regard to diet composition ($F = 0.30$, $P = 0.83$) or diet variety ($F = 0.34$, $P = 0.55$). See Table S3 for details on diet composition.

Food availability

A total of 14,350 specimens were sampled in the wetland: 11,369 with sweep nets and 2,981 with yellow bowl traps (see Table S4 for details). Diptera were the most abundant group and accounted for almost half of the total samples. Considering both sampling methods together, overall abundance was highest in grassland (50%), followed by rushes (40%) and reeds (10%). The main arthropod groups (more than 50 individuals) were more abundant in grassland followed by rushes, except Heteroptera (more abundant in rushes) and Psocoptera (more abundant in reeds; see Table S5 and Figure S1). Arthropod composition significantly differed between the three habitats ($F = 15.45$, $P < 0.001$), pairwise comparisons being significant in all cases ($P < 0.05$).

Diet selection

With regard to prey selection, the chi-square test rejected the hypothesis that all groups were selected equally (χ^2_{13} = 70.4, $P < 0.001$). Thus, a highly significant preference for some groups of arthropods and not for others was observed. The Jacobs' index indicated high preference for Odonata, Orthoptera, Araneae and Lepidoptera, and moderate preference for Heteroptera (Table 2). Selection of the remaining groups either corresponded to their availability in the habitat or had a value of –1 as they were not found in faecal samples, except for Diptera, which, despite being well represented in the faecal samples, had a very high negative value. Manly's B index indicated a high preference for Odonata, which was the most selected group, followed by Orthoptera, Araneae and Lepidoptera. Bonferroni's confidence intervals showed positive selection for Araneae, negative for Diptera and a selection corresponding to prey availability for the other four orders; the rest were either not found in the faecal samples or their availability was too low to be compared with this method.

Table 2. Values of the Jacobs' and Manly's B selection indices and differences between the observed and expected values based on Bonferroni's confidence intervals ($P < 0.05$) for each arthropod group in El Villar lagoon. Jacobs' index varies between –1 (maximum negative selection) and +1 (maximum positive selection), and values close to zero indicate no selection. Manly's B selectivity index reflects the probability of selecting a specific resource on a scale of 0 to 1 depending on its availability. A test based on Bonferroni's confidence interval shows preference confidence levels indicating positive (>) or negative selection (<), or selection in proportion to availability (=). Arthropod groups with less than 5% availability cannot be categorised reliably.

Group	Jacobs' index	Manly's B index	Bonferroni confidence interval test	
			Observed	Expected
Araneae	0.70	0.091	0.215	> 0.046
Ephemeroptera	–1.00	0.000	0.000	0.002
Odonata	0.93	0.535	0.015	0.001
Orthoptera	0.80	0.171	0.031	0.003
Dyctioptera	–1.00	0.000	0.000	0.001
Pscoptera	–1.00	0.000	0.000	0.004
Heteroptera	0.45	0.044	0.215	= 0.095
Homoptera	0.18	0.026	0.185	= 0.137
Neuroptera	–1.00	0.000	0.000	0.010
Coleoptera	0.17	0.027	0.092	= 0.067
Trichoptera	–1.00	0.000	0.000	0.001
Lepidoptera	0.63	0.086	0.015	0.003
Diptera	–0.75	0.005	0.123	< 0.500
Hymenoptera	–0.11	0.016	0.108	= 0.131

DISCUSSION

Diet composition of Aquatic Warblers stopping over at the Iberian Peninsula was similar to that in their breeding areas in Poland (Schulze-Hagen *et al.* 1989) and at stopover sites in France (Audierne Bay: Kerbiriou *et al.* 2011; Seine estuary: Provost *et al.* 2010; Girondine estuary: Musseau *et al.* 2014; Brière marshlands: Marquet *et al.* 2014). The number of prey per faecal sample (5.4) was similar to that recorded in Audierne Bay and the Seine estuary (4.9 and 5.1, respectively), and differed from that found in Girondine (2.1). Araneae and Heteroptera were the most abundant groups found in the faecal samples; whereas in stopover areas in France, Homoptera and Diptera were the most abundant groups: together making up over 50% of consumed prey. Mean prey length was noticeably smaller than in Audierne Bay or in the breeding areas, where it exceeds 8.0 mm.

Most biomass was contributed by specimens with a large body size from Odonata, Orthoptera and Araneae, which is in agreement with other studies (Schulze-Hagen *et al.* 1989; Kerbiriou *et al.* 2011; Musseau *et al.* 2014). Additionally, Diptera biomass was also important in our study, since three out of eight Diptera specimens found in the faecal samples were Tipulidae, which have a considerable size and high biomass (Tipulidae accounts for 0.31% of Diptera captures in the availability samples). All in all, diet is relatively constant amongst breeding areas and stopover sites, though comparisons should be considered with some caution due to the low number of faecal samples analysed in our study.

In relation to food availability, the rushes and grassland of El Villar lagoon provide a greater variety and abundance of the principal groups of arthropods in the diet of Aquatic Warblers. In fact, radio-tracking studies in other stopover sites indicate that selected habitats have low levels of flooding and low-growing helophytic communities (Andueza *et al.* 2014). They also underline the importance of nearby areas of open water and stretches of highly heterogeneous vegetation (Provost *et al.* 2010, Musseau *et al.* 2014). Even in the Gironde estuary (Musseau & Herrmann 2013) there is a higher relative abundance of Aquatic Warblers in areas with lower-growing helophytes versus high reeds. Other authors have also reported that Aquatic Warblers select similar habitats, mainly those with the highest prey availability (Schäffer *et al.* 2006, Tanneberger *et al.* 2009, Arbeiter & Tegetmeyer 2011, Kloskowski *et al.* 2015).

The results for prey selection by Aquatic Warbler indicated that some arthropod groups were selected actively, particularly Araneae. All the indices used show a preference for groups with larger bodied species, and therefore a higher biomass, in comparison with others that are much more abundant but generally smaller. The selection of large-bodied prey could be the effect of an optimal foraging strategy (Stephens & Krebs 1986), thus obtaining high biomass with a relatively low foraging effort.

Waterlogged habitats with low-growing vegetation play an important role in the life cycle of the Aquatic Warbler's preferred prey, including some Orthoptera and Araneae (Baldi & Kisbenedek 1997, Kerbiriou *et al.* 2011), which are particularly abundant there. In El Villar lagoon different types of vegetation and open water combine to form a mosaic and create ecotones, which are also important for many other prey species, thus likely contributing to a better habitat quality for Aquatic Warblers at this stopover site. The feeding behaviour of this warbler – climbing between stems whilst hiding from predators – is an adaptation to waterlogged environments with low and dense vegetation (Leisler *et al.* 1989, Whittingham & Evans 2004), which has the most available biomass of prey invertebrates compared to other habitats (Arbeiter & Tegetmeyer 2011).

Our observations call for the development of strategies to conserve and manage wetlands as stopover sites with favourable feeding conditions for Aquatic Warblers. Management measures should, among other aspects, focus on increasing densities of large-bodied arthropod prey, which could be achieved by increasing patch heterogeneity in the form of habitat mosaics and maintaining or creating areas with open water (Kerbiriou *et al.* 2011). Measures such as grazing and cutting would provide suitable structural conditions for the development of young arthropods, including Orthoptera and Araneae (Schmidt *et al.* 2005). Special care should be taken in areas of intensive farming, where overuse of insecticides has a direct impact on the availability of grasshoppers and spiders and their prey (Wilson *et al.* 1999, Musseau *et al.* 2014). Similarities in the diet, conditioned by vegetation and water presence, suggest what wetland types are important during autumn migration of Aquatic Warblers. This knowledge of the foraging habitat quality at stopover areas can help the conservation of this highly endangered songbird.

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SAMENVATTING

Kennis van de voedselkeuze van vogels en inzicht in de voedselbeschikbaarheid is van groot belang om de ecologische waarde van doortrekgebieden voor een soort te kunnen inschatten en om effectieve maatregelen te kunnen treffen om habitats te herstellen en vogelsoorten beter te beschermen. De Waterrietzanger *Acrocephalus paludicola* is een op wereldschaal bedreigde vogelsoort die tijdens de najaarstrek in belangrijke mate gebruikmaakt van wetlands op het Iberisch Schiereiland. Tot nu toe is hier geen onderzoek uitgevoerd naar voedselkeuze en voedselbeschikbaarheid van de soort. In dit artikel wordt een onderzoek gepresenteerd naar de beschikbaarheid van Arthropoda (geleedpotigen, voornamelijk insecten en spinnen) in door Waterrietzangers gebruikte habitats (rietmoerassen, moerassen met russen, graslanden) in de lagune El Villar in het noordwesten van Spanje. Uit het onderzoek blijkt dat Arthropoda talrijker in rus- en grasvegetaties zijn dan in rietlanden. Vergeleken met rietlanden lijken moerassen met russen en graslanden zowel qua uiterlijk als qua samenstelling van de ongewervelde fauna veel op elkaar. Wat aantallen prooien betreft, wordt het voedsel van de Waterrietzanger in het gebied gedomineerd door Araneae (spinnen), Heteroptera (wantsen) en Homoptera (gelijkvleugeligen, zoals cicaden en plantenluizen). Qua biomassa zijn Diptera (vliegen en muggen), met name Tipulidae (langpootmuggen), Odonata (libellen) en Orthoptera (krekels en sprinkhanen) het meest belangrijk, gevolgd door spinnen. De selectie-indexen van de prooisoorten laten zien dat deze soortgroepen worden geprefereerd boven andere groepen, waarschijnlijk omdat de geprefereerde prooien alle groot zijn. De voedselkeuze van de Waterrietzanger in deze wetlands komt veel overeen met dat in het broedgebied en dat in andere doortrekgebieden, met dit verschil dat in El Villar spinnen getalsmatig de belangrijkst prooien zijn.

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SUPPLEMENTARY MATERIAL

Table S1. Plant species of three water-logged communities in the studied wetlands (recognized by their physiognomy and dominant species) and the estimation of plant cover by Braun-Blanquet (1979): +: <1%, 1: 1–5%, 2: 6–25%, 3: 26–50%, 4: 51–75%, 5: >75%.

Species/Community	Reeds	Rushes	Grassland
Range vegetation height (cm)	100–280	60–110	30–50
Maximum water depth (cm)	90	30	15
Agrostis stolonifera		1	
Alisma plantago-aquatica	+		
Allium sphaerocephalon			2
Apium nodiflorum			2
Asparagus officinalis		+	
Brachypodium phoenicoides		3	1
Bromus catharticus		+	
Carex cuprina		+	
Carex distans		+	
Carex divisa		2	1
Carex hirta		+	
Cirsium arvense		1	+
Cirsium pyrenaicum		1	1
Cirsium vulgare		+	
Convolvulus arvensis		+	1
Crepis vesicaria subsp. *taraxaifolia*		+	
Deschampsia cespitosa subsp. *subtriflora*		2	1
Eleocharis palustris		3	
Eleocharis uniglumis		1	
Elytrigia repens subsp. *repens*		+	4
Epilobium hirsutum		2	+
Epilobium parviflorum		1	
Festuca arundinacea subsp. *arundinacea*		+	
Galium aparine subsp. *spurium*		+	+
Galium palustre	+		
Galium verum			+
Holcus lanatus		+	
Juglans regia			+
Juncus acutiflorus		1	
Juncus articulatus		1	
Juncus compressus		1	
Juncus effusus		+	
Juncus inflexus		2	1
Lactuca serriola		+	+
Lycopus europaeus		1	+
Myosotis sicula		+	
Potentilla reptans		1	
Rorippa microphylla		+	1
Rumex conglomeratus			+
Rumex crispus		+	+
Schoenoplectus lacustris subsp. *lacustris*	5	+	
Scirpoides holoschoenus		3	3
Sparganium erectum subsp. *neglectum*			1
Torilis arvensis subsp. *recta*		+	
Typha domingensis		1	
Typha latifolia	1	+	1
Verbena officinalis		+	
Veronica anagallis-aquatica			1

Table S2. Selection indices used in the study.

Jacobs' selectivity index (Jacobs 1974):

$$S = (p - c) / (p + c - 2\,p\,c)$$

where *p* is the proportion of a taxonomic group of prey analysed in faeces and *c* the proportion of availability of that group throughout the study area.

Manly's B selectivity index (Manly *et al.* 2002):

$$B_i = w_i / \left(\sum_{i=1}^{I} w_j \right) \qquad w_i = \frac{u_i/u_j}{\pi_i}$$

where *wi* is the probability of selection of taxonomic group i, calculated from *ui* (number of prey from group *i*), *u*+ (total number of prey) and *πi* (proportion of prey from group i in comparison with the total number).

Table S3. Order, family and species of arthropods found in faecal samples of Aquatic Warblers *Acrocephalus paludicola*. The number of prey individuals is shown in brackets. *Taxa cited for the first time in the diet.

(Sub)Order	Family	Species
Araneae	Theridiidae (1)	
	Thomisidae (2)	
Odonata	Coenagrionidae (1)	*Ischnura elegans* (1)
Orthoptera	Tettigoniidae (1)	*Conocephalus discolor* (1)
Heteroptera	Coreidae (1)	
	Corixidae (1)	
	Lygaeidae (9)	*Cymus melanocephalus* (1)*
		Nysius thymi (8)*
	Tingidae (3)	*Agramma atricapillum* (3)*
Homoptera	Cercopidae (1)	
	Cicadellidae (3)	*Conosanus obsoletus* (2)*
		Neophilaenus lincatus (1)*
	Jassidae (2)	
Coleoptera	Catopidae (1)	
	Chrysomelidae (1)	
	Coccinelidae (2)	*Anisosticta novemdecimpunctata* (1)
	Ptinidae (1)	
Lepidoptera		
Diptera	Tipulidae (3)	
Hymenoptera	Ichneumonidae (1)	

Table S4. Number of prey items of each arthropod group found in the three sampled habitats of El Villar lagoon. The number of captures per sampling effort using sweep nets was highest in the grassland (39.1 ± 12.6 captures/m), medium in the rushes (29.8 ± 15.2) and lowest in the reeds (6.9 ± 1.5). The number of captures using traps was similar in the grassland and the rushes (42.8 ± 5.9 and 43.8 ± 29.8 captures/day, respectively) and lowest in the reeds (12.7 ± 8.1).

(Sub)Order	**Number of prey items**							
	Sweep nets			Yellow bowl traps				
	Reeds	Rushes	Grassland	Reeds	Rushes	Grassland	Total	% of overall total
Araneae	40	267	333	7	4	6	657	4.6
Ephemeroptera		2	17	2		3	24	0.2
Odonata	4	2	2				8	0.1
Orthoptera		21	29				50	0.3
Dyctioptera		2	10				12	0.1
Pscoptera	22	3	5	12	9	4	55	0.4
Heteroptera	64	1017	234	4	35	12	1366	9.5
Homoptera	44	539	1306	21	20	33	1963	13.7
Neuroptera	10	35	85		2	7	139	1.0
Coleoptera	34	135	682	2	28	78	959	6.7
Trichoptera	3	4	1				8	0.1
Lepidoptera		14	25	2	2	7	50	0.3
Diptera	740	2009	2191	303	1007	924	7174	50.0
Hymenoptera	75	415	948	28	208	211	1885	13.1
Total	1036	4465	5868	381	1315	1285	14350	100.0

Table S5. Results of generalized linear models (GLM) comparing the abundance of the main arthropod groups found in the three sampled habitats of El Villar lagoon. Differences in abundance between habitats are indicated by symbols: significantly higher (>), significantly lower (<) and no significant differences (=). Re: reeds, Ru: rushes, Gr: grassland.

Group	**Global test (χ^2)**	**Differences in abundance**	**Pair-wise comparisons**		
			Ru–Re	Gr–Re	Gr–Ru
Arthropoda	70.82^{***}	Re < Ru = Gr	***	***	
Araneae	267.05^{**}	Re < Ru = Gr	*	**	
Orthoptera	41.83^{***}	Re < Ru = Gr	***	***	
Psocoptera	19.02^{**}	Re > Ru = Gr	*	**	
Heteroptera	62.95^{***}	Re < Ru > Gr	***	***	***
Homoptera	46.33^{***}	Re < Ru < Gr	***	***	*
Neuroptera	78.90^{***}	Re < Ru < Gr	**	***	**
Coleoptera	939.58^{***}	Re < Ru < Gr	***	***	***
Lepidoptera	31.96^{**}	Re < Ru = Gr		*	
Diptera	29.48^{***}	Re < Ru = Gr	***	***	
Hymenoptera	139.98^{***}	Re < Ru < Gr	***	***	***

$^{*}P < 0.05$, $^{**}P < 0.01$, $^{***}P < 0.001$.

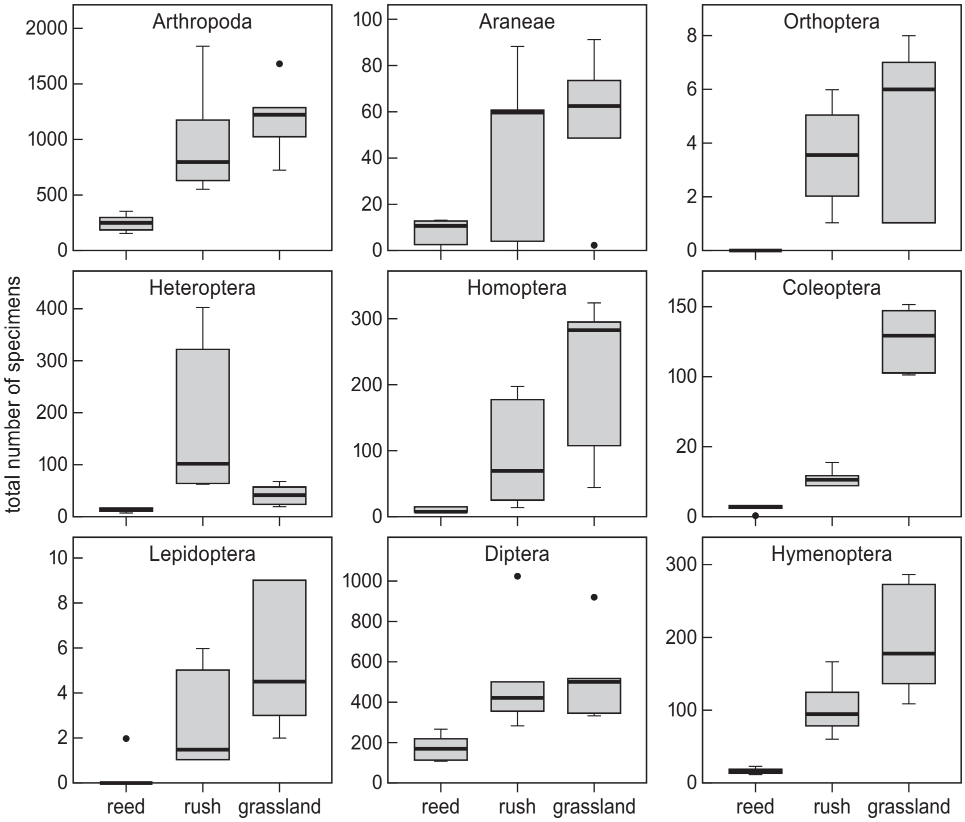

Figure S1. Boxplots of the overall arthropod abundance and those of the main arthropod groups found in the diet of the Aquatic Warbler *Acrocephalus paludicola*. Boxplots show the median (black line), the first and third quartiles (upper and lower limits of the box), 1.5 times the interquartile range from the box (ends of the whiskers) and values out of these limits (individual dots).