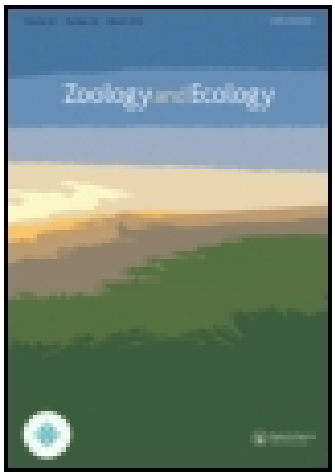

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Variation in the diet of Common Moorhen *Gallinula chloropus* (Aves, Rallidae) at Lake Réghaïa, Algeria

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The diet of the Common Moorhen *Gallinula chloropus* was studied at Lake Réghaïa (Algeria). A total of 600 faecal samples were collected from February 2010 to January 2012. The results showed that green plant materials (especially Poaceae) were the dominant faecal components (86.7 ± 23.8%), followed by invertebrates (13.2 ± 23.8%) and grit (0.03 ± 0.05%). Seventeen plant species belonging to eight different families were identified in 2010/2012. The major item identified in faecal contents was Poaceae. *Paspalum distichum* was the most important diet category. Others grasses mostly eaten were *Poa annua*, *Avena* sp., *Phragmites* sp. and *Panicum repens*. Other plant species recorded in faeces were *Carex hispida*, *Polygonum lapathifolium*, *Thypha angustifolia*, *Plantago major*, *Mentha pulegium*, *Plantago crassifolia*, *Panicum repens* and *Carex hispida*. The Common Moorhen diet contained invertebrates, and ephippium of *Daphnia* sp. were the most dominant. Insects were recorded, but with a negligible proportion.

Nendrinės vištelės *Gallinula chloropus* mityba buvo tiriama pagal Réghaïa ežere (Alžyras) surinktus ekskrementus. Nuo 2010 m. vasario iki 2012 m. sausio surinkta 600 ekskrementų mėginių. Rezultatai parodė, kad žalioji augalinė medžiaga (ypač Poaceae) buvo dominuojanti ekskrementų dalis (86,7 ± 23,8%). Bestuburiai sudarė 13,2 ± 23,8%, žvyras – 0,03 ± 0,05%. Tyrimo metu ekskrementuose aptikta 17 rūšių augalų, priklausančių 8 šeimoms. Poaceae augalai buvo svarbiausias ekskrementų komponentas. Dominavo *Paspalum distichum*. Kitos populiaresnės žolės buvo *Poa annua*, *Avena* sp., *Phragmites* sp. ir *Panicum repens*. Ekskrementuose taip pat aptikta *Carex hispida*, *Polygonum lapathifolium*, *Thypha angustifolia*, *Plantago major*, *Mentha pulegium*, *Plantago crassifolia*, *Panicum repens* ir *Carex hispida*. Nustatyta, kad nendrinės vištelės mito ir bestuburiais, ypač *Daphnia* sp. efipijomis, bei vabzdžiais, kurie sudarė nedidelę raciono dalį.

Keywords: Algeria; Common Moorhen; diet; faecal analysis; food composition

Introduction

The Common Moorhen *Gallinula chloropus* has a worldwide distribution and is found in North and South America, tropical Africa, and the cold and temperate zones of Asia and Europe (Sauer 1984). This bird prefers robust, emergent, tall grass-like vegetation interspersed with pools and channels containing leafy plants (Bannor and Kiviat 2002). Most Palearctic species of Rails, Gallinules and Coots (Rallidae) are omnivorous. Although their diets are made up of a very wide variety of both plant and animal foods (Cramp and Simmons 1980), they have not been well researched. Rails are usually associated with marshy habitats covered by dense vegetation, which makes their observation difficult (De Kroon 2004).

In Algeria, no data have been published about the food composition of the Common Moorhen *Gallinula chloropus*; direct observations are difficult to conduct since these birds are shy. The knowledge of Common Moorhen food habits in Algeria would increase the understanding of their environmental and nutritional requirements. Seasonal changes in diet are important to investigate because of differences in nutritional requirements during annual events such as moult, migration and reproduction (Hohman, Ankney, and Gordon 1992). This study aimed to describe the diet of the Common Moorhen at Lake Réghaïa (Algeria) by analysing faeces over the annual cycle.

Materials and methods

Study area

The nature reserve of Lake Réghaïa is located along the Mediterranean coast in northern Algeria. It is located between latitudes 36° 45′ and 36° 48′ North and longitudes 03° 19′ and 03° 21′ East, 30 km east of Algiers. The surface area of the reserve is approximately 842 ha and of the lake itself around 75 ha. Its hydrology depends on the flows of Réghaïa, El-Biars and Boureah Rivers. The littoral vegetation belt of Lake Réghaïa is dominated by Common Reed *Phragmites communis* and Lesser Bulrush *Typha angustifolia* with some mixture of Common Club-rush *Scirpus lacustris*, Cosmopolitan Bulrush *Scirpus maritimus* and Yellow Iris *Iris pseudacorus*.

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Faecal samples

Faecal samples were used to determine seasonal changes in Common Moorhen diet. This is a nonintrusive method that is commonly used to investigate diets of mammal and many bird species (Tigar and Osborne 2000). Faecal analysis is an accepted method for diet studies of herbivorous waterfowl and can provide quantitative measures of diet composition of these species (Owen 1975; Krapu and Reinecke 1992).

Faecal analysis has several unique advantages which account for its popularity as a research tool. These advantages are the absence of interference with the natural behaviour and usefulness in studying secretive and/or endangered species. However, faecal analysis has important disadvantages such as inaccuracy due to nonproportional composition compared to the food consumed, differences in digestion rates, difficulty to find some food items in faeces and an extensive reference plant collection required (Slater and Jones 1971; Owen 1975; Scotcher 1979).

Fresh faecal samples were collected where groups of Common Moorhens were observed resting. Before collection, birds were observed with a telescope, and a sketch was made using clumps of vegetation as reference points before wading to collect fresh faeces (Green and Sánchez 2003). A total of 600 faecal samples belonging to different individuals (up to 30) were collected at a rate of 25 samples per month. The mean number of fragments examined per faecal sample was 200 according to the method of Butet (1985). After various types of testing, it was found that the enumeration of 200 fragments taken randomly from a homogenized sample was representative of the composition of an individual bird's faeces.

All food items were compared to reference collection. A photomicrographic collection of epidermal tissue from lake plant species was prepared and used to identify plant fragments. Most epidermal fragments were identified to the species level.

Faecal samples were preserved in a paper cone. Before analysis they were rehydrated in water for 24 h. They were then washed through a 0.2-mm mesh sieve to eliminate small unidentifiable fragments (Sparks and Malechek 1968). The obtained samples were placed in bleach to 12° with slow agitation for 20 min to clear up epidermis fabrics and then rinsed with water. The plant fragments obtained were placed between the slide and slip cover with a drop of glycerinated gelatin and examined under a microscope.

Arthropod fragments were removed from the sample and placed in a Petri plate. They were identified to the lowest taxonomic unit possible by comparing it to reference collections of Arthropods collected at the Zoology Laboratory at the Department of Biology, Faculty of Biological Sciences and Agronomics, University of Tizi Ouzou (Algeria).

Fragments that could not be positively identified were recorded as unidentified. A proportion of grit in a faecal sample was scored relative to the number of fragments analysed.

Data analyses

Statistical analyses were performed using Stat. Box Pro 6.40. All data collected were expressed as a relative abundance of different food items in each faecal sample. Means ± SD were computed. The statistical significance of differences was tested by Student's *t*-test to determine whether plants consumed differed between the two study years.

Results

Food composition

Our results showed that the Common Moorhen fed almost exclusively on plants (86.7 ± 23.8%). The invertebrates constituted 13.2 ± 23.8%. Small amounts of grit (0.032 ± 0.05%) also were present. In 2010/2011, the faecal samples contained an average volume of 84.2 ± 29.1% of plant and 15.8 ± 27.8% of animal foods (Table 1), whereas in 2011/2012, they contained an average volume of 89.3 ± 17.8% of plants, 10.7 ± 17.8% of animals and 0.07 ± 0.09% of grit (Table 1). All plant species identified in the first season of our study were also identified in the second season, except for *Cynodon dactylon*, *Mentha pulegium*, *Inula viscosa*, *Potentilla reptans*, *Lycopus* sp. (Tables 2 and 3). Fifteen plant species belonging to eight different families were identified in 2010/2011 (Table 2). In the second season of our study, 13 plant species belonging to six different families were identified (Table 3).

The major item identified in faecal contents was Poaceae. It represented a mean relative abundance of 53.4% (CV = 54.5) in 2010/2011. Poaceae was followed by Polygonaceae (9.9%), Plantaginaceae (5.9%), Typhaceae (5.5%) and Cyperaceae (4.2%). Among Poaceae, a mean relative abundance was greater for *Paspalum distichum*, *Poa annua*, *Avena* sp. and *Phragmites* sp. with 20, 9.1, 8.9 and 7.7%, respectively (Table 2). Other plant species detected in faecal samples were *Polygonum lapathifolium* with a mean relative abundance of 9.9%, *Typha angustifolia* (5.5%), *Carex hispida* (3.5), *Plantago major* (3%) and *Plantago crassifolia* (2.9%). Other species were represented in negligible proportions with a high coefficient of variation but with the lowest relative abundance (Table 2).

In 2011/2012, a mean relative abundance recorded for Poaceae was 42.3% (CV = 51.7%), followed by Polygonaceae, Typhaceae, Cyperaceae, Lamiaceae and Plantaginaceae with 13.2, 11.7, 9.6, 5.8 and 6.5%, respectively. Other families occupied a negligible share (with a high coefficient of variation) (Table 3). Among Poaceae, the mean relative abundance was important for *Paspalum distichum* (20.1%; CV = 89.6%) and *Poa annua* (10%; CV = 121.7%). Other plant species

Table 1. Percentage of food items of plant/animal origin in the diet of Common Moorhens at Lake Réghaïa. Samples size: 24 food items in 2010/2011 and 25 food items in 2011/2012.

Study seasons and origin of food items in the diet	Months												
	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	I	$\bar{x}$
2010/2011 season													
Plant food items	100	100	100	100	45	22.7	42.6	100	100	100	100	99.7	84.2
Animal food items	0.0	0.0	0.0	0.0	55	77.3	57.4	0.0	0.0	0.0	0.0	0.3	15.8
Grit	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2011/2012 season													
Plant food items	99.8	99.2	100	100	60.7	47.6	70.6	94	99.6	99.9	99.9	100	89.3
Animal food items	0.2	0.6	0.0	0.0	39.2	52.4	29.4	5.9	0.1	0.1	0.1	0.0	10.7
Grit	0.0	0.2	0.0	0.0	0.2	0.0	0.04	0.1	0.3	0.0	0.0	0.0	0.07

Table 2. Relative abundance of food items in the diet of Common Moorhen at Lake Réghaïa by months and by taxons in 2010–2011. Total number of food items $n = 24$.

Plant and animal taxons	February 2010–January 2011												Statistics		
	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	I	$\bar{x}$	SD	CV%
Avena sp.	6.7	5.0	36.4	44.7	2.7	0.9	4.0	0.5	0.0	3.6	2.8	0.1	8.9	15.0	167.8
Cynodon dactylon	14.5	7.5	0.5	0.0	1.5	0.5	0.0	0.0	0.4	3.8	2.0	6.9	3.1	4.5	142.4
Panicum repens	10.1	10.3	10.4	13.0	4.3	3.3	0.9	0.0	0.9	0.3	0.1	0.8	4.5	5.0	109.4
Paspalum distichum	13.7	2.1	29.2	23.5	2.5	0.1	1.4	22.8	5.5	64.7	63.6	10.6	20.0	22.8	114.0
Phragmites sp.	0.4	0.3	0.0	0.0	0.2	0.2	6.0	48.0	26.3	3.4	7.0	0.2	7.7	14.7	192.2
Poa annua	24.2	24.8	9.7	8.8	10.2	1.1	1.1	1.7	0.4	5.8	4.8	16.6	9.1	8.6	94.8
Total of Poaceae	69.5	50	86.2	89.9	21.3	6	13.5	73	33.6	81.5	80.2	35.2	53.4	29	54.5
Carex hispida	0.1	0.9	1.0	0.1	0.0	0.0	14.2	1.5	4.3	5.2	11.9	2.8	3.5	4.8	136.7
Scirpus maritimus	0.9	0.0	0.2	0.9	0.1	0.0	0.0	0.0	0.0	0.6	1.5	4.0	0.7	1.2	170.5
Total of Cyperaceae	1.0	0.9	1.2	1.0	0.08	0.0	14.2	1.5	4.3	5.8	13.4	6.8	4.2	5.0	119.5
Typha angustifolia (Total of Typhaceae)	2.4	5.3	0.3	0.7	3.2	2.5	4.6	0.5	24.2	5.7	2.4	14.6	5.5	7.0	126.9
Plantago crassifolia	12.2	10.0	1.8	0.1	0.0	0.0	0.0	0.1	8.9	0.5	0.3	1.0	2.9	4.6	157.3
Plantago major	7.3	6.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.0	3.0	6.6	217.9
Total of Plantaginaceae	19.5	16.9	1.8	0.1	0.0	0.0	0.0	0.1	8.9	0.5	0.3	23	5.9	8.8	148.7
Polygonum lapathifolium (Total of Polygonaceae)	3.7	4.2	9.5	3.7	18.0	12.6	8.7	11.2	27.7	5.2	1.8	12.1	9.9	7.4	74.7
Inula viscosa (Total of Inulaceae)	0.1	17.5	0.5	0.0	1.6	0.2	0.0	13.8	1.3	0.6	0.0	0.0	3.0	6.0	201.8
Muntha pulegium (Total of Lamiaceae)	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.0	0.0	0.6	1.8	7.3	1.0	2.1	222.6
Potentilla reptans (Total of Rosaceae)	3.7	5.1	0.5	4.6	0.9	1.2	0.0	0.0	0.0	0.0	0.0	0.5	1.4	1.9	140.8
Invertebrates															
Coleoptera sp.	0.0	0.0	0.0	0.0	0.02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.002	0.01	346.4
Coleoptera–Curculionidae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.12	0.01	0.03	346.4
Hymenoptera Formicidae sp.	0.0	0.0	0.0	0.0	0.06	0.06	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.02	233.6
Formicidae *Messor barbara*	0.0	0.0	0.0	0.0	0.0	0.04	0.0	0.0	0.0	0.0	0.0	0.0	0.003	0.01	346.4
Hymenoptera–Formicidae *Tetramorium biskrensis*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.08	0.007	0.02	346.4
Hemiptera sp. 1	0.0	0.0	0.0	0.0	0.0	0.02	0.0	0.0	0.0	0.0	0.0	0.0	0.002	0.01	346.4
Hemiptera *Pyrrhocoris apterus*	0.0	0.0	0.0	0.0	0.04	0.0	0.08	0.0	0.0	0.0	0.0	0.0	0.01	0.03	258.7
Ephippium of *Daphnia* sp.	0.0	0.0	0.0	0.0	54.9	77.2	57.3	0.0	0.0	0.0	0.0	0.0	15.8	29	183.9
Unidentified invertebrates	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.14	0.012	0.04	346.4

Table 3. Relative abundance of food items in the diet of Common Moorhen at Lake Réghaïa by months and by taxons in 2011–2012. Total number of food items: 25.

	February 2011–January 2012												Statistics		
Plant and animal taxons	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	I	$\bar{x}$	SD	CV
Avena sp.	0.0	0.5	14.2	19.5	1.7	2.0	0.0	0.0	0.0	2.2	0.2	5.5	3.8	6.4	167.4
Hordeum murinum	1.0	0.0	0.0	0.1	1.3	1.0	0.2	0.0	2.7	2.8	0.2	4.3	1.1	1.4	125.0
Panicum repens	9.7	8.2	4.0	12.2	2.0	0.2	6.3	0.1	0.0	2.7	1.3	4.0	4.2	4.1	96.6
Paspalum distichum	6.4	10.3	58.6	43.0	6.2	0.0	2.2	25.1	34.8	26.3	16.5	11.6	20.1	18.0	89.6
Phragmites sp.	0.2	0.1	0.0	0.1	2.3	21.6	0.8	6.5	4.8	0.0	0.0	0.0	3.0	6.2	204.7
Poa annua	36.9	31.4	6.9	2.7	0.0	5.0	15.5	12.5	5.1	1.4	2.1	1.1	10.0	12.2	121.7
Total of Poaceae	54.2	50.7	83.7	77.6	13.5	29.7	25	44.2	47.4	35.3	20.4	26.4	42.3	21.9	51.7
Carex hispida	5.1	4.0	10.2	13.7	1.5	8.4	22.5	2.8	8.1	12.7	8.2	9.9	8.9	5.7	63.7
Scirpus maritimus	0.1	0.0	0.0	5.7	0.0	0.0	0.0	1.0	2.1	0.0	0.0	0.0	0.7	1.7	229.5
Total of Cyperaceae	5.2	4.0	10.2	19.4	1.5	8.4	22.5	3.7	10.2	12.7	8.2	9.9	9.6	6.2	64.4
Typha angustifolia (Total of Typhaceae)	12.4	7.0	0.1	0.0	18.3	3.3	6.4	12.1	20.8	19.7	15.1	25.0	11.7	8.4	71.7
Plantago crassifolia	1.4	1.1	1.2	0.0	0.0	0.0	0.0	0.0	0.0	1.3	19.3	2.3	2.2	5.4	244.4
Plantago major	0.2	1.2	0.7	0.0	0.0	0.0	0.0	8.8	0.9	8.0	18.8	13.2	4.3	6.4	148.1
Total of Plantaginaceae	1.6	2.3	2.0	0.0	0.0	0.0	0.0	8.8	0.9	9.3	38	15.5	6.5	11	169.9
Polygonum lapathifolium (Total of Polygonaceae)	8.2	17.0	3.5	2.2	12.0	6.2	16.8	15.5	15.4	22.2	16.8	22.7	13.2	6.8	51.6
Lycopus sp. (Total of Lamiaceae)	18.2	18.1	0.5	0.7	15.3	0.0	0.0	9.6	5.0	0.7	1.3	0.5	5.8	7.4	127.6
Invertebrates															
Coleoptera–Carabidae sp.	0.0	0.0	0.0	0.0	0.04	0.0	0.0	0.0	0.0	0.0	0.06	0.0	0.008	0.02	239
Coleoptera–Curculionidae *Apion* sp.	0.0	0.0	0.0	0.0	0.04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.003	0.01	346.4
Coleoptera–Staphylinidae sp.	0.0	0.32	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.027	0.09	346.4
Coleoptera chrysomelidea sp.	0.0	0.04	0.0	0.0	0.08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.010	0.02	248.6
Coleoptera sp.	0.02	0.0	0.0	0.0	0.1	0.1	0.268	0.528	0.0	0.0	0.02	0.0	0.09	0.16	185.5
Hymenoptera–Formicidae *Pheidole pallidula*	0.0	0.12	0.0	0.0	0.06	0.0	0.0	0.167	0.0	0.02	0.0	0.0	0.03	0.06	184.6
Hymenoptera Formicidae *Crematogaster* sp.	0.0	0.0	0.0	0.0	0.04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.003	0.01	346.4
Hemiptera sp.	0.1	0.0	0.0	0.0	0.0	0.0	0.038	0.0	0.06	0.0	0.02	0.0	0.02	0.03	177.7
Dermaptera *Forficula auricularia*	0.08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.007	0.02	346.4
Ephippium of *Daphnia* sp.	0.0	0.0	0.0	0.0	38.7	52.3	28.9	4.9	0.0	0.0	0.0	0.0	10.4	18.6	178.5
Unidentified invertebrates	0.0	0.1	0.0	0.0	0.1	0.0	0.15	0.2	0.04	0.06	0.02	0.0	0.061	0.08	122.7
Grit	0.0	0.2	0.0	0.0	0.16	0.0	0.04	0.11	0.26	0.0	0.0	0.0	0.064	0.09	146.7

detected in faecal samples were *Polygonum lapathifolium* with a mean relative abundance of 13.2%, *Typha angustifolia* (11.7%) and *Carex hispida* (8.9%) (Table 3).

During the first study season, invertebrates were mostly represented in June, July and August with a relative abundance of 55, 77.3 and 57.4%, respectively (Table 1). Ephippium of *Daphnia* sp. (Crustaceans) were the most dominant with 54.9, 77.2 and 57.3%, respectively. Insects were recorded, but with a negligible proportion. The species represented were *Pyrrhocoris apterus* in June and August with a relative abundance of 0.04 and 0.08%, respectively, Formicidae sp. in June and July (0.06%), and Coleoptera sp. (0.02%) in June. In July, *Messor barbara* was represented with a relative abundance of 0.04%; Hemiptera sp. was recorded with 0.02% in July. In January, unidentified invertebrates were most important with a relative abundance of 0.14%, followed by Curculionidae sp. (0.12%) and *Tetramorium biskrensis* (0.08%) (Table 2).

In June, July and August of 2011, animal foods occurred in the diet in greater proportions (with a relative abundance of 39.2, 52.4 and 29.4%, respectively) than during the rest of the year. In September, animal food constituted 5.9% (Table 1). Ephippium of *Daphnia* sp. were consumed in the largest quantity in June, July, August and September with a relative abundance of 38.7, 52.3, 28.9 and 4.9%, respectively. Insects were taken at low proportions. Coleoptera including Carabidae sp., *Apion* sp., Staphylinidae sp., Chrysomilidea sp. and Coleoptera sp. were predominant with a mean relative abundance of 0.13%. They were followed by Hymenoptera: Formicidae (0.034%), Hemiptera (0.02%) and Dermaptera (0.007%). Unidentified invertebrates were recorded with a mean relative abundance of 0.061%. Grit occurred in March, June and from August to October 2011 with a mean relative abundance of 0.064% (Table 3).

Seasonal variation of plant foods contained in faecal samples

The total richness of the plant foods consumed by the Common Moorhen varied from one month to another (Table 4).

It was the highest during winter and spring and the lowest during summer and fall. In 2010/2011, the highest richness was registered in February, March and January (14 species). The lowest value was noted in August and September (9 species). The plant species present in the faecal samples varied from one month to another. *Paspalum distichum* made up a high proportion of the Common Moorhen diet; November and December were the months when percentages of *Paspalum distichum* in faecal samples increased to a relative abundance of 64.7 and 63.6%, respectively. It was followed by *Poa annua* which was the most important in February, March and January with a relative abundance of 24.2, 24.8 and 16.6%, respectively. *Avena* sp. was dominant in April and May faeces with 36.4 and 44.7%, respectively. *Phragmites* sp. was the most important in September (48%) and October (26.3%). *Polygonum lapathifolium* was dominant in October (27.7%) and June (18%), and *Typha angustifolia* in October and January with a relative abundance of 24.2 and 14.6%, respectively (Table 2).

In 2011/2012, total richness was higher in February (12 species) than in all other months. The lowest value was recorded in July and August with eight species. *Paspalum distichum* made up a high proportion of the Common Moorhen diet. April, May, September, October and November were the months when percentages of *Paspalum distichum* in faecal samples increased to a relative abundance of 58.6, 43, 25.1, 34.8 and 26.3%, respectively. *Poa annua* was dominant in February and March faeces with 36.9 and 31.4%, respectively. *Avena* sp. was important in April (14.2%) and May (19.5%), and *Phragmites* sp. only in July (21.6%). *Carex hispida* was present in all months, a mean relative abundance was 8.9% (CV = 63.7%). *Typha angustifolia* was important in January, October, November and December with a relative abundance of 25, 20.8, 19.7 and 15.1%, respectively (Table 3).

When comparing plant food items, differences were significant between 2 years ($t = 2.53$, df = 22, $p > 0.05$). Total richness of the plant foods consumed by the Common Moorhen in 2010–2011 was higher than that of 2011–2012 with a mean of 11.83 ± 1.9 and 10.17 ± 1.27%, respectively.

Discussion

An analysis of the faeces of the Common Moorhen showed that a food spectrum was dominated by plants. Invertebrates were less represented. This is comparable to 93% of plant and 7% of animal foods reported by Mulholland and Percival (1982) in north-central Florida. In a study conducted in Porto Rico, over 90% of the Common Moorhen's diet consisted of grass and rootlets,

Table 4. Monthly fluctuations of the total richness of plant foods consumed by Common Moorhens at Lake Réghaïa in 2010–2012.

	Number of types of plant foods in each month											
Study seasons	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	I
February 2010–January 2011	14	14	13	11	11	10	9	9	11	13	13	14
February 2011–January 2012	12	11	10	11	9	8	8	10	10	11	11	11

6% of seeds of terrestrial grasses and weeds and about 3% of insects and molluscs (Wetmore 1916). This is also consistent with findings for other moorhen subspecies (Broshears and Parrish 1980; Cramp and Simmons 1980; Greij 1994). Hawaiian Moorhens (*Gallinula chloropus sandvicensis*) are primarily herbivorous, with plant tissue comprising up to an estimated 95% of gut contents (Broshears and Parrish 1980).

Seventeen plant species belonging to eight different families were identified during our investigation in 2010/2012. The major item identified in faecal contents was Poaceae. *Paspalum distichum* was the most important diet category. Other Poaceae mostly eaten were *Poa annua*, *Avena* sp. and *Phragmites* sp. In the Middle Paraná River (Argentina), Beltzer, Sabattini, and Marta (1991) found that leaves and stems of *Paspalum repens* and seeds of *Polygonum accuminatum* constituted the most abundant item in the diet of the Common Moorhen, followed by crustaceans, molluscs and insects. Sabattini and Lorenzatti (1987) reported that *Paspalum repens* was a very good quality nutritious food, given its high tenors of protein (11.59%) and low fibre (22%). On the other hand, this species presents higher dry matter content ($x = 9.30 \pm 1.2\%$) compared to other hydrophytes (Sabattini 1985; Emiliani et al. 1987).

Other plant species recorded in faeces were *Carex hispida*, *Polygonum lapathifolium*, *Thypha angustifolia*, *Plantago major*, *Mentha pulegium*, *Plantago crassifolia*, *Panicum repens* and *Carex hispida*. The importance of the proportion of these species in faeces could be due to their higher nutrition values. DesRochers et al. (2009) reported the gross energy and macronutrient content of 10 plant species consumed by endangered Hawaiian Moorhens (*Gallinula chloropus sandvicensis*) along with gross energy and macronutrient content of three plant species not known to be consumed by moorhens. Energy density, fat, ash, nitrogen, protein, carbohydrates and fibre of these wetland plants were analysed. Their results suggest that *Typha latifolia* was consistently high for energy content, fat and protein. It might be a potentially good plant for moorhens, and in fact, moorhens regularly use the plant in nest construction. *Paspalum vaginatum* also had low energy density and fat content, but medium values of other nutritional components relative to other species compared. The same authors also found that sedge species, including *Schoenoplectus californicus* (Cyperaceae), were consistently in the top 50% for nutritional values in all categories, except for nitrogen and crude protein. *Bolboschoenus maritimus* (previously, *S. maritimus*), *Cyperus polystachyos*, *Cyperus javanicus* (Cyperaceae) and *Echinochloa* sp. (Poaceae) had gross energy content.

Mulholland and Percival (1982) reported that the major foods of Common Moorhens were leaves and stems of *Hydrilla verticillata*, seeds of *Polygonum* sp., insects of the family Chrysomelidae, order Odonata and snails, *Planorbella* sp. Montalbano, Hardin, and Hetrick (1979) found a high utilization of *Hydrilla* by ducks and coots in central Florida study sites and suggested the importance of *Hydrilla* to waterfowl.

Ciach (2007) reported that there were often instances of Crakes and Moorhens foraging at distances greater than their body lengths. Instances of foraging 3–4 m from each other were common. The Common Moorhens generally keep to the cover of dense vegetation, wading or dabbling at the edges of open water to feed on grass and sedge seeds, *Phragmites*, *Ulmus*, *Rubus*, *Sorbus*, Rosa, berries, foliage, underwater plants, and duckweed (*Lemna* spp.) and various orchard fruits. Animal foods include earthworms, crustaceans, adult and larval insects, spiders, small fish, tadpoles and occasionally eggs of birds (Bent 1926; Del Hoyo, Elliott, and Sargatal 1996; DeGraaf and Yamasaki 2001).

According to Dillon Ripley (1977), the food of this species consists chiefly of vegetable matter, including duckweed, seeds of *Polygonum*, *Rumex*, *Ranunculus* and *Sparganium*, pond weeds and various other weeds, ivy, yew, bramble, sea-buckthorn and rowan, some fruits usually picked on the ground, plums, apples and pears. Insects recorded in the diet include caddis flies, Caterpillars, Hemiptera, Coleoptera, Hymenoptera and Diptera. Molluscs in the diet include *Limnaea*, *Planorbis* and *Helix.*

In Rio Grande do Sul, Brazil, the Common Moorhen was observed feeding on pieces of aquatic macrophytes (mainly *Eichhornia crassipes* and *Pistia stratiotes*) and removing macrophytes in search for invertebrates that utilize them as a habitat (Luz Wallau et al. 2010). They also observed the Common Moorhen eating small fish.

Telino-Júnior, Azevedo-Júnior, and Neves (2003) reported that in the State of Pernambuco (Brazil), the Common Moorhen fed on small insects found mainly in flowers of *Nymphaea rudgeana* and *Nymphaea coerulea*, in addition to their flower buds. However, results of the current study show that Common Moorhens were almost exclusively feeding on plants.

A comparison of the monthly faecal samples in two years showed that Common Moorhens relied on plant foods in all months, except for June, July and August, in the first year. While in the second year, they showed an increased reliance on animal foods only in July. The lists of foods identified in the two years contained 24 and 25 food items, respectively. *Paspalum distichum* was the most preferred species. Total richness of the plant foods consumed by Common Moorhens was very variable from one month to another. It was the highest during winter and spring and the lowest during summer and fall. The changes in abundance of different plants in the diet at Lake Réghaïa between months are probably related to the difference of plant food diversity in the feeding and resting areas of Common Moorhens.

In June, July and August, the faecal samples contained a high proportion of *Polygonum lapathifolium* and *Carex hispida* in the first year. While in the second year, they contained a high proportion of *Typha angustifolia*, *Phragmites* sp. and *Carex hispida*. These results may be

explained by a low diversity of plant food resources in summer (climatic conditions were less favourable) and by the fact that Common Moorhens were located in the nests surroundings to monitor offspring. Consequently, they consumed the plant species existing within the lake. The differences in the diet recorded between seasons may reflect differences in accessibility of food items. Plant phenology determines the availability and alimentary quality of a plant resource.

Our results showed that the animal fraction makes up a significant proportion in the diet of the Common Moorhen during the breeding period. Invertebrates present protein vital for duckling growth, as found in many other ducks (Krapu and Reinecke 1992). In both years, an increased consumption of *Daphnia* sp. (Crustaceans) may correspond to peaks in egg-laying by Common Moorhens at Lake Réghaïa. An increased amount of invertebrates in diets and their nutritional significance to waterfowl during the egg-laying period has been discussed by Krapu and Swanson (1975). Other Common Moorhen subspecies increase consumption of animal matter during breeding (Bannor and Kiviat 2002). In September (after post-breeding wing moults), the diet was based on plant species. In the territory of the Lake Réghaïa reserve, carrion behaviour was not noted for this species. However, Ciach (2004) reported that on the Vistula River in the centre of Kraków (south Poland), two adult moorhens were seen foraging on a dead gull. Information about moorhens consuming carrion is extremely rare. This phenomenon related to the secretiveness of this species possibly could be more common and it could be an adaptation.

Grit occurred with a very low relative abundance. According to Owen (1973), its role is to grind vegetative parts by breaking the cell walls. The ingested grit provides for optimum digestion because it increases the mobility and grinding action of the gizzard and enhances digestibility of coarse and fibrous foods in the remainder of the alimentary tract (Sturkie 1976).

Common Moorhens showed seasonal variations in the proportions of animal and plant food taken, and this may reflect seasonal changes in the availability of food, the need for a greater consumption of protein in the breeding season to satisfy the requirements for egg-laying. They increase their intake of animal food in summer, and plant food in spring, autumn and winter.

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Disclosure statement

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