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ORIGINAL PAPER

Behaviour of the Common Moorhen in Rio Grande do Sul, Brazil

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Abstract This study presents data on behavioural acts performed by the Common Moorhen *Gallinula chloropus* in southern Brazil, and compares these with the behaviours previously reported for other populations. Focal observations of individuals were conducted in the municipality of Santa Maria, in the central region of the state of Rio Grande do Sul, Brazil. The sampling was done in 2-hour sessions, between January and March of 2007. A total of 20 behavioural acts, grouped in seven categories, were identified and described: locomotion (*N*=5 acts), grooming (*N*=4), intra-specific behaviour (*N*=2), inter-specific behaviour (*N*=3), foraging (*N*=2), reproduction (*N*=2) and rest (*N*=2). Among the observed behaviours were acts that are not described in the literature such as greeting of offspring and some feeding acts. Regarding the use of habitat, we observed that this species has a preference for water or aquatic macrophytes, which is contrary to other reports. In the analysis of behavioural daily variation, overall behavioural categories did not vary significantly throughout the day, whereas we observed a significant difference in the use of categories during the periods 11:00 am–1:00 pm, 1:00–3:00 pm and 5:00–7:00 pm. The contrasting data between studies indicate that the variation between habitats and ecological interactions may generate different selective pressures on the behaviour of *G. chloropus*.

Keywords *Gallinula chloropus* · Behavioural acts · Populations · Behavioural geographic variation · Brazil

Introduction

The Common Moorhen *Gallinula chloropus* is a member of the rail family. The species 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 inhabits wetlands, lakes, small lagoons, and reservoirs (Belton 1994), preferring habitats with sparse palustrine vegetation (Sigrist 2006). The Common Moorhen is an adaptable species that is able to spread rapidly and colonise a wide range of habitats. In addition, the species is locally migratory, capable of flying during the night from one location to another (Sigrist 2006).

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Males and females are sexually monomorphic in plumage, although females are often smaller than males (Petrie 1983; Efe et al. 2001). The beak has a yellowish tip and a red base, which joins with the crown of the same colour. The legs are yellowish-green, with a red splash near the body. The animal has a "rump patch" composed of the partly white infra-caudal feathers that can be observed while the bird is swimming. The young are olive-drab, with a whitish throat, blackish beak, and small crown (Efe et al. 2001). Moorhens live in small family groups and may interact with other birds that inhabit the same environment (Moraes and Krul 1995).

Previous studies on the behaviour of the Common Moorhen stop short of describing and explaining some of the behavioural aspects such as the success of nest-building, incubation, and dispersal (Byrd and Zeillemaker 1981; Eden 1987; Forman and Brain 2004; Petrie 1983), vigilance against predators (Alvarez 1993; Alvarez et al. 2006), parasitism (Gibbons 1986; MacRae 1996a), social interactions (Alvarez et al. 2005a, b; Eens et al. 2000; Leonard et al. 1988; Petrie 1983, 1984, 1988; Randler 2007; Ueda and Narui 2004), and reproduction (Bannor 1997; Fenoglio et al. 2002; Forman 2005; Forman and Brain 2004; Gibbons 1986; Gibbons 1987a, b; Jamieson et al. 2000; MacRae 1995, 1996a, b, 1997, 1998; MacRae and Burke 1996; Post and Seals 2000; Siegfried and Frost 1975). Thus, the aims of this study were to describe the behavioural repertories and analyse the distribution of behavioural aspects throughout the day in populations of the Common Moorhen *G. chloropus* in southern Brazil, and to compare these with the behaviours previously described for other populations.

Material and methods

Study area

The study was undertaken in the municipality of Santa Maria (29°41′S, 53°48′W), in the central region of the state of Rio Grande do Sul, Brazil, in two neighbouring reservoirs, which are separated by a dirt road. The reservoirs cover areas of 8.815 and 18.377 m^2 and are affected by different types of human actions, including trash deposits, and domestic and agricultural runoff (from rice paddies). The advanced eutrophication in these environments is evidenced by the presence of large rafts of floating aquatic macrophytes (*Eichhornia crassipes* and *Pistia stratiotes*) (Esteves 1998), which occasionally completely cover both reservoirs. Approximately 20–30 individuals of Common Moorhen were counted in the two reservoirs. These are divided in four to six distinct groups that contained adult and young individuals.

Observational design

Observation was conducted over the period from 7:00 to 19:00 hours, in 2-h sessions (i.e., 7:00–9:00 am, 9:00–11:00 am), between January and March 2007, through the ad libitum method (Lehner 1996). This method was chosen because it allows the observer to record the time in minutes of each behavioural act and the behavioural sequence between the acts. All sessions were repeated at least five times, amounting to a total of 60 h of observation; however, only 48 h of observations were used to obtain quantitative data.

In order to describe the behavioural repertory, behavioural acts grouped into behavioural categories were defined based on Porto and Piratelli (2005). In addition, behavioural illustrations were prepared. The time of each behavioural act was counted in minutes. Only behavioural acts that were observed for at least 1 min were considered. The total time of each category was evaluated by a Chi-square test to examine if the behavioural categories have significant differences between them. The one-way ANOVA via randomisation (bootstrap with 1,000 interactions) was utilised to test the differences found in each category throughout the day and within each period of the day. For this purpose, the mean time was obtained for each category in each 2-h block.

Results

A total of 20 behavioural acts were described, grouped into seven categories: locomotion ($N=5$), grooming ($N=4$), intra-specific behaviour ($N=2$), inter-specific behaviour ($N=3$), foraging ($N=2$), reproduction ($N=2$), and rest ($N=2$).

Locomotion: walking, running, jumping, flying, and swimming

Walking The Common Moorhen walks on plant substrates (e.g., *E. crassipes* and *P. stratiotes*) flicking its tail and showing its rear "tail light". When walking, the Common Moorhen keeps its neck raised, bobbing its head back and forth.

Running The bird inclines its body and extends its neck forward, taking quick steps in the desired direction.

Jumping The bird generally performs this behavioural act when it is on a certain substrate (branches or aquatic vegetation). When jumping in the desired direction, it flexes its legs and occasionally beats its wings (Fig. 1a).

Flying Long flights (>10 m): during the initial beating of the wings, the bird flexes its legs and feet; upon taking

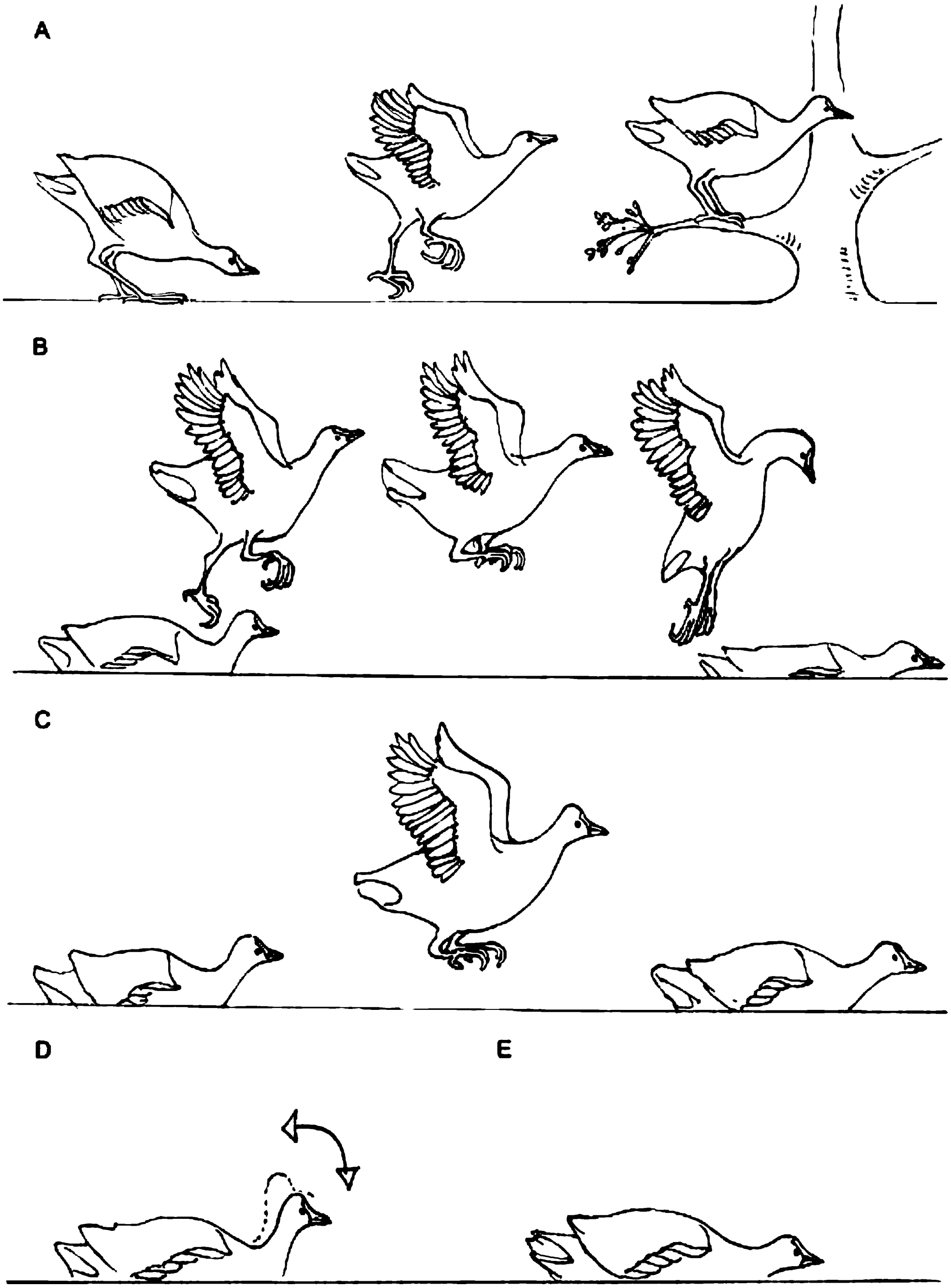


Fig. 1 Locomotion. **a** Jumping. **b** Long flights. **c** Short flights. **d** Slow swimming. **e** Fast swimming

flight, it hides its legs below the tail feathers, extends its neck forward, and beats its wings constantly (Fig. 1b).

Short flights (<10 m): the bird flexes its legs and positions its feet in a semi-inclined manner for impulsion; it extends its neck out, flying close to the surface of the water (occasionally dipping its feet into the water). Upon landing, it retracts its legs and feet, beats its wings slowly, and retracts its neck (Fig. 1c).

Swimming Slow swim: the individual beats its feet in the water and bobs its head from front to back (Fig. 1d).

Fast swim: the individual beats its feet more quickly in the water, extending its wings backward and the neck forward, ploughing through the water (Fig. 1e).

The categories flying and jumping occur in agonistic intra- and inter-specific interactions.

Grooming: bathing, shaking the feathers, preening the feathers, and cleaning the beak

Bathing Bathing is undertaken in shallow depths near the shore of the reservoir. Standing, the bird dips the front portion of its body ten to 20 times, making the water run down the dorsum; it then dips the posterior portion of the body (tail) three to five times.

Shaking the feathers After bathing, the birds roost in the vegetation (*Polygonum punctatum* and *Mimosa bimucronata*) and shake their feathers to remove water from their bodies.

Preening the feathers Preening is done in dry places, in sunlight, on branches, or on aquatic vegetation, and includes four subcategories: preening the wing feathers, preening the breast feathers, preening the dorsal feathers, and preening the axilla feathers.

> Preening the wing feathers: The individual preens its feathers with its head facing backward and sometimes smoothes its feathers with its beak.
> Preening the chest feathers: The individual, standing on the substrate, angles its head downward and preens its feathers in the chest area or smoothes the feathers in this area with its beak.
> Preening the dorsal feathers: The individual angles its neck, turning the head towards the dorsum, and preens or smoothes the feathers in this area with its beak.
> Preening the axilla feathers: With one wing half-open, the individual turns its head in the direction of the wing and alternately preens and smoothes the axilla with its beak.

Cleaning the beak The bird lowers its head and passes its feet over its beak repeatedly.

Intra-specific behaviour: *intra-specific aggression* and *greeting of offspring*. Intra-specific aggression is divided into two subcategories: *attack–escape* and *combat*.

Intra-specific aggression This behavioural act occurs probably as the result of disputes over foraging areas when there is encroachment by individuals from different groups (adults and offspring). The individual that moved in attack position toward the other individual (swimming rapidly) was considered the attacker. The individual that moved toward the foraging area of the attacker was considered the intruder.

> Attack–escape: An adult individual would attack an intruder from a neighbouring moorhen group when the latter invaded the former's territory. The intruder, upon perceiving the attack, would swim rapidly and then dive (about 3 m underwater) or would fly in the opposite direction from the attack, making long or short flights. A three-step sequence of behaviour in attack–escape was observed:

1. Initially, the attacking individual swims normally, bobbing its neck. Upon sighting the intruding individual, it departs in that direction, approaching with its neck extended, ploughing the water (swimming rapidly). The attacker, from a distance of about 2 m from the intruder, initiates the attack with long and short flights, according to the distance that it maintains from the intruder; it may or may not touch its feet in the water.
2. The intruder, upon observing the approach of the attacker, departs in the opposite direction with its tail pointing upward, utilising two strategies of escape: (a) short flight or long, either touching its feet in the water or not, and (b) the individual dives in the water and moves about 3 m away underwater. This strategy is generally utilised by young individuals and rarely by adult individuals.
3. The attacker, upon returning to its point of origin, keeps its neck raised vertically for 15 to 20 s, and then bristles its feathers after that interval.

The attack–escape behavioural pattern may occur in isolation or be repeated in sequence. There may be more than one intruder per attacker or even more than one attacker per intruder in the same location.

> *Combat* The individuals face each other on the water with their bodies in the vertical position, with their heads raised and beaks pointed in the direction of the opponent. They use their beating wings to maintain balance and attack with the feet and beak.

Greeting of offspring This behavioural act is undertaken when the offspring comes from an encounter with a parent, the parent makes a sign of greeting to the nestlings with a movement of the head from up to down, positioning the beak on its own chest (Fig. 2). This behaviour is repeated for each nestling that approaches.

Inter-specific behaviour: inter-specific aggression, tail-flicking, and stationary observation

Inter-specific aggression Adult individuals of Common Moorhens have been observed chasing *Jacana jacana* (Wattled Jacana), *Porphyrio martinica* (Purple Gallinule), and *Pitangus sulphuratus* (Great Kiskadee), when these

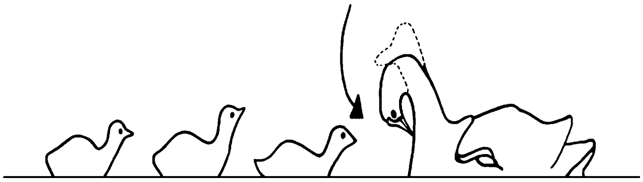


Fig. 2 Greeting of offspring

species invaded the area where a Common Moorhen group was foraging or when they approached the nests and offspring. Chasing is done through short-level flights or rapidly swimming with the neck extended forward in the direction of the individual of the other species. The fleeing individual swims or flies in the opposite direction from the Common Moorhen.

Tail-flicking This demonstrates rapid vertical movements of the tail to show the rump patch. This act is observed when the Common Moorhen is walking over the substrate or when it is swimming (Fig. 3).

Stationary observation The bird remains stationary, observing its surroundings with 2 ft on the substrate, or roosting on branches or plastic soda bottles. This behaviour was observed in the presence of the falcons and hawks Southern Caracara *Caracara plancus*, Yellow-headed Caracara *Milvago chimachima*, Chimango Caracara *Milvago chimango*, and Roadside Hawk *Rupornis magnirostris*.

Foraging: eating and drinking

Eating The bird utilises three methods for obtaining food. In the first, while either stationary or walking, it picks at portions of vegetation, removing and ingesting pieces of aquatic macrophytes (mainly *E. crassipes* and *P. stratiotes*). In the second, the bird utilises its beak as bait, bobbing the head from one side to the other with the beak partially immersed in the water, with the objective of attracting small prey. In the third, the bird picks up pieces of plants with its beak in order to capture small invertebrates that live in association with macrophytes. The Common Moorhen may forage alone or in groups of up to six individuals, including offspring.

Drinking When swimming, the birds stick their beaks in the water and then raise the neck pointing upward in order to swallow the water. These movements are performed from two to six times in sequence when the individual is swimming slowly or when it is stationary.

Reproduction: courting and copulating

Courting An individual A walks in circles, either to the left or to the right, over the substrate (aquatic vegetation or field vegetation). Upon stopping, the head is positioned at the substrate level, and the tail is directed upward, showing the anal shield. Individual B, upon observing this behaviour, moves rapidly toward the encounter with individual A. Upon the first bodily contact, B extends its neck upward and places the breast in A's wing area, generally doing two or three laps in a circle together with A (Fig. 4).

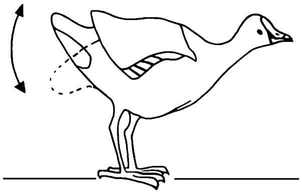


Fig. 3 Tail-flicking

Copulating An individual A stops in the same initial position of the courting process, with the head placed level on the substrate and the tail directed upward (Fig. 5), and individual B rises over A, with copulation occurring in this position and lasting from 10 to 30 s. These behavioural acts (courting and copulating) were observed only twice during the sampling period.

The individuals described above were designated as A and B because Common Moorhen adults are sexually monomorphic; they possess identical morphometric measurements, and there is no record of observation related to the copulation position for the species. Hence, in order to differentiate the sexes with precision, the utilisation of molecular tools is necessary (Lee and Griffiths 2003).

Resting: sprawling and wings open/half-open/beating

Sprawling An individual remains on the substrate, and extends one wing and one leg, on the same side of the body, backwards, and the neck forwards.

Wings open/half-open/beating The behavioural act occurs between the acts of eating and drinking when the bird stops foraging. It is observed only when the sun's rays strike the substrate.

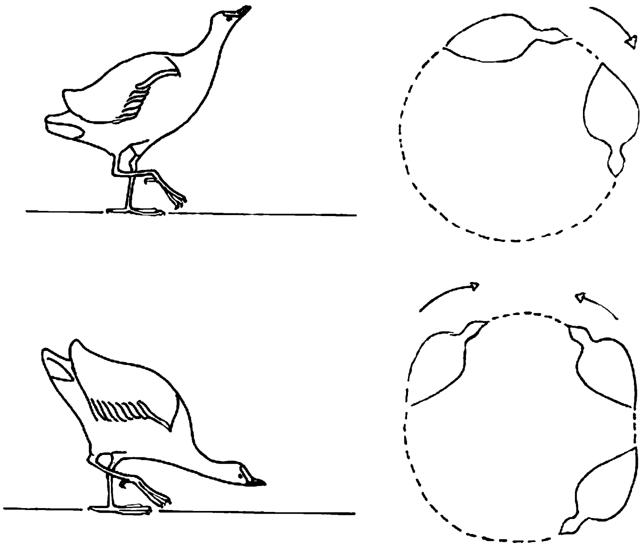
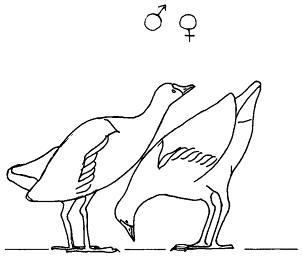


Fig. 4 Courting

Fig. 5 Start of sexual intercourse



Daily behavioural distribution

The Common Moorhen exhibits behavioural categories in different intensities. Foraging was the most common category, with occurrence of 28.5% of the time, followed by resting (24.0%), locomotion (22.3%), grooming (19.9%), and agonistic interactions (5.2%). The Chi-square test showed a significant difference in the frequency of these categories ($X^2=388.05$, df=4, $p<0.0001$).

The mean times and standard deviations of the behavioural categories (in minutes) are shown in Table 1 and Fig. 6. The mean time of each category during daylight did not vary significantly ($p>0.05$). However, there were significant differences in the time length of categories in three periods of the day: 11:00 am–1:00 pm (ANOVA bootstrap=5.905, $p=0.003$), 1:00–3:00 pm (ANOVA bootstrap=7.353, $p=0.08$), and 5:00–7:00 pm (ANOVA bootstrap=8.474, $p=0.023$).

Discussion

The Common Moorhen performs the greater part of the described behaviour on the surface of reservoirs, as much in the water as on the aquatic macrophytes; it was rarely seen moving about and foraging along the shore. These observations contrast with the study of Acquarone et al. (2001) in Italy, where the dominant habitat is grass field.

The 20–30 individuals counted in both reservoirs may be the result of the species population peak occurring in the months of January and February (Telino-Júnior et al. 2003), the period in which the study was undertaken, or due to the high degree of eutrophication of the reservoirs, as a consequence of the depositing of domestic trash and runoff, which indirectly supply more resources for the proliferation of the species. As described in other still-water environments, the accumulation of organic matter increases nutrient availability in the ecosystem and, consequently, population increases in associated species (Matsumura-Tundisi et al. 2002).

Locomotion and grooming

The behaviours described in the locomotion and grooming categories was quite similar to those described for the same species by Moraes and Krul (1995). Locomotion was observed frequently, mainly swimming and walking. This is likely because the species is a generalist with regard to habitat, covering a greater portion of the area that it inhabits. The five behavioural acts described in the category grooming were observed alternately after bathing or in the intervals between other behavioural acts.

Social interactions

Some species are commonly associated with the Common Moorhen such as the *Amazonetta brasiliensis* (Brazilian Teal), the *J. jacana* (Wattled Jacana), and the *Vanellus chilensis* (Southern Lapwing) (Moraes and Krul 1995). The same species were associated to the Common Moorhen here, in addition to the previously cited *J. jacana*, the *P. martinica* (Purple Gallinule) and the *P. sulphuratus* (Great Kiskadee), being observed sharing the same habitat. The difference in the bird species associated with the Common Moorhen may be a function of the differences in the areas, or even more possibly, to the period of sampling of the study. All incidents of inter-specific aggression occurred when other species of birds approached groups of Common Moorhens while they were feeding.

Tail-flicking was another behaviour present in the inter-specific interactions. According to Sick (1997), the Common Moorhen demonstrates nervousness by nearly constant tail-flicking. This behaviour was mentioned by Teixeira (1981) and described by Alvarez et al. (2006) as a possible defence mechanism whereby the prey (the Common Moorhen) signals to possible predators its level of

Table 1 Time of each activity of the Common Moorhen during the daylight period at Santa Maria, Rio Grande do Sul state, southern Brazil. Means ± standard deviations in minutes ($N=48$ h) are provided

Time	Locomotion	Foraging	Grooming	Social interactions[a]	Resting
7–9	26.75 (±15.65)	31.50 (±1.73)	24.25 (±16.50)	9.0 (±7.61)	28.50 (±12.82)
9–11	31.33 (±19.55)	39.33 (±16.16)	22.67 (±17.21)	2.67 (±1.53)	24.0 (±7.94)
11–13	28.12 (±10.55)	33.37 (±5.12)	22.55 (±11.44)	4.25 (±4.34)	13.12 (±13.19)
13–15	17.33 (±8.39)	23.67 (±4.16)	17.0 (±2.64)	6.67 (±8.96)	55.0 (±22.72)
15–17	24.66 (±13.05)	33.83 (±20.83)	21.50 (±29.55)	7.83 (±8.40)	33.33 (±32.74)
17–19	27.50 (±1.73)	38.0 (±12.83)	26.25 (±1.50)	6.0 (±4.55)	22.25 (±11.32)

[a] Social interactions (intra-specific behaviour and inter-specific behaviour)

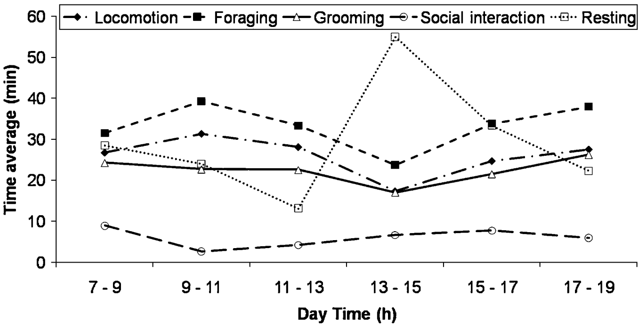


Fig. 6 Mean times of behavioural categories throughout the day. Locomotion (*losenge*), foraging (*black Square*), grooming (*triangle*), social interactions (*circle*), and resting (white Square)

awareness and vigilance, thus reducing its individual risk of predation. This idea was corroborated by Randler (2007) who affirmed that the tail-flicking behaviour becomes more frequent whenever a possible predator approaches.

In the intra-specific behaviour category, the Common Moorhen showed movements similar to the attack–escape and combat movements found by Craig (1977) for *Porphyrio porphyrio melanotus*, the Purple Gallinule. Most of the time, combat occurred between individuals from different groups, which were probably competing for foraging areas, with frontal attacks, using the beaks and feet as weapons. Sigrist (2006) and Wood (1974) mentioned that a Common Moorhen couple defended its territory against intra-specific invaders, facing them moving subtly the body slightly outside water by rapidly moving the feet and wings, in a tentative to move upward from the water.

MacRae (1998) described the parental care of the Common Moorhen as an important strategy for survival of the offspring. The behavioural act "greeting of offspring" that we have described corroborates the existence of parental care in this species. In contrast, Leonard et al. (1988) noted that this kind of behaviour also shows parent-offspring aggressions that possibly reduce competition among siblings and encourage chick independence.

Feeding behaviour

Beltzer et al. (1991), in their study undertaken in a still-water environment near the Middle Paraná River, Argentina, described the Common Moorhen as having an omnivorous diet and feeding mainly on leaves and stems of *Polygonum repens* and seeds of *Polygonum accuminatum*, and secondarily on crustaceans, molluscs, and insects. Similarly, in our study, the bird was observed feeding on pieces of aquatic macrophytes (mainly *E. crassipes* and *P. stratiotes*) and removing macrophytes in the search for invertebrates that utilise them as habitat. We also observed the Common Moorhen eating small fish. In the state of Pernambuco, Brazil, Telino-Júnior et al. (2003) reported the Common Moorhen feeding on small insects found mainly in flowers of *Nymphaea rudgeana* and *Nymphaea coerulea*, in addition to its flower buds.

Reproductive behaviour

The behavioural acts related to reproduction were observed in the sequence of courting and copulating, respectively. The duration of these behavioural acts combined was approximately 1 to 2 min. The position of copulation described here is similar to that described for *P. porphyrio melanotus* (Craig 1977). After coupling, the Common Moorhen begins the construction of nests and lays eggs beginning in May (Bannor 1997). Generally, this species lays five to seven eggs, with each female producing one clutch per mating season (Sigrist 2006). However, there are populations that have two or more clutches per mating season, as in Miami, North America (Bannor 1997) and Cambridgeshire, United Kingdom (Eden 1987; Gibbons 1987b). In the present study, we observed that parents were usually together with four or five small young individuals and two or three larger young individuals. These were likely individuals from different clutches. The first brood of juveniles remains home 18 days on average after the second brood is hatched (Eden 1987), to assist the parents in protecting the territory and in obtaining food (Eden 1987; Skutch 1935; Skutch 1961). This aid also results in a significant increase in the number of individuals in the second brood (Gibbons 1987a).

Resting

Sprawling may be related to maintaining the muscles well stretched, which is necessary for chasing and escaping in intra- and/or inter-specific interactions. The bird was observed assuming an immobile posture, which may have an unknown adaptive advantage, possibly a sub-product of other behaviour.

The behaviour of maintaining the wings in differing degrees of openness may be related to various factors including thermoregulation, facilitation of the removal of parasites, increase in vitamin D synthesis, facilitation of balance, social exhibition, social signalling for the success of foraging, shade for the nest, and reordering, grooming, or drying of feathers (Oliveira 2005). Because we did not observe nests during this study, we were unable to confirm that the shading of the nest contents is a possible result of maintaining the wings in differing degrees of openness. Resting is a plausible explanation for this behaviour.

Daily behavioural distribution

The quantitative analysis showed that during the summer, the frequencies of the different behaviours did not vary significantly throughout the day.

Similarly, in a study carried out in Italy during the spring (Acquarone et al. 2001), the Common Moorhen maintained constant activity throughout the day, with an upward trend from 12:00 am to 2:00 pm. In our analysis, we found an upward trend for resting from 1:00 to 3:00 pm (Fig. 4), possibly related to the high temperatures at this time of day, in accordance with the observations of Acquarone et al. (2001).

In Scotland, Fordham (1978) observed a higher feeding frequency just before sunset than after sunrise. Here, we observed no significant difference in feeding throughout the day (Table 1). This difference between populations in foraging for food may be due to human presence (which has a strong impact in the study area), seasonal differences, and the climatic zones where the studies were carried out. According to Pollock and O'Halloran (1995), people indirectly offer food supply in the environment near cities, which probably changes the feeding time of the Common Moorhen.

Conclusion

The contrasting behaviours between populations of the Common Moorhen in different regions suggest that site-specific ecological conditions may exert differential selective pressures on the behavioural development and distribution throughout the day.

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