

Breeding behaviour of Brazilian Merganser *Mergus octosetaceus*, with a tree-cavity nest in Serra da Canastra National Park, Minas Gerais, Brazil

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Embora os esforços para a preservação do pato-mergulhão *Mergus octosetaceus* tenham aumentado na última década, seu comportamento reprodutivo permanece com muitas lacunas a serem esclarecidas. Até o momento, apenas dois ninhos foram relatados e ambos descrevem informações parciais. Este trabalho apresenta o comportamento reprodutivo de um casal de *M. octosetaceus* que se reproduziu em uma cavidade arbórea durante os anos de 2005, 2006 e 2007. São descritos os comportamentos desde a incubação dos ovos até os cuidados parentais observados após o abandono da área de nidificação. Descreve-se ainda as características do ninho, a avaliação ambiental da área de nidificação e detalha-se o comportamento dos pais durante a incubação e após a eclosão dos ovos. O comportamento da família durante o abandono do ninho, o comportamento dos filhotes e os cuidados parentais nos seus primeiros dias de vida também são descritos. Este artigo é o primeiro relato do comportamento reprodutivo do pato-mergulhão, espécie criticamente ameaçada, o qual houve o acompanhamento de todas as etapas acima descritas.

Brazilian Merganser *Mergus octosetaceus* is one of the rarest waterfowl in the world, categorised as Critically Endangered⁸. Originally distributed across central-south Brazil and adjacent Argentina and Paraguay, in Brazil its range once encompassed Bahia, Goiás, Minas Gerais, Tocantins, Paraná, São Paulo, Rio de Janeiro and Santa Catarina⁷, and it is still present in the headwaters of the São Francisco, Tocantins and Paraná river basins. The species inhabits forested rivers rich in rapids in unpopulated regions, it being one of the few Brazilian birds adapted to montane rivers¹³. They are territorial and monogamous, with pairs apparently remaining on the same stretch of river their entire lives¹¹. The total population is hypothesised to be no more than 250^{3,5,11}. In Serra da Canastra National Park, Minas Gerais (SCNP) the population was estimated to be c.80 birds⁹.

Little has been reported concerning the species' breeding behaviour, as only two nests of *M. octosetaceus* have been described. Partridge¹² found a nest in a tree hole in Misiones, Argentina, and Lamas & Santos¹⁰ a rock fissure nest in the SCNP, from which the female disappeared before the eggs hatched. Our purpose here is to describe the breeding of a pair of Brazilian Mergansers during 2005–07, including incubation, hatching and parental care.

Methods

On 10 July 2005 an employee of the SCNP observed a female *M. octosetaceus* leaving a tree-cavity nest beside the rio São Francisco, and the nest was monitored on 12–18 July 2005. In 2006, the female returned to the same nest, and was monitored on

18 June–13 July, and again on 15 June–18 July 2007. The nest was in the lower part of the park (20°18'S 46°35'W), at c.880 m. The pair's behaviour was monitored using notes and photographs, from dusk until dawn, for a total of 67 hours in 2005, 111 hours in 2006 and 208 hours in 2007. To facilitate observation and minimise disturbance, a camouflaged tent was placed c.13 m from the nest. After departing the nest, the pair and their young were monitored on 19–23 July 2005 for a total of 24 hours. In 2006, the family was monitored sporadically on 14 July–2 September, totaling 36 hours of observation. In 2007, the family was monitored sporadically in July–September, with ten hours of observations.

Results

Nest characteristics.—The *Calophyllum brasiliense* (Clusiaceae) tree supporting the nest was c.2 m from the river and c.10 m high, with dbh of 1.3 m. The nest's opening faced north-east into direct sunlight, and was 1.5 m above ground and 4 m above water level. Oval, the opening had a max. height of 64.5 cm and max. width of 9.8 cm. The main opening continued downward as a fissure c.2.5 cm wide to the base of the nest, which was 52 cm deep (Fig. 1). Via this fissure, it was possible to view inside the nest, including the eggs and young. The base of the nest was c.1 m above ground, the inner chamber being 25 cm wide and 31 cm long. Materials used comprised old layers of feathers and eggshells.

The relevant part of the river flows between rocks of different sizes, and is not more than 1.5 m deep and c.12 m wide. Slight currents are found

100 m above and 50 m below the nest. The riverbed in front of the nest comprises rocks of different sizes, partially or wholly submerged, four of which were frequently used (especially by the male) and are hereafter termed 'base stones'. About 40 m above the nest a large area of clear water was used by the male to feed, as well as being frequented by tourists. The environs of the nest comprise well-conserved gallery forest, >30 m wide, on a steep slope, whilst a trail used by tourists lies just 25 m above the nest.

The bank adjacent to the nest abruptly drops c.2.5 m, and especially at its base is covered by roots, grass and stones. Opposite the nest is a c.10-m strip of sand surrounded by stones that separate the river from the gallery forest. Near the nest entrance there were no twigs, trees, rocks, etc., which could hinder the female entering the cavity.

Incubation.—In 2005 the nest was found after incubation of the seven eggs had been initiated. The last seven days were monitored. On 18 June 2006, eight eggs were found in the nest, and we observed the last 24 days of incubation. In 2007, the female returned to the cavity and commenced incubating the seven eggs on 15 June. Hatching occurred on 17 July, after 33 days of incubation. Except on the dates of hatching and abandoning of the nest, the behaviour of the adults varied very little. The female, distinguished by the smaller crest, alone is responsible for incubation, leaving the nest at least once during the morning, and, also during the evening (Fig. 1). When the female left the nest, the eggs were covered with feathers.

Each morning, the male arrived near the nest around 06h30 (06h13–06h37; $n=33$), soon after dawn, uttering a 'barking' sound in flight, and on landing slowly swam to the 'base stones', where it continued to vocalise.

While the female was incubating, the male remained c.7 hours in the environs of the nest, not considering intervals when the male was absent, either with the female or alone. During this period, the male spent most time on one of the 'base stones', resting, sleeping or preening. Many times during the day, it would enter the water, to bathe, dive or fish, near the nest. Even when resting with its head turned backwards, on top of its wings, it was alert to noises or movements. Occasionally (once to four times per day), it moved away to an unknown area, these periods lasting 9–106 minutes. During the morning, the female left the nest c.50 minutes (11–471 minutes; $n=32$) after the male's arrival. Encountering the male in the water, the pair would vocalise intensely. On landing, the female would usually defecate, drink and then copulate with the male, taking flight downriver three minutes (1–13 minutes; $n=33$) after leaving the nest, followed by the male usually just one second later.

The pair would return c.97 minutes (23–147 minutes; $n=33$) later, vocalising and flying side by side. They frequently bathed, landed on the rocks to dry and preen their feathers, and occasionally copulated (Fig. 2). After a few minutes, they would fly to the rocks 50 m upstream of the nest. Around 12 minutes (5–43 minutes; $n=37$) afterwards, they would fly to the nest, the female would enter and the male, after accompanying the female to the entrance, would land on the water, uttering an energetic 'bark'. Sometimes they would fly past the nest, return upstream and repeat this up to three times before the female entered the nest. The female left the nest every afternoon. On the female's return, the male would remain in the environs of the nest. Between 15h07 and 16h44 ($n=22$) the male would depart, usually roosting downstream of the nest.

On 15 July 2005, although the female had left the nest, the pair did not depart the general area. On 10 July 2006, after leaving the nest and vocalising intensely, the male did not reappear in the nest's environs, the female then swam alone out of sight (its whereabouts unknown), returning 72 minutes later, still alone. Although the male was seen in the nesting area during the morning, it left the area at 13h06, not returning that day. Similar behaviour occurred in the afternoon of 9 July 2007. After leaving the nest, the female did not encounter the male nearby, and swam alone out of sight.

On the days before the eggs hatched (16 July 2005, 11 July 2006 and 17 July 2007), the female did not leave the nest during the afternoon. Specific data concerning incubation periods are presented in Table 1. During the three years of monitoring, on many occasions tourists entered the environs of the nest, but left after we alerted them to the birds' presence.

Post-hatching behaviour.—On the days when the eggs hatched in 2005 and 2006, the female exceptionally left the nest later, at c.10h50. After encountering the male in the water, the pair vocalised loudly, swam a few metres and took flight together. While they were away from the nesting area, we noted that the eggs had hatched (Fig. 3). In 2006, the layers of feathers placed over the eggs were greatly exposed. The young also vocalised, while positioning themselves. During the three years, the pair returned c.1 hour later and the female did not leave the nest again that day, while the male remained in the general area.

In 2005 and 2006, we observed that on the morning the nest was abandoned, minutes after the male arrived in the nest area the female partially exited the nest, emitting a characteristic vocalisation, and left the nest soon after. The pair flew but, unlike on other days, returned 30 minutes later, then copulated and bathed, and 15 minutes

Table 1. Behaviour of a pair of Brazilian Mergansers *Mergus octosetaceus* during the incubation period, in 2005–07.

Day	Morning			Afternoon						
	Arrival of male at nest site	Female exits the nest	Departure and arrival of the pair at the nest area	Female enters the nest	Female exits the nest	Departure and arrival of the pair at the nest area	Female enters the nest	Departure of male for unknown place		
2005	12 July	NO	NO	NO	09h17	-	-	-	16h26	
	13 July	NO	NO	NO	09h39	13h13	13h25–14h42	14h46	16h44	
	14 July	06h26	07h16	07h20–09h05	09h11	13h48	13h50–15h09	15h20	16h36	
	15 July	06h28	07h21	07h24–09h40	09h54	14h58	-	15h43	16h11	
	16 July	06h32	07h07	07h09–09h06	09h12	-	-	-	16h32	
	Hatching	17 July	06h27	10h58	11h00–11h58	12h20	-	-	-	16h09
	Abandonment	18 July	06h27	07h03	07h08–07h31	07h48	*	*	*	*
	2006	3 July	NO	NO	NO	NO	13h08	13h12–14h51	15h12	15h40
4 July		06h28	07h29	07h31–09h52	10h00	14h25	14h26–15h30	15h40	15h36	
5 July		06h28	07h09	07h11–08h42	08h50	13h10	13h16–14h34	14h43	16h23	
6 July		06h30	07h12	07h14–09h24	09h31	13h17	13h19–14h48	15h53	16h34	
7 July		06h28	07h43	07h45–09h28	09h35	-	-	-	15h38	
8 July		06h30	07h01	07h05–08h30	08h55	12h20	12h22–14h06	15h00	16h08	
9 July		06h28	07h17	07h19–09h04	09h11	13h39	13h45–15h20	15h28	16h17	
10 July		06h30	07h40	07h44–10h11	10h22	14h32	14h35–15h47	15h58	13h06	
11 July		06h29	08h10	08h13–09h49	09h59	-	-	-	15h38	
Hatching		12 July	06h28	10h40	10h42–11h41	11h53	-	-	-	16h27
Abandonment		13 July	06h24	07h30	07h33–08h04	08h14	*	*	*	*
2007		16 June	NO	06h31	06h44–07h45	08h10	10h54	10h54–11h23	12h25	NO
		17 June	06h18	06h29	06h31–07h45	07h56	10h52	10h54–11h44	11h52	NO
	21 June	06h13	06h28	06h32–07h27	07h37	10h21	10h22–11h09	11h12	15h07	
	23 June	NO	08h25	08h26–09h15	09h20	11h56	11h57–13h08	13h15	NO	
	24 June	NO	NO	NO–07h20	07h49	11h45	11h48–12h25	12h36	NO	
	29 June	NO	NO	NO–07h49	07h54	11h38	11h47–12h50	13h04	NO	
	30 June	NO	NO	NO–08h11	08h16	11h37	11h42–12h13	12h28	NO	
	2 July	06h25	07h05	07h09–08h56	09h06	13h13	13h20–14h40	14h57	15h14	
	3 July	06h25	06h51	06h55–08h15	08h25	12h42	12h46–13h53	14h13	NO	
	4 July	06h25	07h02	07h05–08h15	08h26	12h58	13:06–NO	NO	NO	
	5 July	06h23	06h48	06h51–07h58	08h10	12h16	12h19–13h23	13h35	NO	
	6 July	06h30	06h55	06h57–08h45	08h50	12h51	13h05–15h01	15h09	NO	
	7 July	06h20	07h55	07h57–09h20	09h40	13h26	13h27–14h47	14h54	NO	
	8 July	06h22	07h05	07h08–08h30	08h35	12h44	12h46–14h28	14h33	NO	
	9 July	06h20	07h24	NO–09h22	09h34	13h20	NO–14h55	15h07	15h30	
	10 July	06h20	07h18	07h20–09h05	09h15	14h13	14h15–15h10	15h17	15h19	
	11 July	06h19	07h02	07h05–08h18	08h27	NO	NO	NO	NO	
	12 July	06h25	06h58	07h04–08h30	08h41	NO	NO	NO	NO	
	13 July	06h37	07h40	07h43–09h20	09h40	13h07	13h13–14h04	14h08	NO	
	14 July	06h25	07h28	07h31–09h14	09h24	13h30	NO	NO	NO	
	15 July	NO	07h15	NO	09h00	13h44	13h47–15h24	15h42	NO	
	16 July	06h25	07h03	07h08–08h42	08h48	-	-	-	15h57	
	Hatching	17 July	06h26	07h44	07h48–08h26	09h09	-	-	-	15h39
Abandonment	18 July	06h24	*	*	*	*	*	*	*	

NO: Not observed.

-: Female did not abandon the nest.

*: Ducklings abandoned the nest at 09h20 in 2005, 09h42 in 2006 and 08h10 in 2007.



Figure 1. Female Brazilian Merganser *Mergus octosetaceus* exiting the nest via the main opening (Sávio Bruno)

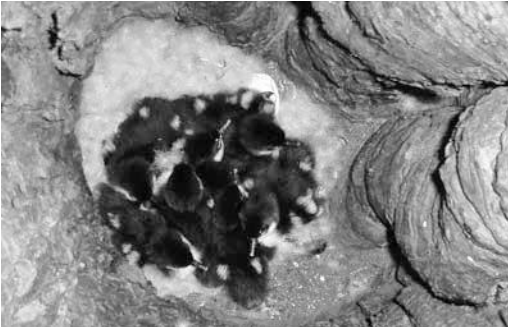


Figure 3. Ducklings of Brazilian Merganser *Mergus octosetaceus* in the nest (Sávio Bruno)



Figure 2. Pair of Brazilian Mergansers *Mergus octosetaceus* copulating (Sávio Bruno)



Figure 4. Adult Brazilian Merganser *Mergus octosetaceus* feeding a fish to the young (Sávio Bruno)

later the female returned to the nest while the male flew to the 'base stones'.

Minutes before the young departed the nest the female initiated an intense and increasing vocalisation while still inside the nest. The male, immediately on hearing this, swam to the bank in front of the nest, its tail held up and 'barking' continuously. In 2005, soon afterwards, at 09h20, two young leapt from the nest to the ground. Thereafter, the female left the nest and joined the male in the river, both adults vocalising. Following this, the remaining five young leapt, one by one, through the opening at the base of the nest.

In 2006, at 09h42, the female left the nest after vocalising, landing on the water, where it continued to vocalise with the male. The first five young left, one by one, joining the adults in the water. After waiting for the three remaining young, which tried to reach the superior cavity in the nest, the female jumped onto a stone on the bank adjacent to the nest, being followed by two other ducklings vocalising next to her. The three remaining young jumped, grabbing the laterals of the nest with their feet, departing via the superior cavity. While the pair vocalised, the young chirped intensely. In 2007, the female initiated the vocalisation earlier than other years, at 08h07, and left the nest with the ducklings at 08h10.

In all three broods, the ducklings, on reaching the ground, walked c.2 m towards the river until they reached the edge of the bank. On jumping into the water, their fall was broken by the roots of the vegetation. The time between the first young leaving the nest and the entire family reaching the water was less than three minutes in 2005 and 2007, and c.7 minutes in 2006.

Post-departure behaviour.—The young could swim immediately on leaving the nest, chirping intensely when joining the pair on the water. Immediately afterwards, the entire family swam rapidly off, the male at the front and the female last. In 2005, soon after leaving the nest, they reached some narrow rapids where the São Francisco meets the rio Cachoeirinha, and the ducklings swam rapidly with the current, appearing to 'walk' over them. However, two swam against the current away from the rest, although one subsequently swam back down river, meeting the group a few metres ahead. The other mounted the right bank, where it remained in the vegetation for c.10 minutes. The bird walked swiftly between the stones and grass to a cavity in the ground, c.0.9 m deep, next to a decomposing trunk and c.8 m from the bank. After ten minutes, we decided to retrieve the bird and place it in quiet water 300 m from the family, which it soon rejoined.

In 2006, the day after the nest was abandoned, three young became separated from the family in trying to follow a current c.900 m downstream of the nest. Noticing that they were moving away from the family, we decided to enter the river, thereby obstructing the young's passage, whereupon they swam upstream. Reaching the rapids where they had left the adults, the young mounted the bank, crossing a c.30 m-wide area of partially submerged stones and some grass, at which point the adults were 100 m ahead. On seeing the young, they vocalised intensively and swam towards them. Once the family was reunited, they continued upriver.

In 2006, after leaving the nest, the young remained ten minutes on the rocks with the female, while the male swam nearby. Thereafter, the family entered the water and the male started to fish. The young frequently submerged their heads, following the underwater movements of the adults. Sometimes they were submerged for a few seconds. The same day we observed the young capturing tiny invertebrates on the surface and in riparian vegetation. Similar behaviour was observed two days after the brood departed the nest in 2005. The adults were surrounded by the ducklings on capturing a fish, which they held transversely in the bill, feeding it to the young (Fig. 4). In 2005–06, four days after leaving the nest, the ducklings had not moved more than 2.9 km but at ten days old they could fish and capture invertebrates themselves.

Discussion

Nest characteristics.—The nest environs were similar to those described by Partridge¹² and Lamas & Santos¹⁰. In all these cases, there was both swift-moving currents and quiet water in the environs, which according to Sick¹³ characterise the species' habitat.

Partridge¹² stated that the nest in Misiones was 25 m above the water, whilst Lamas & Santos¹⁰ described a nest in a rock cavity at SCNP 10.5 m above the river. The position of the present nest, 3.8 m above the river, suggests that height does not determine nest site selection. The same is not true in respect to the nest's distance from the riverbed, as all nests found to date^{10,12} have been a few metres away. Also noteworthy is that all nests have faced the river, facilitating the female and young's entry and departure. Given that on leaving the nest, the young immediately go to the water, the greater the distance between the nest and the river increases the risk of the young becoming disoriented or predated. The shorter distance also facilitates the pair's communication during the incubation period.

Concerning nest materials, Partridge¹² noted a few pieces of decomposing wood, whilst Lamas &

Santos¹⁰ mentioned that feathers were deposited on top of the eggs when the female left the nest, which behaviour has also been described for Scaly-sided Merganser *Mergus squamatus*¹⁶. In all three years, the nest, besides the feathers, held layers of eggshells and feathers. As this was true in 2005 suggests use of the same cavity for at least four consecutive years. Such behaviour has been described for other species of Mergini^{16,17}.

According to Silveira & Bartmann¹⁴, Brazilian Merganser does not depend on extensive forest for its survival. Water quality and presence of gallery forest are more important and, together, permit the species to tolerate human disturbance. It was observed, however, that although the nest was sited in an area regularly used by people, the couple avoided the area of the river frequented by tourists for bathing.

Incubation.—The period of 33 days observed in 2007 is remarkably consistent with the 33 days recorded for *M. squamatus* and 32 days in Goosander *M. merganser* and Red-breasted Merganser *M. serrator*⁸. Partridge¹² observed that the female alone incubates, leaving the nest just once per day, with off-bouts of 60–90 minutes. In SCNP, the female spent a mean 112 minutes (45–162 minutes; $n=21$) off the nest, with single 'breaks' in the morning and, usually, in the afternoon.

Post-hatching behaviour.—On the day of hatching, the female left the nest later than on previous days, at c.10h30, and not at all in the afternoon. Partridge¹², although his observations were less precise, noted that on the two days prior to the nest being abandoned, the female did not leave, indicating hatching. In SCNP, over the three years, the female did not depart the nest on the afternoon prior to hatching. Similar behaviour is known for *M. squamatus*, which rarely leaves the nest during the final four days of incubation and not at all on the last two days¹⁶. The day the young left the nest was marked by the shorter period in which the female was absent from the nest area, c.23 minutes in 2005, 31 minutes in 2006 and 38 minutes in 2007. In Misiones, this time was 30 minutes¹².

Although Partridge¹² described the nest being abandoned in the evening, the broods in SCNP left the nest in the morning. Abandonment of the nest by the young appears to be influenced by the adults' vocalisations. Moments before the young leapt from the nest, both of the pair vocalised intensely, until all of the young were in the river. Zhengjie *et al.*¹⁶ related that the young of *M. squamatus* left the nest of their own volition, although they are probably encouraged by the adults vocalising.

Post-departure behaviour.—Partridge¹² related that the day after leaving the nest, the young could move quickly over the water, but he did not observe them diving. Although the adults fed the

young fish and invertebrates, it is possible that the ducklings, even in the first days of life, are not wholly dependent on the adults, given that they can follow their movements underwater, diving and capturing small invertebrates on the vegetation and water surface. At ten days old, the young were observed fishing on their own, further reducing the need for food provided by their parents. Young of *M. serrator* can also capture invertebrates on the water's surface, being able to dive on their third day of life and fish on the eighth day¹⁵.

Some young from both broods moved slightly away from the adults possibly because they became lost amongst the many rapids interspersed by rocks, earth banks and vegetation. Nothing similar has been previously recorded. Despite being extremely careful to minimise disturbance, it is still possible that this behaviour was caused by our presence. The return of the young to the family reinforces the family ties in *M. octosetaceus*^{1,2}.

Silveira & Bartmann⁴ related that young can stay with their parents until December–January. Bruno *et al.*⁴ observed young with their parents until February and alone until April, and Bartmann¹ affirmed that the young can stay in their parents' territory until the next breeding period. The seven young in 2005 were observed sporadically until January 2006, when they were seen for the last time with their parents. During 2006, some *Mergus* of smaller size were observed near the nest; these were probably the 2005 brood.

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