

## Reproductive Indicators of Cuban Flamingos in the Wild and in Semi-Captivity

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### ABSTRACT

From 1998 to 2009, the behavior of the reproductive indicators of the Cuban flamingo (*Phoenicopterus ruber ruber*) was investigated, in the wild and in semi-captivity, in two locations under similar climate conditions. One of them was the Maximo River, in Camagüey, Cuba, and the other was San Diego Zoo in the United States. A random design was used. Central tendency and dispersion statistics were calculated using SPSS (Statistical Package for the Social Sciences) version 15.0 software. It was found that the main reproductive indicators of wild flamingos were better than in the semi-captive ones. Incubation time ranged between 87.77 % and 31.73 %, and hatching values were between 88.67 % and 36.14 %, at the Maximo River and San Diego Zoo, respectively. There is an apparent tendency towards improvement from 2007 to 2008. Mortality of the chicks in both areas was high, as well as the rate of unfertilized eggs and dead embryos.

**Key Words:** *flamingo, reproduction, semi-captivity, wild, incubation time*

### INTRODUCTION

Richardson, Pickering and Shannon (2001) report the existence of six species of flamingos: *Phoenicopterus ruber ruber*, *Phoenicopterus ruber roseus*, *Phoenicopterus chilensis*, *Phoenicoparrus andinus*, *Phoenicoparrus jamesi*, and *Phoeniconaias minor*. However, some authors have reported that there are actually five species, including the largest one, the greater flamingo (*Phoenicopterus ruber*) which includes two well differentiated subspecies: *Phoenicopterus ruber ruber* and *Phoenicopterus ruber roseus*. The *Phoenicopterus ruber ruber*, also called the American, Caribbean, Cuban or pink flamingo, lives in the Caribbean, from Yucatan and the West Indies to the northwest coast of South America. This species is perfectly reproduced in captivity (SeaWorld Education Department Program, 2005; IUCN, 2008; Zoological Society of San Diego, 2009).

According to Riera (2003), Cuba has the biggest breeding colony of flamingos in the Caribbean, which is located at Maximo River wildlife refuge, in Camagüey, Cuba. Richardson *et al.* (2001) point out that those species find food and refuge at the Maximo River project, which extends over 41 000 ha; an institution that won, in 2002, one of the awards granted by the conservation program run by British Petroleum (BP).

Different studies about the species of flamingos have been reported during the last 15 years. Most of them dealing with the *Phoenicopterus ruber roseus* in the wild (Rendón-Martos *et al.*, 2007; Nissardi *et al.*, 2007; Máñez *et al.*, 2007 and Curcó *et al.*, 2007). Other investigations have been published, such as *Fowl preservation in the Mediterranean* (Samraoui *et al.*, 2006 and Rendón-Martos *et al.*, 2007); *Factors Influencing Flamingo (Phoenicopterus roseus) Distribution in the Pulicat Lagoon Ecosystem, India* (Ramesh y Ramachandran, 2002) and *Flamingo Monitoring in Natural Habitats* (Rendón *et al.*, 2007).

So far, few studies on captive flamingos have been reported, and the only ones found include Andean, Chilean and James's flamingos (Sabat, Novoa y Parada, 2001; Sanger, 2008). No works were found on the species this investigation deals with, that could be used for reference.

Because they live in large colonies in fragile marshes that can be polluted and fragmented, all flamingo species can suffer rapid declines in their populations. They can be significantly affected by changes in their habitat caused by human activity, such as variations in the depth, quality, and salinity of the water. It is a fact that man is flamingos' worst enemy.

Therefore, reproductive conditions of these birds have to be studied in both wild state and captivity. Using such knowledge, their life quality

can be improved in both exploitation systems, and thus make possible the survival of the species.

The objective of this research was to study the behavior of the main reproductive indicators of the Cuban flamingo both in the wild and in semi-captivity.

## MATERIALS AND METHODS

### Location

The project was carried out at the Maximo River wildfowl natural ecological reserve, in Camagüey, Cuba, and at San Diego Zoo, in the United States.

### Design and treatments

A completely random design was used in both areas from 1998 to 2008.

The data gathered during that period were used to characterize the indicators.

The following parameters or indicators were obtained:

- Nests with and without eggs
- Number of eggs
- Hatched eggs
- Emerged chicks
- Surviving chicks
- Dead chicks

The corresponding rates of these indicators were calculated as follows:

- Mortality rate =  $(\text{dead chicks} / \text{emerged chicks}) * 100$
- Birth rate =  $(\text{emerged chicks} / \text{number of eggs}) * 100$
- Survival rate =  $(\text{surviving chicks} / \text{emerged chicks}) * 100$
- Unfertilized eggs + dead embryos =  $\text{number of eggs} - \text{emerged chicks}$
- Empty nests =  $\text{number of nests} - \text{number of eggs}$
- In addition, these indicators were estimated:
- Hatching rate =  $(\text{emerged chicks} / \text{number of eggs}) * 100$
- Incubation time =  $(\text{surviving chicks} / \text{number of eggs}) * 100$

### Statistical analysis

Absolute and relative frequencies of each parameter were determined in each area, as well as their average (central tendency) and standard error (dispersion), using SPSS professional software, version 15.0.

## RESULTS AND DISCUSSION

Table 1 shows the general behavior of the first indicator (nests with and without eggs) at San Diego Zoo (semi-captivity system) and in Maximo River (natural state). 35 couples out of 53 built their nest and 18 did not, accounting for 66.03 % and 33.97 %, respectively. The author considers that this occurs because not all couples are heterosexual. When both members are the same sex, not always will they build their nest; and even if they do, they might not lay eggs in case they are not sexually mature.

According to J. Morales and L. Vázquez (personal communication, April 18, 2009), Maximo River averaged 50 000 flamingos over the last 10 years, as they use the reserve as nesting ground. Table 1 shows that the average of nests built is 31 505, which proves that only 63 % of the birds that come to that place actually breed there.

It is also observed that the number of nests without eggs (1 996) represents 6.34 %, while the remaining 93.66 % (29 510) contained eggs. In the case of San Diego Zoo, 5 nests were reported empty, for 14.29 %. This result is in agreement with the observations of Richardson *et al.* (2001), Perry (2001) and Seaworld Education Department Program (2005), who stated that flamingos lay a single egg per year, and just in very rare cases they lay two eggs (for instance, when the egg is separated from the nest due to natural or artificial causes). Moreover, the number of eggs at San Diego Zoo is 30, (85.71 %). This means that flamingos lay 7.95 % fewer eggs in this area than they do in Maximo River, which is apparently influenced by their semi-captive state.

Table 2 shows that the number of emerged chicks at Maximo River is bigger than at San Diego Zoo, which may be due to stress. Because the birds in San Diego are always exposed to the view of many people and, as Seaworld Education Department Program (2005) points out, they need privacy to mate, couples are forced to leave the area for a private place. Furthermore this may be the cause of the low hatching rate in San Diego.

Regarding the number of dead chicks, it was found to be similar to the mortality rate (within parenthesis in the table). It is lower in Maximo River (6.20 %) than in San Diego (10.82 %), which does not match the records reported by most authors, (Richardson *et al.*, 2001), Perry

(2001), Seaworld Education Department Program (2005) and Smithsonian National Zoological Park (2008), who coincide in that the mortality rate among the chicks in wild conditions should be higher than that of chicks born in semi-captivity. The main cause is the negative effect of land predators that attack when the water level falls. It seems to be the case that conditions are not equally favorable for predators in the Maximo River, because there are few of them; besides, human intervention can counteract their negative influence.

The survival rate in Maximo River is 93.80 %, while at the zoo it is 89.18 %. This result has an inverse relationship with the above-mentioned indicator, and its explanation is implied in the previous paragraph. Accidents is another factor behind the decline in survival rates that have led to sacrificing some chicks. (A. Wilson, personal communication, August 2<sup>nd</sup>, 2008).

The hatching rate is higher in the Maximo River (88.67 %) than in San Diego (36.14 %). This may be influenced by the prevailing temperatures in these two locations during the breeding season. In the Maximo River the air temperature has ranged between 22 °C and 30 °C during the months in which breeding takes place. In contrast, flamingos at San Diego Zoo have experienced temperatures from 28 °C to 20 °C. Taking into consideration that the optimal incubation temperature is between 37.22 °C and 37.5 °C, with a relative humidity of 55 %, according to Branch *et al.* (2001) and Perry (2001) it is likely that the temperature of the nests in the Maximo River are better for the incubation process.

The Incubation time rate in San Diego is 31.73 %, while in the Maximo River it is 87.77 %. The difference has the same explanation as for the hatching rate, but it is also influenced by factors like age, nourishment, and health of the breeding animals, according to the reports by Madrazo (2001), Ahmad and Balander, (2003), Lim *et al.*, (2003) and Sardá (2003) on the machine-incubation process of hens (*Egg grading*, 2001). It is also affected by genetic factors like consanguinity, present in San Diego, according to A. Wilson (personal communication, August 2<sup>nd</sup>, 2008).

Unfertilized egg and dead embryo rates accounted for 11.24 % and 63.87 % in Maximo River and San Diego, respectively. Since in San Diego that indicator is very high, which translates

into few hatchings, observation confirms the accuracy of hatching and incubation time rates. Besides, the already mentioned factors, some others could be added relating to nutrition. For example these birds are fed with industrial products whose protein content is lower than 19 % (Johnson *et al.*, 2003 and Wright *et al.*, 2006), while in the wild they eat crustaceans, plankton, algae, diatoms, insects, and worms with higher nutritional value (Direnfeld *et al.*, 2001; Richardson, Pickering y Shannon, 2001; Saeworld Education Department Program 2005; Flamingo Learning Zone, 2008).

Moreover, Wilson (2008) states that there are homosexual couples. In the case of female couples, there might be eggs on the nests, but they will not be fertile. Likewise, the sexual behavior of these birds has to do with the intimacy they need to copulate, a condition that is absent in San Diego, as the zoo covers just a small area (Sea-World Education Department Program, 2005).

As explained before, consanguinity can be a cause of embryo malformation or death. González and Guerra (2009) inform that the death of embryos may also result from shell diseases as aspergillosis or other vertically transmitted diseases.

The analysis of births (Fig. 1) shows a greater stability and rate in the Maximo River, with an apparent tendency towards increment over the last two years, raised after a period of nearly equal values from 2004 to 2006. Seemingly, birth rates in San Diego were not stable during those years, always showing very low rates under 50 %. It is important to emphasize that 2008 showed a lower birth rate, which indicates the possibility that semi-captivity conditions could have deteriorated. Máñez *et al.* (2007) states this indicator ranges between 78.6 % and 97.63 % in San Diego, which is similar in the Maximo River, according to Nisardi *et al.* (2007), where it ranged between 78 % and 91 % from 2004 to 2007.

Table 2 shows that in the Maximo River there was less oscillation in the mortality rate during the years of the study. The highest number of dead chicks was obtained in 2006, while 2004 and 2008 showed the lowest number of deaths, with similar mortality rates.

In San Diego, the mortality rate is quite unstable, with varying values, similar to those obtained in 2005 and 2008, in which there were no deaths; and those of 2006, when there was a 20 % rate. This is a remarkable fact, since such high values

are not observed even in species that live in total captivity like hens, whose mortality rate is never above 10 % (UECAN, 2003). In general, both reserves showed a decrease in the number of deaths in 2008, and reached their peak in 2006.

In both cases (Table 3) there was a high survival rate during the years studied. In Maximo River; the annual rate was very similar over the course of these years. In San Diego, the lowest value observed was in 2004, followed by 2006; and the best results were obtained in 2005 and 2008, although it can be noted that these values seem to have a tendency towards increase since 2006. The results shown in this chart are better than those observed by Rendón-Martos (2007), (17.63 %, in 2007; and 56.22 %, in 2005) in Fuente de Piedra, Spain. They are also better than those of Curcó *et al.* (2007), who report an average value of 51.91 %, also between 2004 and 2007.

## CONCLUSIONS

The main reproductive indicators of wild flamingos show better results than those of flamingos kept in semi-captivity. However, the latter could be improved in order to boost reproduction.

The rates of unfertilized eggs and dead embryos are high in both areas.

Incubation time rates accounted for 87.77 % and 31.73 % in the Máximo River and San Diego, respectively.

## RECOMMENDATIONS

We recommend including incubation time and hatching rates as indicators of the reproductive activity of the Caribbean flamingos and other varieties of the same species, as well as using the calculation method proposed.

We also suggest the use of these results in the analysis of reproductive behavior in other reserves.

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Received: 10-6-13

Accepted: 10-7-13

**Table 1. Characterization of parameters for the egg production in San Diego and the Maximo River, for 10 years**

Parameter	San Diego		MaximoRiver	
	Mean	ET	Mean	ET
Nest total (u)	35 (66.03 %)	4.1	31 505 (63.00 %)	4 035.1
Egg total (u)	30 (85.71 %)	2.1	29 510 (93.66 %)	3724.2
Nests without eggs(u)	5 (14.29 %)	2.2	1 996 (6.34 %)	454.1

**Table 2. Incubation behavior of Cuban flamingos in San Diego and Maximum River for 10 years**

Parameter	San Diego		MaximoRiver	
	Mean	ET	Mean	ET
Born chicks (u)	11 (36.13 %)	1.3	26 471 (92.30 %)	3 785.6
Dead chicks (u)	1 (10.82 %)	0.6	1 635 (6.20 %)	248.4
Surviving chicks (u)	10 (89.18 %)	1.1	26 218 (93.80 %)	3 463.3
Incubation percent (%)	36.14	4.953	88.67	3.588
Incubation rate (%)	31.73	4.023	87.77	1.829
Unfertile eggs/dead embryos (u)	19 (63.87 %)	2.6	31 505 (11.24 %)	1 112.3

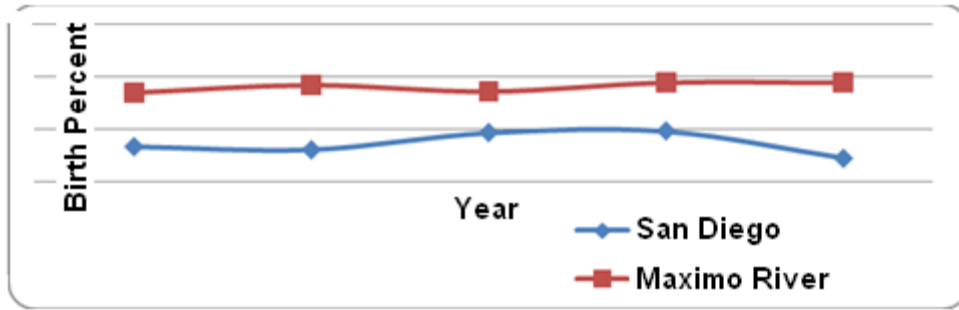


Fig. 1. Birth percent in the two areas (2004-2008)

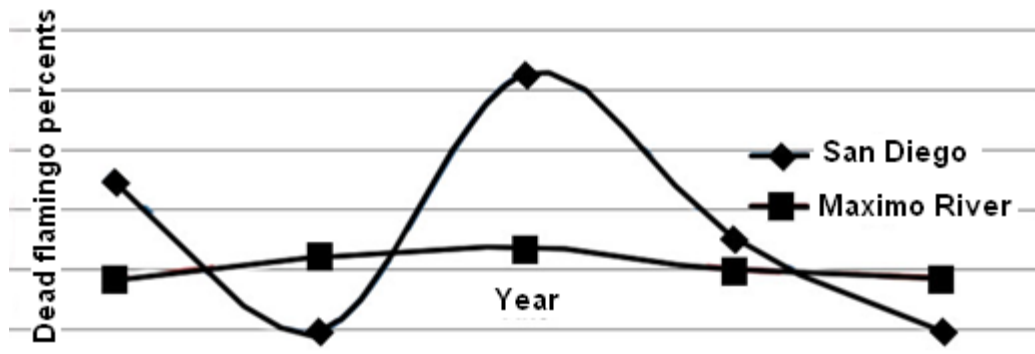


Fig. 2 Dead flamingo percents in the two areas (2004-2008)



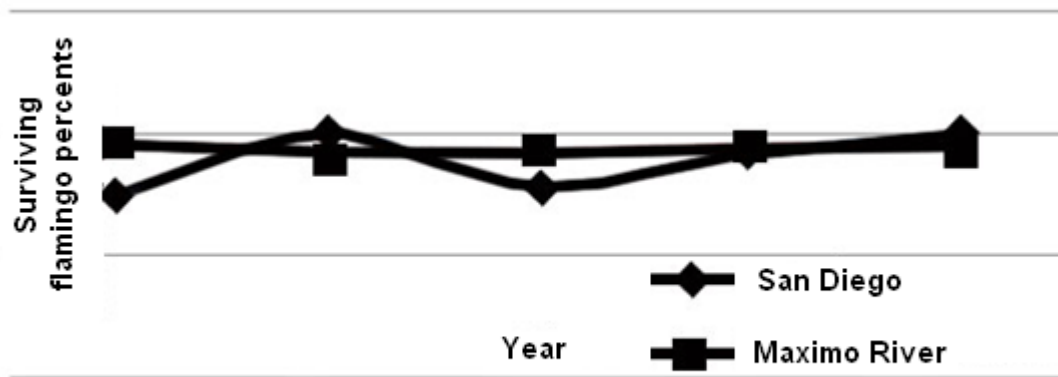


Fig. 3 Percent of surviving flamingos (2004-2008)