

## AGE DETERMINATION OF CAPTIVE CHILEAN FLAMINGO (*PHOENICOPTERUS CHILENSIS*) CHICKS BASED ON PLUMAGE CHARACTERISTICS

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**Abstract** · Many aspects of the breeding biology of the Chilean Flamingo (*Phoenicopterus chilensis*) are still unknown. We studied captive breeding Chilean Flamingos at La Plata Zoo, Buenos Aires, Argentina between February and July 2014 to document chick-aging methods based on molt and coloration of bare parts, such as beak and legs. The development of young was divided in three age categories: 1. Chick (less than 15 days old), with white down and salmon-pink beak and red coral legs. 2. Pre-juvenile (1–3 months old), birds covered with gray down (due to a combination of a double down coat) and when the white down falls, a brownish down coat is more evident. In this stage, the beak had darkened and the legs turned dark gray. 3. The last category is the juvenile (4–5 months old), characterized by the presence of vanned feathers, dorsal feathers are pale brown with a dark rakis, underparts are white and inner coverts have a pale-salmon coloration; the beak is curved and has a blueish base with a charcoal gray tip and legs are pale gray. The information presented in this study may help to age young Chilean Flamingos in the wild.

### Resumen · Criterios para determinar la edad de pollos de Flamenco Austral (*Phoenicopterus chilensis*) en cautiverio basadas en características del plumaje

Varios aspectos de la biología reproductiva del Flamenco Austral (*Phoenicopterus chilensis*) son aún desconocidos. Estudiamos una colonia en cautiverio de Flamencos Australes pertenecientes al Zoológico de La Plata; Buenos Aires, Argentina entre febrero y julio de 2014 para obtener criterios para determinar la edad de los pollos basados en la coloración del plumaje y de las partes desnudas, como pico y patas. El desarrollo de los pollos se dividió en tres categorías: 1. Pollo (menos de 15 días de edad), cubiertos por plumón blanco, pico de color salmón-rosado y patas rojo coral. 2. Pre-juvenil (1–3 meses), cubiertos por plumón gris (debido a la combinación de una doble capa de plumón). A medida que el desarrollo avanzó, el plumón blanco se perdió y el plumón de color pardo se hizo más evidente. En este estadio, el pico se oscureció y las patas se tornaron de color gris oscuro. 3. La última categoría, el juvenil (4–5 meses), se caracterizó por la presencia de plumas, las plumas dorsales son de color marrón pálido con un rakis oscuro, las plumas ventrales son blancas y las coberteras inferiores son salmón pálidas. El pico es curvo y tiene una base azulada con la punta gris y las patas tienen una coloración gris pálida. La información presentada en este trabajo provee ayuda para categorizar a los jóvenes de esta especie y puede ser de utilidad en estudios demográficos.

**Key words:** Chilean Flamingo · Chick aging · Juvenile · Mesoptile · Neoptile · Phoenicopteridae · Plumage development

## INTRODUCTION

Birds undergo a series of molts before acquiring their definite adult plumage (Gill 2006). There is little information regarding molt in flamingos (del Hoyo 1992), and few studies describe the juvenile plumage in some species (Fox 1962; Johnson, Cézilly & Boy 1993).

The Chilean Flamingo (*Phoenicopterus chilensis*) is one of the three species of flamingos found in South America (del Hoyo 1992), and there is little information on the plumage of chicks and immatures for this species. Such information, especially if linked to known ages, is of importance to establish aging criteria that can be used

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**Table 1.** Developmental parameters and characteristic used to age Chilean Flamingos (*Phoenicopterus chilensis*) in captivity. The duration of each developmental stage (in days) is shown as mean  $\pm$  SD (n = 9 chicks).

Stage	Plumage	Legs	Bill	Duration (days)	Age
Chick	white down	coral red	salmon pink - straight	7.25 $\pm$ 3.5	> 15 days old
Pre-juvenile	gray / brownish-gray down	grayish-black	greyish-lilac, bill base dark-grey - slightly curved	43.0 $\pm$ 8.0	1–3 months old
Juvenile	true feathers, grayish-brown (dorsal region) - inner wing coverts pale salmon	pale gray	base ash-colored, tip grayish-black - curved	66.1 $\pm$ 10.0	4–5 months old

in the field. Such data are often hard to obtain in the field since it relies on following marked individuals of known ages. Data collection in captivity is a relatively simple alternative and represents a valuable resource, providing information that can complement field work (King 2000) and provide information about plumage, molts, and behavior (Shannon 2000a, 2000b).

Hence, the main objective of this study was to investigate plumage development of the Chilean Flamingo chicks using morphological parameters to assess their age. Our study may be useful in studies of demography and behavior since it provides a detailed description of different stages in chick's plumage development.

## METHODS

The study was carried out at La Plata Zoo (34°55' S; 57°59' W), Buenos Aires province, Argentina. Between February and July 2014, nine Chilean Flamingo chicks were observed every two days from hatching until five months of age. Birds were not handled but observed through a special net surrounding the breeding area of the enclosure to avoid disturbing the birds. Photographs were taken using a Canon 50sx camera under similar light conditions, which were used to record changes in color and shape of the beak, and color of tarsus and plumage. Color nomenclature was based on the color table in Canevari et al. (1991).

Adult captive flamingos were provided with standard care for the species. Diet of adult flamingos consisted of canine and porcine balanced diet, fish flour, raw eggs with shells, liquefied carrots, carotenoids (xanthines), calcium powder, preventive antibiotics in low concentrations, and salt. This diet is based on literature recommendations (Kear 1974, Duplaix-Hall & Kear 1975, Griswold 1975, Lint & Lint 1983) and tailored to the resources available in Argentina.

## RESULTS

Table 1 summarizes the information about plumage, beak, and tarsus coloration development in known-age flamingo chicks divided in three stages: chick, pre-juvenile, and juvenile.

Newly hatched chicks (n = 9) remained in the nest for 7.3  $\pm$  5.0 (SD) days (d) (range: 2–12 d) and in the surroundings of the nest for an additional 4.2  $\pm$  4.4 d (SD) (range: 0–8 d). At the time of hatching, chicks were covered with a dense and uniform white down plumage (neoptile) and had a straight salmon-pink beak (Figure 1A and 1B) and coral-red tarsus.

As the development of the chicks continued, a new coat of brownish-gray down appeared under the white down. The pre-juvenile stage was characterized by the presence of a gray down plumage (mesoptile) originating from the combination of two plumages (Figure 1C). The brownish-gray down continued growing under the original white down as a second coat (Figure 1D), and as the birds grew, the white down was lost and the brownish-gray down coat became more evident (Figure 1E). The gray coloration was maintained for 16.6  $\pm$  1.2 d (SD) on average, and the entire pre-juvenile stage (gray down and brownish-gray down coats) averaged 43.0  $\pm$  8.0 d (SD). The beak started to curve at 14.0  $\pm$  0.9 d (SD) of age and the process continued until day 30.2  $\pm$  0.8 d (SD); at that time, the beak had darkened and acquired a grayish-lilac coloration and the tarsus had turned dark-gray.

True feathers (vaned or pennaceous feathers) appeared after the brownish-gray down coat. Juveniles had pale brownish dorsal feathers with a blackish-gray central part; the neck and its base were pale brown and feathers of the underparts were white with a dark rachis. The inner wing coverts had a pale salmon coloration. Remiges were charcoal-gray and tarsus had a pale gray color. The beak had a bluish base and a charcoal-gray tip (Figure 1F).

## DISCUSSION

Flamingo chicks are semi-precocial, they hatch with open eyes and are ptilopaedic (i.e., covered with down) (del Hoyo 1992, Navas 1995). Many bird species acquire their definite plumage through a succession of juvenile and immature plumages and some species, such as loons and penguins, have a second generation of down before the acquisition of the juvenile plumage (Gill 2006). Accordingly, these plumages are called "pre-juvenile downs" (del Hoyo 1992). Chilean Flamingo chicks have two down plumages before obtaining their juvenile plumage. The



**Figure 1.** A: Chilean Flamingo (*Phoenicopterus chilensis*) chick, 2-d old, 14 April 2014. B: Chick (11-d old), the tarsus and beak began to darkened, 21 April 2014. Pre-juvenile (1–3 months old) with gray plumage due to the combination of two down coats, 21 April 2014. C: Pre-juvenile, detail of white down feathers and the brownish-gray down feathers below, 5 May 2014. D–E: Pre-juvenile with brownish-gray plumage, 13 May 2014. Note some remaining white down feathers. F: Juvenile (4–5 months old) with vanned feathers, 27 May 2014. All photographs were taken at La Plata Zoo, Buenos Aires, Argentina by Luis Pagano.

first plumage is called “natal down” with neossoptile feathers having a simpler structure than adult down (Proctor & Lynch 1993, Kozák 2011). The second down plumage is darker and grows right under the natal down from the same follicles (Navas 1995) and is termed “pre-juvenile down” or mesoptile (Thomas

1984); vanned feathers that constitute juvenile plumage (teleoptile) appear after the pre-juvenile down.

Our study provides a detailed characterization of the coloration and development of the plumage and bare parts of Chilean Flamingo chicks. Navas (1995)



described only two stages of plumage development for this species: chicks with two coats of down and orange beak and legs, and immatures with true feathers and brownish plumage. By definition, the juvenile plumage is “the first covering of true (vaned or penaceous) feathers” (Palmer 1972), and the term immature includes the juvenile plumage (Pittaway 2000) and other succession of plumages until the acquisition of the definite adult plumage. We differentiated three age stages (i.e., chick, pre-juvenile and juvenile) and disregard “immature” used by Navas (1995) to describe juvenile plumage, considering that the term immature implies another plumages as well, until birds acquire the adult plumage.

From our description, it is apparent that the plumage-development pattern of Chilean Flamingo chicks is similar to that of other species of the same genus: American (*Phoenicopterus ruber*; Fox 1962) and Greater (*Phoenicopterus roseus*; Johnson et al. 1993, Johnson & Cézilly 2007) Flamingos. In the latter species, chicks have a white down coat that turns brownish-gray and a juvenile stage determined by the presence of grayish-brown dorsal feathers and white underparts, with little pink in the inner wing coverts, which is similar to the same stage in Chilean Flamingos. The beak in juvenile *P. roseus* has a gray base and legs are black or dark gray, with dark joints (Johnson & Cézilly 2007). These stages happen at similar ages between these two species.

It would be very interesting to study plumage-delayed maturation (PDM) in this species. PDM refers to a delayed acquisition of the definite adult plumage and is evident in large birds (Hawkins et al. 2012). Flamingos may be an example of this occurrence, and this may confer some benefits to younger individuals; the melanin-based plumage and bare parts of juveniles might be helpful for preventing solar burns (Fox 1962) and for resistance of plumage wear in harsh environments (Amat & Rendón 2017). Also, it would be important to study other flamingo genera (i.e., *Phoeniconaias*, *Phoenicoparrus*) to document if there are special adaptations in the plumage of their chicks to face the harsh environments they inhabit (alkaline and high-altitude wetlands).

This study provides a characterization of different stages of plumage development for captive Chilean Flamingo chicks that can be a useful tool in field and captivity demographic studies of the species. While observations in captivity are valuable, we will continue our analysis in wild Chilean Flamingo chicks, considering that some aspects, such as diet quality or food availability, can differ and may lead to differences in development.

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