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The potential contribution of captive flamingos to research

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Abstract
Investigations on topics such as flamingo behavior, physiology and reproduction are often more easily carried out in zoological settings than in the field, as illustrated in this article. Field and zoo researchers would benefit from closer collaboration in identifying potential research contributions of captive flamingos and in conducting relevant studies.

Introduction

Flamingos are extremely popular zoo animals: for example, approximately 70% of European Association of Zoos and Aquaria (EAZA) zoos have flamingos (King and van Weeren, 2005). The total number of captive flamingos registered world-wide with the International Species Information System (ISIS) is 14,324 (ISIS 2008). Although this number is probably less than half of the true number of flamingos in captivity, as many flamingos are held by non-ISIS-registered zoos and by private breeders, it is likely to reflect the impressive number of flamingos potentially available for research projects.

Field research in many areas of flamingo biology is beset with potential problems. Flamingo movements are unpredictable, thus field studies may end prematurely because of disappearance of the study subjects. Even when flamingos remain at a given location, they are often so difficult to approach that detailed observation of behaviours and experimental manipulation is impossible. While there are some ongoing field programs to band flamingos with coloured plastic rings that allow identification at a distance, only a small portion of the birds is banded. The advantages of using captive birds in studies are that many zoos use such bands to identify all their flamingos, flamingos can be observed at short distances, and there are possibilities to capture and handle animals as well as to experimentally alter the environment with relative ease.

Although captive flamingos are not suitable for studies in topics such as migratory behaviour, there are a number of areas in which captive flamingos have contributed to our understanding of basic flamingo biology and to managing wild populations and/or their habitats, and in which they can continue to do so in the future (King 2000).

Life History Statistics

To date, the oldest living wild flamingos known have been a male Greater Flamingo (*Phoenicopterus roseus*) that was 40 years and 23 days of age (Johnson 1998) and a Lesser Flamingo that was 40 years and approximately nine months of age (Childress 2004). We know from flamingos in captivity that the potential to live, and to breed, is even longer. A male Greater Flamingo at Basle Zoo bred successfully at minimally 57 years of age (Studer-Thiersch 1998) and a female that lived minimally 71 years laid an egg when she was at least 60 years old (see "The

last veteran flamingo at Basel Zoo's has died", this issue). A Greater Flamingo currently alive at the Adelaide Zoo is minimally 72 years of age (Bogle and Watson 2008).

Communication and Reproductive Research

Analysis of ring information on Greater Flamingos nesting in the Camargue indicates that these birds, which nest in the thousands in the Camargue, do not usually re-pair with the partner from the previous year, or even from the same year if a bird makes two breeding attempts in the same season (Cezilly and Johnson 1995). Contrarily, flamingos in captivity tend to maintain partnerships for several years. At Rotterdam Zoo, the mean number of partners that Greater Flamingos had over a ten year period was 3.1 ± 1.4 S.D. (n = 26; range: 1-7) (King 2006). Similar to the situation with captive birds (Pickering 1992), it may be that in the wild the rate of partner change increases as colony size increases, and that smaller colonies are more monogamous than larger ones. This could simply be because the flamingos that were paired the year before have a more similar physiological cycle (Studer-Thiersch 2000). It has also been observed that flamingos that arrive together at a zoo tend to pair with other birds from that same shipment (King 2000), which could be for the same reason. Understanding the dynamics of mate choice and the effect of size of colonies could be important in maintaining sound genetic bases in small wild flamingo populations in the future.

Studies indicate that individual aggression and dominance interactions could have a negative effect on feeding time, and thereby fitness, of free-ranging flamingos (Bildstein *et al*. 1991; Schmitz and Baldasarre 1992). Studies on dominance and agonistic behaviours in captivity can help elucidate the relative importance of factors that can influence the outcome of agonistic encounters (*e.g.* size, age, reproductive status, sex, familiarity with the surroundings).

Voice recognition is very important in flamingos, as parents must be able to find each other and to find their young in the crèche. Studies involving transfer of eggs and chicks at various stages of hatching to unfamiliar nests in captivity could help to discern when recognition starts. An investigation of vocalization development of parent- and foster-reared chicks could provide insight into genetic and behavioural components of vocalisation acquisition.

Cézilly *et al*. (1997) concluded that Greater Flamingos nesting in the Camargue have an age-assortative mating system, with directional preference towards older and more experienced birds. They suggested that differences between individuals in the performance of displays could provide proximate cues for assessing age. Testing this hypothesis by measuring qualitative and quantitative variation in display performance could be much more easily achieved in captive populations.

Morphology, Physiology, Endocrinology and Feeding Studies

Any study that involves measuring a physical or behavioural value can be more easily undertaken with captive flamingos. Investigations on sexual and taxonomic differences in several morphological parameters have been conducted with captive flamingos (Studer-Thiersch1986, Richter and Bourne 1990, Richter *et al*. 1991). Captive flamingos have been used as a material for studies of filter-feeding structures and mechanisms (Beckman 2006, Jenkins 1957, Zweers *et al*. 1995), metabolism of carotenoids (Fox 1975), moult (Shannon 2000), vocalizations (Boylan 2000), vision (Martin *et al*. 2005), crop milk (e.g. Lang 1963, Studer-Thiersch1966) and normal blood chemistry values and values for comparative taxonomic cytochemistry (Hagey *et al*.1990, Péindo *et al*. 1992). It has been proposed that flamingos can manipulate the gender of their young, with males hatching earlier in the season and females later, but finding a morphological indicator of age of juveniles that is independent of sex would be helpful in studying this topic (Bertault *et al*. 2000), a goal that could be more easily accomplished using captive flamingos. Bildstein (1990) cites flamingos as an example in a paper he wrote advocating the use of zoo collections in studies of feeding ecology and conservation biology in wading birds.

Development of Management Techniques

Management techniques for free-ranging flamingo populations can often be tested and adapted using captive populations. Marking methods, and harnesses and transmitters for radio or satellite tracking can be tested easily. Use of artificial nests to encourage free-ranging flamingos to colonize a particular breeding area was adopted from zoos, and has been successful (*e.g.* Rendon and

Johnson 1996). Studies related to disease such as avian influenza and response to medications and vaccinations can be studied much more easily in captive birds.

Other advantages of collaboration with zoos

Cooperation with zoos can have other advantages in addition to provision of study subjects and sites. Captive flamingos can be very useful tools for illustrating problems and potential solutions in the ecosystems of their wild counterparts. The collaboration can be helpful in gaining financial, logistical and political support for field research and conservation projects. For example in addition to carrying out in-house research, Dallas Zoo has been working since 1999 on a project in the Yucatan, Mexico to better understand the natural history of Caribbean Flamingos. Hundreds of young flamingos are banded, sexed and crop samples taken each year to gather data needed to create sound action plans. The Dallas Zoo's role is primarily supportive: channelling money, providing the leg bands, equipment (scales, band applicators), veterinary services, staff expertise with flamingo husbandry, means for DNA sexing and nutritional analysis of the crop samples. The zoo also provides education support and materials to the NGO, Ninos Y Crias, for this organization to educate children of the region about the flamingos and wetlands habitat preservation (C. Brown, pers. comm.).

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