# AN EXAMINATION OF POTENTIAL REASONS FOR VARIATION IN EGG-LAYING CYCLES OF WATTLED CRANES

by Nicole R. Bohlman

**Abstract**

This study was conducted to examine possible reasons for the variations in laying cycles of captive Wattled Cranes *Bugeranus carunculatus*. Egg-laying records were collected from the International Crane Foundation, North Carolina Zoological Park, Baltimore Zoo, Miami Metrozoo, Oklahoma City Zoological Park, White Oak Conservation Center and St Catherines Wildlife Survival Center. Correlation tests were run with the egg-laying data and a significant relationship was found between the location of the breeding facility with both the start and end dates of the breeding season. Strong patterns were seen when correlation tests were run against the 'number of eggs laid per season'. 'Season length' and 'number of eggs laid per season' were also strongly correlated. Finally 'number of eggs laid' positively correlated with 'latitude' and with inland sites, and negatively with coastal localities. The results indicate that captive breeding centers in the USA that are located further east have later starting dates (and later end dates) for egg-laying cycles and coastal locations as compared to inland locations also have later starting dates.

**Introduction**

The Wattled Crane is the largest and rarest of the six crane species that occur in Africa. The total population remained at an estimated 13,000-15,000 during the 1990s, but the trend is towards a general decline due to the loss and degradation of wetland habitats and human disturbance (Burke in Meine & Archibald, 1996). Because of this, captive propagation has become more widespread with about 218 Wattled Cranes in captivity in 1997 (Beall, 1998).

Wattled Cranes have extreme variation in laying cycles both in the wild and in captivity (Urban & Davenport, 1993; Balzano, 1988). It is important for captive breeding facilities to understand this variation for several reasons. They have been known to lay all months of the year in the wild in Malawi, South Africa, Zambia and Zimbabwe. In captivity, their egg-laying season occurs at opposite times of the year when compared with other crane species. For instance, while most cranes' breeding seasons are in spring and summer, Wattled Cranes start laying eggs in October, November and December. It is much more difficult for institutions located in temperate zones to breed in the winter, therefore, it would be beneficial to understand these laying cycles and develop better breeding techniques (S. Swengel pers. comm.).

In captivity, this species is relatively difficult to breed and fertility rates are low compared to other crane species (Burke in Meine & Archibald, 1996). They also have the smallest clutch size of the world's cranes (Johnsgard 1983). Many of the Wattled Cranes in zoos and other institutions are older birds that have difficulty copulating because of their pinioned wings. For these reasons, artificial insemination (AI) is required. In order for AI to be worthwhile or successful there must also be some predictability in egg-laying patterns. Finding factors that stimulate captive breeding may help to understand both wild and captive Wattled Crane breeding (S. Swengel pers. comm.).

**Methods**

Records for this analysis were received from the International Crane Foundation, North Carolina Zoological Park, Baltimore Zoo, Miami Metrozoo, Oklahoma City Zoological Park, White Oak Conservation Center and St Catherines Wildlife Survival Center. Included in these records was the date of the first egg laid per female for every year she laid eggs, the last egg that was laid of the season, the season length and the number of eggs laid per season. These were the dependent variables run in correlation tests.

Independent variables in the correlation tests included latitude and longitude of each facility that participated in the study, total annual precipitation and season length for each crane's breeding season. Finally, each institution that participated in the study was assigned a (inland vs coastal) code of one if it was a coastal area and two if it was an inland area. North Carolina Zoological Park was counted as inland because it is far enough from the coast to mitigate most of the effects of a maritime climate. The latitude and longitude were retrieved from the Rand McNally Road Atlas, and the precipitation data was retrieved from the website for the Southern Regional Climate Center.

Data were collected for 21 female Wattled Cranes during the years from 1977-1999. There was a sample size of 96 when correlation tests involved the 'number of eggs laid per season'. With all other correlations the sample size was 112 (for 16 females x egg seasons, data on total eggs laid was not received). Statistical analyses including linear single regression and linear multiple regression were performed on dependent variables vs independent variables.

Averages from each breeding facility were taken for every variable and correlation tests were run. Included in these tests were the average monthly precipitation and temperature (taken for the 30 year period 1961-1990 from the 1998 *World Almanac and Book of Facts*) that corresponded with the average start date of egg-laying at each facility. Systat version 7.0 was used for all statistical analyses. Only tests with $P<.05$ were considered statistically significant and tests with $P<.1$ were considered nearly significant.

**Results**

Averages of each variable from the individual locations that data was collected from were calculated, and correlation tests were conducted. All the P-values were >.1, so none of them were statistically significant.

There were repeated patterns that showed a negative correlation between longitude and both the start and end dates. When 'season length' was tested with the independent variables there were no correlations that showed a P<.1. When 'number of eggs laid per season' was tested with the independent variables there were very strong, significant patterns. These patterns showed correlations between 'number of eggs laid per season' with 'season length', 'latitude', 'longitude' and 'inland vs. coastal' (Table 1).

There were two variables that had significant effects (P<.05) on the first egg laying dates. 'Longitude' was the most important variable and had a negative correlation with a P-value of .014 in the single regression. In the multiple regression (which included the variables 'latitude', 'longitude' and 'annual total precipitation') 'longitude' also had a negative correlation and a P-value of .023. In this same regression there was an overall P-value of .103, making it nearly significant. The second important variable that correlated with start date was 'inland vs. coastal'. This also had a negative correlation in the single as well as multiple regressions. There was a P-value of .022 in the single regression and in the multiple regression there was a P-value of .038 (Table 1).

'Longitude' repeatedly had a negative correlation when tested with the end date. In the single regression there was a P-value of .025. In the first multiple regression, the end date was tested with 'latitude', 'longitude', 'total annual precipitation' and 'inland vs. coastal'. 'Longitude' had a negative correlation and a P-value of .016 and 'inland vs. coastal' had a positive correlation and a P-value of .1 52. Since these numbers (longitude vs. inland/coastal) oppose each other, two more multiple regressions were tested. One of these included only 'latitude', 'longitude' and 'total annual precipitation', and the other included only 'latitude', 'total annual precipitation' and 'inland vs. coastal'. In the multiple regression including 'longitude', there was a negative correlation and a P-value of .029 (Table 1).

There were repeated patterns in correlation tests involving the 'number of eggs laid per season'. 'Season length' was the strongest variable having a P-value of 0.00 and a positive correlation. This P-value was the same throughout all of the regressions with 'number of eggs laid'. The overall P-value that was given in the multiple regressions was .00 for every regression. 'Latitude' was a relatively strong variable when tested with the 'number of eggs laid'. When tested in a single regression it had a positive correlation and a P-value of .078, making it nearly significant. When tested in a multiple regression with 'season length', 'longitude' and 'total annual precipitation', 'latitude" was given a P-value of .032. 'Longitude' was given a P-value of 0.00 when tested with 'season length', 'latitude', 'longitude', 'total annual precipitation' and 'inland vs. coastal' . In this same regression, 'longitude' had a positive correlation and 'inland vs. coastal' had a negative correlation and both variables had a P-value of 0.00. Because these variables have opposing effects, two more multiple regressions were conducted. These additional regressions contained 'season length', 'latitude', 'total annual precipitation' and either 'longitude' or 'inland vs. coastal' in each regression. This resulted in both variables having a positive correlation, but only the multiple regression with the 'inland vs coastal' variable was considered statistically significant because it had a P-value of 0.00. When 'inland vs. coastal' was tested in a single regression there was a P-value of .002 (Table 1).

## Discussion

### Start date

Results suggest that Wattled Crane breeding facilities located further east should expect their cranes to lay their first eggs later than facilities located in the west. Similarly, coastal centres that breed Wattled Cranes should expect their cranes to start laying eggs later than those inland breeding Wattled Cranes.

### End date

There is a lot of evidence suggesting that facilities located farther east will have Wattled Cranes with breeding seasons that not only begin later, but will also end later than in breeding centres that are located in the west. However, there is nothing that suggests a later ending date in centres located on the coast rather than inland.

### Number of eggs laid per season

This study indicates that more eggs will be laid if there is a longer breeding season. It also indicates that breeding facilities that are located in the north will yield more eggs per season than facilities in the south. There is strong evidence that also suggests that breeding facilities located inland as opposed to coastal will have Wattled Cranes that lay more eggs. The very same regression suggested that the farther east a breeding facility is located, the more likely the Wattled Cranes will lay more eggs. Because these statements are somewhat contradictory, more regressions were conducted. These regressions resulted in the former of the two statements being found to be true and significant.

Table 1. Results of regressions testing a correlation between egg-laying data of female Wattled Cranes in North American zoos and external and environmental factors with significant values in bold type.

| INDEPENDENT VARIABLES | DEPENDENT VARIABLES START DATE | | | END DATE | | | SEASON LENGTH | | | NO. EGGS LAID | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Single Regression | N | R | P | N | R | P | N | R | P | N | R | P |
| season length | | not tested | | | not tested | | | not tested | | **96** | **- 0.683** | **0** |
| latitude | 112 | -0.095 | 0.32 | 112 | -0.042 | 0.658 | 112 | 0.041 | 0.665 | **96** | **0.181** | **0.078** |
| longitude | **112** | **-0.232** | **0.014** | **112** | **-0.212** | **0.025** | 112 | 0.008 | 0.929 | 96 | 0.051 | 0.618 |
| annual total precip. | 112 | -0.007 | 0.945 | 112 | -0.006 | 0.952 | 112 | 0.01 | 0.914 | 96 | 0.124 | 0.229 |
| inland v. coastal | **112** | **-0.217** | **0.022** | 112 | -0.104 | 0.275 | 112 | 0.089 | 0.358 | **96** | **0.306** | **0.002** |
| Multiple Regression | | | | | | | | | | | | |
| season length | | not tested | | | not tested | | | not tested | | **96** | **0.647** | **0** |
| latitude | 112 | -0.013 | 0.912 | 112 | -0.088 | 0.464 | 112 | -0.065 | 0.597 | 96 | -0.086 | 0.274 |
| longitude | 112 | -0.172 | 0.325 | **112** | **-0.423** | **0.016** | 112 | -0.223 | 0.211 | **96** | **-0.547** | **0** |
| annual total precip. | 112 | 0.014 | 0.881 | 112 | 0.014 | 0.879 | 112 | 0.001 | 0.394 | 96 | 0.088 | 0.168 |
| inland v. coastal | 112 | -0.071 | 0.722 | 112 | 0.286 | 0.152 | 112 | 0.305 | 0.136 | **96** | **0.769** | **0** |
| overall ‘p’ | | | 0.179 | | | 0.131 | | | 0.612 | | | **0** |
| season length | | not tested | | | not tested | | | not tested | | **96** | **0.684** | **0** |
| latitude | 112 | -0.038 | 0.697 | 112 | 0.012 | 0.904 | 112 | 0.041 | 0.68 | **96** | **0.165** | **0.032** |
| longitude | **112** | **-0.223** | **0.023** | **112** | **-0.216** | **0.029** | 112 | -0.003 | 0.978 | 96 | 0.025 | 0.744 |
| annual total precip. | 112 | -0.013 | 0.989 | 112 | 0.019 | 0.845 | 112 | 0.005 | 0.958 | 96 | 0.1 | 0.182 |
| overall ‘p’ | | | **0.103** | | | 0.169 | | | 0.979 | | | **0** |
| season length | | not tested | | | not tested | | | not tested | | **96** | **0.676** | **0** |
| latitude | 112 | 0.03 | 0.791 | 112 | 0.019 | 0.875 | 112 | -0.009 | 0.938 | 96 | 0.045 | 0.582 |
| annual total precip. | 112 | 0.015 | 0.876 | 112 | 0.016 | 0.87 | 112 | 0.001 | 0.988 | 96 | 0.09 | 0.202 |
| inland v. coastal | **112** | **-0.234** | **0.038** | 112 | -0.116 | 0.312 | 112 | 0.093 | 0.417 | **96** | **0.256** | **0** |
| overall ‘p’ | | | 0.149 | | | 0.744 | | | 0.836 | | | **0** |

Averages from each facility were calculated for every variable. Included in these tests were the average monthly precipitation and temperature that corresponded with the average start date of egg-laying at each facility. All of these tests had a p-value >.1 and are not significant.

## Conclusion

Since the results demonstrate that location of breeding facilities of captive Wattled Cranes influence the beginning, ending and number of eggs laid per breeding season, this is valuable data for breeders of captive Wattled Cranes. While this is useful, this research could be expanded significantly. It would be beneficial to analyse precipitation (preceding the first egg of the season for Wattled Cranes) in a different way than was analysed in this study, and to include temperature in this analysis. It would also be beneficial to conduct an analysis similar to this on a larger scale that would include data taken from every region of the USA and possibly from international captive breeding facilities.

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*Nicole R. Bohlman undertook the above research while an Avicultural Intern at the International Crane Foundation, E-11376 Shady Lane Road, PO. Box 447, Baraboo, WI 53913-0447, USA (E-mail: cranes@savingcranes.org). Her present address is:- 234 NW 21st., Apt. 3, Corvallis, OR 97330, USA.*

# NOTES ON BEHAVIOUR AND ECOLOGICAL REQUIREMENTS OF THE ROTHSCHILD'S MYNAH *Leucopsar rothschildi*

*Dedicated to Prof. Dr Jürgen Nicolai on the occasion of his 75th birthday*

by Walter A. Sontag Jr.

A wealth of literature has been published on this magnificent bird, especially on maintenance and breeding in captivity by aviculturists and zoo staff (e.g. Taynton & Jeggo, 1988; West & Pugh, 1986). Most aspects of its biology, however, in particular its ecology and behaviour in the field, have been dealt with rather poorly (cf. Feare & Craig, 1998). While the Rothschild's Mynah is almost extinct in its natural habitat, which has drastically shrunk, there is presently a well-established captive population including five breeding projects worldwide (those in North America and Great Britain started in 1984, in Europe and Japan in 1992, and in Indonesia in 1993) with currently c. 1,200 individuals (cf. Pagel, 1999). Despite remarkable efforts to reintroduce captive-raised individuals into the last free-living population in the Bali Barat National Park (Pagel, 1999), the re-stocking programme, has generally speaking, failed up to now. In 1999 the situation worsened, when the breeding and pre-release centre in the Bali Barat National Park was attacked twice and four and then 39 (out of 81) individuals were stolen (*Gefiederte Welt* 124:111 (2000)).

Surprisingly, the Rothschild's Mynah, which inhabits dry woodland (Pagel, 1999), is most closely related to a group of typical open habitat starlings comprising some 25 species grouped around the genera *Sturnus* and *Acridotheres*, and including *Leucopsar* (Sontag, 1992). Probably almost all of them perform open-bill probing (see Beecher, 1978 and others), and most of them are found in Asia. Feare & Craig (1998) characterize *Leucopsar* habitat as open woodland with a grass understorey, but detailed studies on space and habitat requirements are largely lacking. Since this species faces extinction in the wild and bearing in mind the purpose of future re-stocking or reintroduction, those working with this species are strongly recommended to offer captive conditions that contain environmental structures and properties characteristic or even necessary for *Leucopsar*. Therefore, I will first report on research dealing with space and habitat aspects in a spacious aviary. The focus is on the (relative) importance of various habitat levels, i.e. ground and higher strata, in an artificial environment that is as natural as possible. Almost nothing is known about potential adaptations of *Leucopsar*