ARTIFICIAL INCUBATION
OF EXOTIC BIRD EGGS

by Richard Rundel
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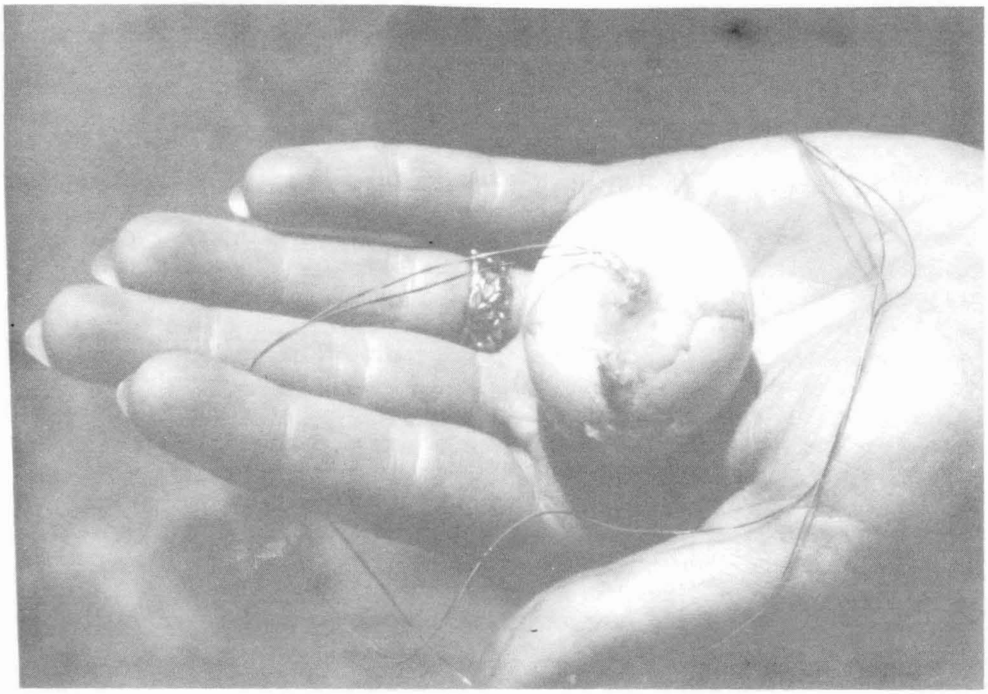
Recognizing the premise that importation of exotic birds will not continue indefinitely, emphasis must be placed upon self-sustaining captive breeding programs. The question that arises, however, is if birds are properly established in a proper breeding environment, won't they successfully rear their own young? The answer involves a basic difference in the dynamics of a wild population as opposed to a captive population. Wild populations rely upon mediocre results on a large scale. Captive populations generally are a "boom or bust". Until the proper breeding requirements are discovered, exotic bird breeding is on a very sporadic and rarely self-sustaining basis. However, once the requirements are outlined, the population virtually explodes, as we have seen with many forms of gallinaceous birds.

Unfortunately, if a breeder is working with a relatively small number of birds, or, as is commonly the case, he is working with a single pair, he may not have a compatible pair, or if compatible, he may not have a breeding pair. Commonly, under the best conditions, he will observe his birds attempting to nest but find they are falling short in terms of hatching the eggs or rearing the young. Even if the adults do rear their young, a bird successfully nests only once or twice a year, and the number of young that will be successfully reared may only amount to one or two. If one of the adults is lost after a few years, the breeder may find himself in big trouble. In short, we generally do not have sufficient space or enough time to rely upon "natural" breeding cycles.

The obvious approach to this problem from a technological point of view is to limit the bird's activities to only what is required to maximize reproductive potential. In this situation, the birds are only needed to lay fertile eggs with the incubation and rearing to be left to an alternative means which may involve hand-raising or foster parents.

This is a commonly used technique for waterfowl and gallinaceous birds, due to the simple care involved. It has not been applied to non-gallinaceous birds due to the problems involved such as: 1) few eggs being laid; 2) difficulty in artificial incubation, and 3) difficulty in hand-rearing, particularly with altricial birds.

As discussed in previous articles, there are successful methods to increase the number of eggs laid (Watchbird Nov. 76) and to hand-raise the young of altricial birds (Watchbird April 76). These techniques are certainly in an experimental stage and I would prefer to allow the adults to incubate and rear their own young, but feel that the establishment of self-sustaining populations will rely upon the development of these techniques. With the present large collection the Los Angeles Zoo maintains, there are pairs that constantly break their eggs if they are not removed. This provides us with the eggs to work with. Results to date have been mixed, but encouraging. Our Stanley cranes normally lay a single clutch of two eggs each year. Through removing the eggs, the birds continue to lay and at the year's end we collected 16 eggs and successfully reared five chicks. Our Harpy eagles laid several fertile eggs which unfortunately failed to hatch under our standard incubation procedure. What works for chickens also works for cranes but not for Harpy Eagles. In checking with several major zoos and institutions, I found wide variances in settings and procedures for temperature and incubation controls. Numerous changes were proposed it was a haphazard approach.



Thermocoupler implanted in infertile egg by researcher, Don Hoyt, UCLA graduate student.

At this point, when all seemed lost, to my pleasant surprise I learned of three UCLA graduate students who were doing studies into this problem, with very interesting results. Don Hoyt designed and commenced research by charting temperature fluctuations through the use of thermocouplers implanted in infertile eggs, refilled with fluids, and replaced in the nest. Dave and Carol Vlect are presently continuing these studies. Their preliminary results documented several important factors, including the natural incubation temperatures, the frequency of eggs being turned, and through measurements of weight loss and eggshell thickness, the necessary humidity. In addition to the above data, we also discovered, as was to be expected, that birds are individuals. Birds that break their own eggs also break thermocoupled eggs. Birds that eat eggs of other birds will also eat thermocoupled eggs if they are not identical in size, shape, and color to their own. Finally, it was clearly demonstrated that the present state of artificial incubation of exotic bird eggs is in a very primitive stage.

The accompanying summary prepared by Don Hoyt outlines the preliminary findings. The final dissertation will be published in approximately one year. Anyone in the Los Angeles area having birds suitable for this kind of study and wishing to cooperate is invited to correspond. Correspondence should be directed to the Los Angeles Zoo and will be forwarded to UCLA.

INCUBATION CONDITIONS: A SUMAMRY OF THE ORNITHOLOGICAL LITERATURE

by Donald F. Hoyt
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TEMPERATURE: Chicken eggs are almost invariably incubated at 37.5°C (99.5°F) in forced draft incubators and hatchability approaches zero when temperatures are held below 35°C or above 40°C. This suggests that in other species, some eggs may hatch at temperatures several degrees away from the optimum but that the closer the optimum temperature is approximated, the higher the percentage of hatch should be and the fewer malformed chicks there will be. In the following table are summarized some of the available data on incubation temperatures in wild species. These temperatures are measured within eggs under conditions of natural incubation. (See Table I.)

continued on next page

Table I

°F	°C	Species	Common Name	Source
100.4	38.0	Toxostoma redivivum	California Thrasher	1
100.4	38.0	Sterna fusca	Sooty Tern	2
99.5	37.5	Gallus domesticus	Domestic Fowl	2
99.5	37.5	Pipilo Erythropthalmus	Rufous-sided Towhee	1
99.5	37.5	Larus argentatus	Herring Gull	2
98.4	36.9	Zeniadura macroura	Mourning Dove	1
97.7	36.5	Calypte anna	Anna's Humingbird	1
97.5	36.4	Phaethon rubricauda	Red-tailed Tropic bird	2
97.5	36.4	Puffinus pacificus	Wedge-tailed Shearwater	2
96.8	36.0	Psaltriparus minimus	Common Bushtit	1
96.3	35.7	Carpodacus mexicanus	House finch	1
96.1	35.6	Catharacta skua	Skua	2
96.		Harpia harpja	Harpy Eagle	1
95.9	35.5	Speotyto cunicularia	Burrowing Owl	2
95.7	35.4	Chaetura pelagica	Chimney Swift	2
95.7	35.4	Taeniopygia castanotis	Zebra finch	1
95.0	35.0	Troglodytes aedon	House Wren	2
94.6	34.8	Oceanodroma leucorhoa	Leach's Petrel	2
94.3	34.6	Icterus galbula	Northern Oriole	1
93.9	34.4	Melospiza melodia	Song Sparrow	2
93.2	34.0	Dumatella carolinensis	Catbird	2
92.8	33.8	Pygoscelis adeliae	Adelie Penguin	2

Sources:
1. Vleck, Carol. Doctoral Dissertation. UCLA (pers. comm.)
2. Drent, R. in Breeding Biology of Birds (several different sources – data summarized here)

It is obvious that, while 37.5°C is the recommended temperature for chickens, Pheasants, Quail, and Ducks, it is unusually high for birds in general. In the absence of specific information about the incubation temperature of the species in question, a safer guest would probably be between 35°C and 36°C.

HUMIDITY: It has been known for a long time that eggs lose weight during incubation. It is generally assumed that virtually all of this weight loss is water. From studies of chicken eggs it is also known that there is an optimum weight loss (about 11% of fresh weight) and that if weight loss is less than 6% or greater than 13%, the hatchability decreases rapidly. At 37.5°C a relative humidity of 60% produces an 11% weight loss in chicken eggs. However, measurements of the rates of weight loss in over 60 species of wild birds under natural conditions of incubation indicate that the average weight loss if about 16%. Once again we see that the chicken egg is unusual and the conditions which produce optimum hatchability in chicken eggs may not be best for all species. The rate of weight loss at a given humidity is a function of the shell porosity. Studies of the shell porosity of over thirty species of birds indicates that shell conductivity is adapted to the size of the egg and to the length of incubation. From these studies it has been possible to calculate an average vapor pressure gradient which will cause the average egg to lose 16% of its fresh weight. This is quite convenient because it means that for any incubator temperature it is possible to calculate a recommended relative humidity which will cause most eggs to lose about 16% of their weight. The following table indicates the relative humidities and corresponding wet bulb temperatures for a number of incubator temperatures. (See Table II.)

All of these relative humidities are less than half the optimum humidity for chickens, pheasants, quail, and ducks. These relative humidities can frequently be achieved by relying upon ambient water vapor and putting no water pan in the incubator at all. The safest procedure would be to monitor weight loss and adjust humidity so that loss did not exceed 16-17%.

TURNING: It has been found in research on chicken eggs that hatchability increases when eggs are turned eight to twelve times per day. It also seems that turning is most important during approximately the middle third of incubation and that it contributes little during the last third. This latter observation is consistent with one made on one species of wild birds which indicates that under conditions of natural incubation, the orientation of the egg becomes remarkably constant during the last half of incubation. This was explained by the observation that the distribution of weight within the egg is asymmetrical and, when allowed to roll free, the egg returned to the same orientation. The same study indicated that, relative to this natural orientation, the eggs were piped in nearly the same place. This indicates that there is a proper orientation for pipping. This being the case it might be best to concentrate efforts to turn eggs during the middle third of incubation.

SUMMARY: While the conditions which produce the maximum hatchability in chicken eggs have served as a useful first guess when incubating the eggs of other species, it can be seen from the above that the chicken is not representative of most species, and the conditions which most species experience in the wild deviate significantly from the optimum conditions for hatching chicken eggs. It is hoped that this summary of the available ornithological literature will provide a better grounds for choosing incubator settings, and thereby, increase hatching success.

Table II

Temperature (°C)	Relative Humidity (%)	Dry Bulb (°F)	Wet Bulb (°F)
38.0	29.6	100.4	75.4
37.6	28.0	99.7	73.7
37.0	25.6	98.6	71.6
36.6	24.0	97.9	70.4
36.0	21.4	96.8	68.8
35.6	19.7	96.1	66.6
35.0	17.0	95.0	65.6
34.6	15.2	94.3	64.3
34.0	12.3	93.2	62.2

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