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RAPTOR RESEARCH is published quarterly in Spring, Summer, Fall, and Winter issues and occasional Supplements. The contents are usually divided into three sections. The first section is *SCIENTIFIC PAPERS* for reports of original research or theoretical analyses. These papers will be given careful editorial and referee scrutiny. A second section, *REPORTS, REVIEWS, AND OPINION,* will include secondary material, translations of material originally published elsewhere, reports of work still in progress, reports on meetings, often in some detail, book reviews, and other similar items. This material will be edited for accuracy but will not receive the critical review given the Scientific Papers. Because of the preliminary or secondary nature of the material in this section the Editors recommend that this material be cited in other papers only with great care or in a very general way and especially with specific preliminary or conference material only after consultation with the source of that information. Papers which express a personal opinion or letters to the Editor will be included in this section. *NOTES, NEWS, AND QUERIES* is used for notices of information or events, requests for information, news items either specially prepared or reprinted from other sources, and similar small items.

This journal began publication as RAPTOR RESEARCH NEWS with Volume 1 in 1967 as a quarterly in typewritten mimeographed form on an 8½" by 11" page size. Volumes 2 and 3 in 1968 and 1969 were offset printed but continued the same frequency, page size, and standard typewriter type. An analytical index for Volumes 1-3 was published. Volumes 4 and 5 in 1970 and 1971 were published six times a year in offset printing, 5½" by 8½" page size, and with IBM Composer typefaces; an analytical index for Volumes 4-5 is in preparation. In 1972, Volume 6, the name of the journal was changed to reflect the broader scope to RAPTOR RESEARCH. Currently the journal is published quarterly by offset printing with 6¾" by 9½" page size and IBM Composer typefaces and annual analytical indexes.

For membership and publication costs see inside back cover.

SOME HAEMATOLOGICAL DATA FOR BIRDS OF PREY

by
J. E. Cooper, B.V.Sc., D.T.V.M., M.R.C.V.S.
Veterinary Services Division
P.O. Kabete, Kenya

Abstract. Haemoglobin and pack cell values are given for 17 "normal" East African birds of prey of 12 species. The significance of such data is discussed.

Introduction. In both human and veterinary medicine blood examination plays an important role in the diagnosis of disease. In avian work there is a shortage of data on normal haematological values with the possible exception of the domestic fowl. One reason for this paucity of information is that a number of the standard haematological tests used in mammals (*e.g.* total white cell counts) cannot be carried out successfully on the blood of birds. As a result certain specialized techniques have to be used, as described by Lucas and Jamroz (1961). These and other techniques are discussed by Leonard (1969) who also gives a summary of figures from other workers. Leonard's summary includes very little information on predatory birds, however.

Two commonly used techniques in haematology are haemoglobin and pack cell volume (haematocrit) estimations. Both of these determinations have been found useful in the diagnosis of poultry diseases (Bierer *et al.*, 1963) and could possibly be of value in raptor work.

Materials and Methods. Birds sampled were either captives or recently captured wild individuals. All were considered "normal", but a number had previously received treatment by the author, mainly for injuries. They were examined at Kabete, Kenya at an altitude of 5000 feet.

Bleeding was carried out with a 25 or 26 guage needle and a 1 ml (tuberculin) syringe. Birds were restrained on their backs. Following plucking and disinfection (with 70% alcohol) of the area over the brachial vein, up to 1 ml blood was withdrawn. This was placed immediately in a bottle containing crystals of EDTA as anticoagulant.

Pack cell volumes were measured using a micro-haematocrit centrifuge (Hawksley, Sussex, U.K.).

Haemoglobin estimations were carried out by a conventional mammalian colorimeter method.

Results. Data for pack cell volumes and haematocrit are shown in Table 1. The figures obtained are generally similar to those described for other non-domesticated birds (see Leonard, 1969) though the variations observed in some cases warrant further investigation. The haemoglobin values obtained for Barn Owls resemble those of Christoph and Frank (1965), but it is of interest that the latter authors' figure of 10.8 g% haemoglobin for the European Eagle Owl

Table 1. Pack cell volumes (PCV) and haemoglobin estimations for 12 species of birds of prey. [Additional sets of figures represent different runs with the same bird.]

Species	Age	PCV (%)	Haemoglobin (g%)	Comments
STRIGIFORMES				
Barn Owl	Adult	24	–	Blood partly clotted
(Tyto alba)	"	44	17.5	–
	4-5 weeks No. 1	46	13.4	–
	" " "	37	19.4	–
	4-5 weeks No. 2	39	13.0	Blood partly clotted
	" " "	35	17.5	–
	4-5 weeks No. 3	37	11.5	Blood partly clotted
	" " "	44	19.7	–
Spotted Eagle Owl	Adult	38	20.8	–
(Bubo africanus)	"	43	22.3	–
FALCONIFORMES				
African Harrier	Adult No. 1	38	23.1	Male bird
Hawk *(Polyboroides*	" "	47	22.7	" "
typus)	Adult No. 2	40	25.3	Female bird
	" "	46	25.7	" "
Hooded Vulture	Adult	42	21.6	–
(Necrosyrtes	"	41	20.1	–
monachus)				
Lizard Buzzard	Adult	27	15.6	–
(Kaupifalco	"	38	14.1	–
monogrammicus)	"	40	21.2	–
African Hawk-eagle	Sub-adult	45	22.3	–
(Hieraaetus fasciatus	"	40	23.8	–
spilogaster)				
Black Kite	Sub-adult	39	20.8	–
(Milvus migrans)	"	45	23.8	–
	2 weeks	32	15.3	Hand reared

Table 1, continued.

Species	Age	PCV (%)	Haemoglobin (g%)	Comments
African Goshawk	Sub-adult	33	21.6	–
(Accipiter tachiro)	"	37	20.1	–
Black Sparrowhawk *(Accipiter melanoleucus)*	Sub-adult	42	29.8	Just captured
	"	52	–	Before release
Augur Buzzard	Adult	39	21.6	Just captured
(Buteo rufofuscus)	"	–	21.6	Before release
Lanner Falcon	Adult	47	–	Shortly after capture
(Falco biarmicus)	"	42	12.3	
Tawny Eagle	Adult	37	–	–
(Aquila rapax)	"	35	–	–
	"	40	13.8	–
	"	39	19.3	–
	"	39	20.8	–

(*Bubo bubo*) is only half that obtained for the Spotted Eagle Owl (*Bubo africanus*) in this survey.

The number of birds covered in this study was small and relatively few samples were taken from each species. As a result it is not possible to give a range of values nor to compare accurately the results with those of previous investigators. Allowance should also be made for the fact that the work was carried out at relatively high altitude. Nevertheless, a number of species were studied for which, apparently, there are no existing PCV or haemoglobin figures. It is hoped, therefore, that these results may prove of value to those working with raptors. In addition it may serve as an impetus for other workers to take routine blood samples from both normal and sick birds of prey, and to test them for PCV and haemoglobin.

Haematological data probably have a part to play in the diagnosis of clinical disease in birds of prey. An anaemic bird will show changes in PCV or haemoglobin and it is probable that other variations occur in specific raptor diseases. Full blood examinations may aid accurate confirmation of diagnosis. In addition to continuation of this study on PCV and haemoglobin the author is collecting other haematological data, the results of which will be published in due course.

Acknowledgments. I am grateful to technical staff at this laboratory for their assistance with the estimations.

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CAPTIVE BREEDING OF HARPY EAGLES

by
Frank S. Todd*
Curator of Birds
Los Angeles Z00
5333 Zoo Drive
Los Angeles, CA 90027

Abstract

A breeding project involving a pair of Harpy Eagles (*Harpia harpyja*) was initiated at the Los Angeles Zoo in January 1970. To date, a total of 11 eggs and three hatchings have resulted. The first two eaglets were lost within hours, but the third survived 16 days. Data on procedures, behavior, incubation and rearing are presented as well as recommendations.

Introduction

Birds of prey have been maintained in captivity for hundreds of years with few breedings reported. It has only been in the past decade that some of the more common species have bred for the first time under artificial conditions. Fortunately, interest in raptor conservation is increasing and a real emphasis is being placed on breeding as the priorities of zoological gardens begin to shift.

Unfortunately, most institutions will not make the commitment necessary to carry out successful propagation of birds of prey. Raptor breeding is a long-term project. All phases of the nesting process, from nest building to care of the young, apparently have to be learned. Each successive nesting attempt must be carried further than the previous one until success is ultimately achieved. Once successful, a pair should breed annually. Even in the wild, the learning process is long, often with the first nesting attempt ending in failure. It is unlikely that two year-old birds would form a pair bond, so one (the new breeder) has an opportunity to learn from the other (the older, experienced breeder).

Zoological gardens are rapidly awakening to the fact that it is impossible to specialize in everything. Most raptors are merely exhibited, since aviary designs usually preclude nesting. Therefore, at the Los Angeles Zoo we placed most of our emphasis on the breeding of a single species, the Harpy Eagle (*Harpia harpyja*) of the American neotropics. Although the laying of a few eggs by captive pairs has been recorded in the literature, harpies have never until now been bred in captivity.

The status of the Harpy Eagle in the tropical lowlands of Central and South America is not known, but it is believed that they are not numerous. Their future in the wild may be in doubt as the virgin forests which they inhabit are rapidly dwindling. Few reliable observations have been made of them under na-

*Current address: Sea World, 1720 South Shores Road, Mission Bay, San Diego, CA 92109.

tural conditions and there is little available information relative to their breeding biology.

Procedure

To initiate the breeding project at Los Angeles, an isolated circular mammal exhibit with three individual pie-shaped units was selected. The eagles were housed in the middle, flanked by spider monkeys and margays. It is interesting to note that the close proximity to the monkeys (which form a large part of their diet in the wild) did not concern either the primates or the eagles. This particular pair of eagles (the zoo has two pair) is extremely aggressive. No one is allowed to enter the aviary which is maintained externally. This is necessary both to insure the safety of the personnel assigned to the section and to increase breeding potential.

Although the exhibit has proved to be functional, it is by no means ideal. It does provide the necessary isolation. Seclusion may be of primary importance in insuring a successful raptor breeding program, although it has been suggested that large aviaries might be just as important. However, the size of the aviary may not be as critical as previously suspected. Our harpy unit is surprisingly small, measuring only 11x18x23 feet by 11 feet tall. The back and two sides are concrete to a height of 7½ feet. Chain link fencing extends up to 11 feet and over the top. The front is covered with 1x2 inch wire mesh. The floor is concrete with a pool.

In the far corner of the aviary we constructed a nest six feet from the ground that measured five feet across with an 18-inch depression. A variety of materials was used including large oak branches to form the bottom of the nest, and smaller eucalyptus branches for the top. The nest was lined with dried palm leaves, straw, green leaves and soft grass. The roof and sides above and adjacent to the nest were covered with palm leaves to provide greater security and to offer some protection from the weather.

Results

The first sign of nesting activity occurred during July 1970, when the female was observed working at the nest. The entire exhibit was immediately closed to the public. By 24 July both sexes were actively engaged in nest building and the male became increasingly aggressive. On 1 August the first egg was laid, but it was precariously balanced on several crossing branches outside the nest depression. We were able to recover the egg and replace it in the nest. The male was visibly upset and attacked on several occasions. The female began to incubate immediately. Unfortunately, the egg was broken on 3 August.

For the next month and a half both eagles worked at the nest. On 3 October another egg was laid but, apparently, it slipped through the nest and broke. The nest was rebuilt by the zoo staff and reinforced with wire mesh. Additional nesting material was offered and the eagles began immediately to court again. On 13 and 14 October breeding activity was observed and, on 26 November an egg was laid. It was removed on 1 December as the female failed to incubate. The egg was placed in an incubator where it ultimately proved to be infertile.

An additional egg was laid on 12 December, but it was discovered broken outside the nest on 1 January 1971. More nesting material was offered and on 2 February copulation was noted. The fifth egg was laid on 28 February. Unfortunately, the eagles destroyed the egg on 3 April. There was no sign of an embryo.

No further breeding activity occurred until 9 September 1971, when a great deal of courtship took place and copulation was observed. By the 13 September the nest was completely rebuilt by the eagles and again the exhibit was closed to the public. On 19 October two eggs were discovered in the nest, although it was felt that the first egg had probably been laid on the 16th. Both sexes incubated, but the female assumed most of the responsibility. During incubation she sat very low on the nest and was reluctant to leave for any reason. She was frequently fed on the nest by the male.

On 11 November a broken egg was found on the ground some 10 feet from the nest and the male had traces of yolk on his breast. During incubation the eagles were subjected to adverse and diverse weather conditions. The temperature extremes ranged from 36 F to 105 F. In addition, cold winds up to 75 mph pounded the zoo one night. Rain fell on several occasions and once, during a hail storm, the male was observed on the nest with his wings extended; he appeared to be shielding the female from the falling hail.

About noon on 15 December the eaglet hatched. It was consumed shortly thereafter by the female. Efforts to prohibit her from destroying the chick were unsuccessful. As far as could be determined this was the first instance of a captive hatching for the species. The incubation period of 58 days seemed long, but was close to the 60 days reported for the Philippine Monkey-eating Eagle (*Pithecophaga jefferyi*), its counterpart of the Philippines. The incubation period for *Harpia* is heretofore unrecorded, to my knowledge.

On 20 December the exhibit was thoroughly cleaned and the nest was rebuilt. By the 21st the eagles were already attempting copulation and working at the nest. For the next month the eagles courted constantly. Many attempts at mating occurred. Nesting material was added daily and work on the nest continued. Throughout this time the eagles continually called back and forth, employing a variety of calls.

Copulation usually lasted from six to ten seconds, but ranged from three to 30 seconds. In many instances it was not preceded by detectable signs of courtship. Normally the male merely mounted the female by placing his feet at the base of her wings and dropped to his tarso-metatarsal joints. The male's wings were usually half extended and used as balancing aids. Interestingly, the female always moved her tail to the left and the male to the right. The female frequently called during mating which took place either on the ground or on a perch, but most often on the rim of the nest. Occasionally after mating the pair faced one another with half extended wings and fully erected crests. They would then touch bills several times and follow with a bout of allo-preening. Normally, this activity was very brief, one to two minutes in duration. There did not seem to be any ritualized behavior patterns and it was usually impossible to predict

when copulation would occur. Possibly, the frequent mating attempts strengthened the pair bond.

On 25 January 1972 another egg was laid. When the female came off the nest in the afternoon to feed, the male immediately flew up and turned the egg. On 3 February the second egg was laid. Incubation commenced with the laying of the first egg. Clearly, two eggs form a normal clutch. On 11 March one of the eggs disappeared. As incubation advanced, the egg became increasingly stained. Both eagles incubated and turned the egg, but the male usually spent less than an hour a day on the nest. Incubation by the male up to three hours at a time was recorded. Occasionally, both eagles would sit on the edge of the nest and allopreen. Throughout incubation the nest was constantly reworked and fresh nesting material was provided daily. We believe the availability of new nesting material was of prime importance. The constant reworking and rebuilding of the nest during incubation may be a form of displacement activity or it may act as a safety valve for excess or nervous energy. In most instances the male brought material to the nest for the female.

Several weeks before the egg was due, rats were offered to the eagles every day. Normally, they were fed horse meat spiced with bone meal and chicken parts, with rats and day-old chicks given but twice a week.

On 29 March, at 12:42 PM, the remaining egg hatched [Ed.—56 days after second egg laid]. The male perched on the edge of the nest to observe. The nest had been freshly lined with green leaves. At 12:48 the female settled on the chick and began brooding. At 2:10 the eaglet was still wet. By 4:15 it still had not dried and was visibly weak. We removed it at 4:30 and placed it in an incubator, but it died at 5:01. Removal of the chick proved to be very risky and was done only as a last resort. We were attacked continually by the pair.

The eaglet weighed 75.4 g and was 127 mm long. The bill was well formed, hard and strongly hooked. The cream-colored egg tooth was located at the bend of the upper mandible. The upper bill itself was very dark, whereas the lower mandible was blue-gray basally, fading to dirty cream distally. The dorsal aspect was covered with a heavy white down. The down was much more sparse ventrally, particularly in the abdominal area, which was bare. A puncture wound was evident in the right thigh. The chick was probably inadvertently crushed during brooding.

Again the aviary was cleaned and the nest rebuilt. Immediately upon being reintroduced to the exhibit the pair flew to the nest and began to rearrange it. By 17 April copulation was observed. Thereafter, mating occurred daily, often two or three times a day. This behavior continued up to and after the laying of the next egg on 1 June. The egg was noted at 10:10 PM and by 10:20 the harpies were breeding again. The second egg was laid on 9 June. By 20 June one egg had been discarded. It was removed and found to be punctured and empty.

On 2 August, at 4:10 PM, the remaining egg hatched after 56 days of incubation. By 5:45 the chick had dried completely and was covered by the female at 5:51. She appeared to be feeding it early the next morning. The first *confirmed* feeding occurred on 4 August, but from their behavior it would seem that the chick had been fed on a number of previous occasions. Typically, the

male would take a partially skinned rat to the nest where the female would receive it and encourage him to leave.

By the fifth day the chick was obviously stronger and could hold its head up for short periods of time without bobbing. Vocalizations ranged from a faint cheep to a cat-like purr that was clearly audible from four to five feet away. At that age there did not appear to be a distinct hunger call. The female would place her bill very close to the eaglet. This appeared to stimulate a feeding response causing the eyass to tap her beak to initiate feeding.

Non-fresh rats were preferred. Conceivably, aged meat is easier on the digestive system of newly hatched Harpy Eagle chicks. Muscle meat from the fore- and hindlimbs was fed most often. Small pieces (approximately 7 mm^2) were offered the chick on the tip of the female's bill. To feed, the parent had to turn her head nearly upside down. Even at five days the eaglet ate voraciously. During one feeding it was offered in excess of 30 pieces and remained upright for more than 25 minutes. Its chin and upper breast were covered with gore. If the female offered too large a piece, the chick would attempt to consume it, but usually dropped it. This was later removed by the female; the nest was kept very sanitary. The chick was fed as often as five times a day. Although the male brought the food, he was not observed feeding or brooding the chick. He entered the nest occasionally, however. By the ninth day the egg tooth was still evident.

Nest rebuilding and reworking continued even after hatching. It was re-lined daily, usually with fresh green material. The importance of a constant supply of nesting material cannot be over-emphasized.

Discussion

It became apparent after a few days of observing the chick and adult behavior, that the nest might be too confining. The female had to enter very carefully to avoid stepping on the eaglet with her massive feet, although she soon became very skillful at it. Serious consideration will be given to enlarging the structure in the future, particularly the rim. This would facilitate the female backing out of the nest without endangering either an egg or chick. It was also observed that as she moved about in the nest, some twigs had a tendency to spring up. Conceivably, one of these could hit the chick. Therefore, these twigs should be either larger or smaller to prevent a possible accident.

By 17 August the chick had grown considerably and was becoming active in the nest. For the first time since the hatching, the female was observed to fly down and secure her own rat rather than take it from the male. On that occasion she fed the eaglet in excess of 50 pieces of meat.

On the morning of the 18th, the behavior of the adults had changed drastically and we were immediately alerted that something might be wrong. The female was in the nest with half spread wings covering the nest contents. She was calling continually. The high pitched screeches were accompanied by wing flexing. As each call commenced, the female would look up with her crest erect, but as the call was terminated, her head was lowered into the nest. The male was perched nearby emitting a low, resonant "goose-like" call.

Due to the female's position on the nest, it was impossible to observe the condition of the chick. To facilitate better viewing, I climbed to the top of the exhibit and remained there for 30 minutes, hoping she would move. However, before I was able to ascertain the condition of the chick, the male attacked through the palm fronds and chain link. My left eye was struck with two talons and extensive damage was sustained about the eye. Several hours of surgery were required. In the meantime, it was confirmed that the eaglet had died and the partially consumed remains were recovered.

The fact that the eaglet was partially eaten did not necessarily indicate that it had been intentionally killed. In the wild, a dead chick is frequently consumed for sanitary purposes and to prevent possible predation. Inasmuch as only the torso was recovered, the cause of death was undetermined. Circumstantial evidence indicates that a mechanical agent was responsible, *i.e.* a piece of meat caught in the throat, struck by a nest twig, inadvertently stepped on by an adult, etc.

Even though the loss of the chick at 16 days was tragic, much useful information was obtained. The fact that the chick survived the first two weeks without serious mishap, and that both parents learned and accepted their roles, indicates that captive breeding of large raptors is not an impossibility. A sudden and unexpected behavioral change is usually a good indication that something unusual is occurring. The fact that the male became ultra-aggressive may or may not be significant, but it illustrates that personalities may change significantly if conditions alter. We feel the loss of the eaglet can probably be attributed to the size of the nest.

On 29 August 1972 both eagles were caught and had their bills coped. The old nest was completely removed and a new one constructed. The new nest measures 10x10x14 feet with an eight-inch lip across the front. We feel the size of the new nest structure will preclude accidental damage to a chick or eggs and will allow much easier access. Upon completion of the nest, the pair flew to it immediately and began to mouth nesting material.

Throughout the entire project, I found myself under considerable pressure to place at least one egg of a clutch in an incubator. There was also strong feeling that perhaps the chicks should be removed and hand reared. It is at this juncture that many breeding projects fail due to indecisiveness. The decision of what should be done must be the responsibility of one person. Once the course of action has been determined, it must be adhered to unless the situation changes. However, there must be some room for flexibility.

My decision to leave both eggs and chicks with the adults was influenced by a number of factors. Due to the aggressive nature of the birds involved, an egg or chick could easily have been destroyed by their unpredictable movements on the nest if disturbed. Placing an egg in an incubator would simply be risky, since we know nothing of temperature or humidity requirements. Furthermore, the problems of hand raising newly hatched raptors are numerous. Even if successfully hand raised without major mishap, the probability of imprinting is great. However, most important of all is the fact that if the eggs or young are removed the adults will probably never learn to rear their offspring. It is my firm belief

that it is better to risk sacrificing several of the initial breeding attempts than to possibly successfully hand-rear deformed or imprinted birds.

Summary

Status of Eggs

1 August 1970	Broken, 3 August
3 October 1970	Fell through nest, 3 October
26 November 1970	Incubator, 1 December, infertile
14 December 1970	Broken, 1 January 1971
28 February 1971	Broken, 4 April
16 October 1971	Broken, 23 November
19 October 1971	Hatched, 15 December, consumed
25 January 1972	Disappeared, 11 March
3 February 1972	Hatched, 29 March, survived 4 hours
1 June 1972	Punctured, 20 June
9 June 1972	Hatched, 2 August, died 18 August

Two eggs probably form a normal clutch. Three hatchings were recorded with incubation periods of 58, 56, and 56 days, respectively. It would appear from data collected that nesting occurs year round, at least in captivity.

Conclusions and Recommendations

1. Provide the raptors with as much seclusion as possible.
2. Do not hesitate to close an exhibit to the public if breeding activity commences.
3. Do not lose patience; the learning process is long, both for the raptors and institutions involved.
4. Formulate a basic philosophy and stick with it. Do not hesitate to consult with those who have been successful, as there is no need to duplicate failures.
5. Consider seriously the size of the nest. Make sure the bottom is covered to prohibit an egg from slipping through.
6. Have fresh nesting material available at *all times.*
7. Record all data carefully as they will be invaluable during the next breeding attempt. Some of the data may be new and unrecorded in the literature.
8. Use a whole-body diet.
9. Be alert for behavioral changes.
10. Perhaps the most important and frequently overlooked factor is the role of the keeper. The project is doomed to failure without a thoroughly dedicated and observant individual. If such a keeper is on the project, do not ignore his advice. Usually it will have some merit as it is at his level that the intimate contact occurs. Therefore, in conclusion I with to acknowledge the assistance of Tom Meacham who, as much as anyone, is responsible for our success.

(Revised manuscript received November 5, 1972.)

TRANSLATION

A MALE HAWK'S POTENTIAL IN NEST BUILDING, INCUBATION AND REARING YOUNG*

by
Frances Hamerstrom and
Frederick Hamerstrom
RFD, Plainfield, Wisconsin 54966

Abstract

In each of three years, a trained male Red-tailed Hawk built a nest and incubated a hen egg day and night. In two of these years he adopted and reared a total of three red-tail chicks aged 1, 6, and 21 days at the time of adoption. There were no failures. He displayed at and attempted copulation with people who, apparently, were a stimulus for nest building. Food was brought to him by the authors and he served it to the chicks until they could feed themselves. His molt seemed not to be correlated with incubation.

Introduction

The male's role in nesting is not well known among the buteos. Of 25 species listed in Brown and Amadon (1968) no information is given for 14, partial information is given for some, and in no instance has the norm been established. More is given for the Red-tailed Hawk (*Buteo jamaicensis*) than for most species: "Both sexes build, frequently squatting to shape the nest cavity with breast and wings . . . Both sexes incubate, although the female, fed by her mate, usually does most or all" (*Ibid.*:608).

Observations of a captive male red-tail gave us a chance to learn something of the male's potential. All we knew of the early history of this tercel was that he had been taken from a nest in southeastern Wisconsin in 1967 and held in captivity. When brought to us he still had down on his head. He was tame. To insure a successful release we trained him, intending to hack him back into the wild. He proved to be such an excellent hunter that we reconsidered and kept him for falconry.

During the summer of 1968 we molted him in a 3x4 m pen. He was confined with another red-tail, presumably a female. They behaved amicably, but we noticed no signs of sexual interest. His molt was normal and on 22 May 1968 the red central rectrices were about 65 mm long. The wing molt had started earlier (Hamerstrom, 1971). At the end of the summer the female went back to her owner and F. H. (Frances Hamerstrom) took the tercel hunting almost every day.

*This paper is reprinted with permission. It first appeared in *Die Vogelwarte* 26(2):192-197, 1971. "Potential eines männlichen Greifvogels (*Buteo jamaicensis*) in Bezug auf Nestbau, Brüten and Jungenaufzucht." The translation from German to English was done by the authors.

The first sign of sexual activity was on 21 November 1968 when he displayed to F. H. He faced away from her, spread his wings, bobbed his tail up and down like a courting crow, and then dipped his vent to the ground repeatedly as though bathing. The following day he displayed again. Both days were exceptionally warm.

Nest Building

On 29 March 1969, this tercel started trying to build a nest on top of his block perch with his leash. We promptly put him in a roughly 2x4 m screened porch containing an old table. We gave him a few sticks on the table. This established the nest site. He carried more sticks up to the table from a pine on the floor and arranged them in a circle. We put a thick braided rug on the slippery table top to keep the wind from blowing his nest away. The red-tail used his feet more in nest building than our female Golden Eagle (*Aquila chrysaetos*) and, unlike her, pushed ends of sticks into crannies as though to anchor them (for this and later references to our eagle, see Hamerstrom, 1970). His nest building was punctuated with dropping down onto the nest and rolling sideways as though to form a cup. Whenever F. H. approached he mantled, rotating in semicircles with outspread wings as though in defense of a morsel of food or to invite copulation.

The next day we wired some branches together to form a crotch for him to build in, but he thumped down so hard with his breast that he broke the crotch apart. This rough treatment of a potential nest site would have survival value in the wild, as weak branches would be discovered early in nest building. We removed the crotch. He built his nest anew on the table. After the foundation was well formed we put a pile of hay on the nest and he rearranged the cup with it in a matter of minutes. In each case the nest was selected by the "female" (us) placing two or three sticks on the site. It took him about two days to complete the nest.

In subsequent seasons nest building was sporadic early in spring and took considerably longer in total. Available sticks plus the stimulus offered by people increased nest building activity. Even the sight of people watching him through the window offered stimulus, especially after he had attempted copulation.

Copulation

The onset of nest building and the onset of copulation were essentially simultaneous. The tercel attempted copulation on F. H.'s ankle at first, but later preferred her head (Figure 1). In the early stages he mounted carefully, trod essentially on his tarsi with his feet held sideways and toes almost closed. He often fell off. The process was much like that described by Mueller (1970) with a captive Broad-winged Hawk (*Buteo platypterus*), except that the red-tail's call was an insistent, oft-repeated squeaking. After more practice he flew directly to the head of any person who entered his pen and sat down quietly on a bench. He was ready to copulate at about seven-minute intervals. Gradually his technique changed; he no longer fell off, nor did he close his feet. Instead, he got a fairly good (but not puncturing) grip with his feet open, held his tarsi low but not

Figure 1. A Red-tailed Hawk male attempting copulation with an unsuitable object. Photo by Dr. Charles Kemper.

touching his subject's head, and pummeled and scratched with his feet, while swinging his spread tail downwards and from side to side. Had he been mounting a more appropriate mate, this pummeling and scratching might well have stimulated her.

We are left with the question whether the gentle, balled-foot treading is simply preliminary to a somewhat rougher (but still far from dangerous) action, or whether the rougher treading was an over-reaction following repeated failures. Mueller's (*Ibid.*) point is well taken; the balled foot may be an adaptation to prevent injury. On the other hand, stimulation by massaging the region of the gonads is a basic part of the technique of artificial insemination and of the cloacal sexing of raptors (Hamerstrom and Skinner, 1970). On 26 March 1970 we sexed our tercel by the above method. He gave semen.

Incubation

On 2 May 1969 we put a warm hen egg in his nest. He shoved it under his breast with his beak, rocked from side to side with lower breast feathers outspread, and settled to incubate in less than a minute. Leaving the nest for only short periods to feed and preen, he kept the egg warm day and night for nine days and eight nights. We cut the incubation period short at that time by introducing a red-tail chick for brooding.

In later years incubation was fitful for the first two days. He was not on the nest for the first night in 1970 and not for the first two nights in 1971. Our eagle, too, did not incubate steadily during the first few days after the appear-

ance of an egg. Both species often lay when nights are freezing and it is likely that records of eggs deemed infertile by some observers may in reality have been rendered inviable by cold.

A definite brood patch was present in 1971, the only year in which it was looked for. This may be the source of the breast feathers in the nest, mentioned under *Molt*. The brood patch measured about 50x60 mm on 13 May and showed little or no vascularization.

Adoption

The domestic hen egg that he incubated so diligently in 1969 was infertile. We arranged a "hatch" by giving him a red-tail chick for adoption, at the same time leaving the egg in the nest.

Adoption presented no problem. On 10 May after the tercel had been incubating 8½ days, Charles Sindelar brought us a newly hatched red-tail chick and we put it on the nest at 21:25 hours. The tercel left the nest, but as soon as he heard the chick peep he got back on the nest with far greater caution than when incubating. He moved onto the nest on his tarsi and commenced brooding.

We were feeding thawed chicken and, wishing to give him a chance to feed the chick fresh meat, we killed a white mouse on 13 May and threw it onto the floor of the porch. He picked the mouse up gingerly, flew up to the nest with it, and proceeded to brood his bizarre clutch: one hen egg, one red-tail chick, and one dead white mouse. He had moved the three carefully together with his feet and beak. F. H. pushed him off the nest and skinned the mouse whereupon he fed it piecemeal to the chick.

In 1970 the tercel reared two red-tail chicks. Again the young were readily adopted. On 16 May after an unrecorded number of days of incubating a hen egg, we placed a large (about three week old) red-tail chick on his nest. He preened and paddled, and at first seemed distracted. Next we threw food into the porch and within 12 minutes he fed the chick. On 17 May we added another red-tail chick, this one about six days old. Within minutes the tercel was feeding both.

The change-over from incubation to brooding was dependent upon neither the passage of a certain number of days of incubation, nor the stimulus of a hatching egg; the appearance of a chick was enough. Nor was the exact size or age of the chick important, for red-tail chicks of one day, six days, and three weeks were all promptly adopted. Similarly, our female Golden Eagle was not fussy about the size of the red-tail chicks she adopted.

The drive to adopt anything resembling a young chick appears to be strong. Our female Golden Eagle, who has reared three red-tail chicks, once "adopted" a small, dead domestic chicken. She also tried to feed a new large red-tail chick's thigh, which was white, fluffy and approximately eaglet size.

Not all adoptions are successful. Prestwich (1955:7) reports a female Common Buzzard (*Buteo buteo*) which incubated, hatched and reared several broods of domestic chickens, but killed a brood when she had done no prior incubation.

Feeding

We have no idea whether or not female Red-tailed Hawks normally regurgitate food for their very small young. Unlike our female Golden Eagle, the tercel red-tail did not regurgitate food, but offered tiny bits—about half the size of a pea. Each morsel was well moistened as the tercel's salivary juices ran strongly when feeding.

When the first chick was nine days old, the tercel placed pieces of tender meat within its reach and watched the chick feed itself. He ceased brooding the chick at night when it was 16 days old. On 3 June, at 24 days, the chick tried tearing its own food.

By autumn the chick was flying free about our farm and was ready for migration. It departed soon thereafter.

Molt

Olendorff (1971:34), in his fine review of the periodical literature on falconiform reproduction, points out that the correlation between the onset of the molt and the timing of the breeding cycle is still open for investigation. Any tercel, captive or free, must of course be given an egg before he can incubate. His own endocrine balance has nothing to do with the time of arrival of the egg, but probably does affect his readiness to cover it, as well as the timing and progress of his molt. We do not know the earliest date on which our tercel might have accepted an egg, for he covered it when it was first presented in both 1969 and 1971 (no data for 1970).

The first of our red-tails's flight feathers was dropped on 18 April in 1969 and on 21 April in 1971, a year-to-year difference of only three days. We initiated incubation on 2 May and 16 April, respectively, a difference of 17 days, suggesting that the onset of the molt of the remiges was not triggered by incubation per se. Each year we have noticed breast down in the nest; down feathers were in abundance on the 15th and 16th days of incubation in 1971. It is possible that this molt may be correlated with incubation.

Discussion

There have been several instances of the successful hatching of eggs, and of the adoption of young (including the young of other species) by female red-tails in captivity. These, however, are not germane to our discussion of the behavior of males.

We know of only one report in the literature of a male hawk building a nest alone. Nethersold-Thompson and Nethersole-Thompson (in Olendorff, 1971: 68) mention an instance of an unmated male Hen Harrier (*Circus cyaneus*) selecting a nest site and building a nest. During a study of 109 nests of *C. cyaneus* in central Wisconsin (Hamerstrom, 1969) we noted that males frequently built several plucking platforms resembling nests. We never knew a female to lay on one of these platforms, although the possibility exists. We know only that nest-like plucking platforms are common to the species. It would seem to us that the unmated male was perhaps building a plucking platform in the incident reported by the Nethersole-Thompsons.

Despite the expertise of our tercel, it is extremely doubtful that a wild male red-tail could incubate a clutch and rear a brood single-handed–eggs or young would be chilled while the adult was off hunting. It is evident, however, that the male as well as the female has the behavioral repertoire for serious incubation of eggs and rearing of young. It is quite possible that the male shares such family duties more often and more fully than has generally been recognized.

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REPORT

RAPTOR RESEARCH FOUNDATION 1972 CONFERENCE ON CAPTIVITY BREEDING OF RAPTORS

by
Byron E. Harrell

The second captivity breeding conference of the Raptor Research Foundation was held at the Airport Holiday Inn, Sioux Falls, South Dakota on Friday to Sunday, November 24 to 26, 1972.

Copies of reports on breeding projects submitted by 24 cooperators and a copy of the British report on captivity breeding were given to the participants. It was attended by 52 persons and consisted of the following schedule of topics and had the following discussion leaders.

Friday evening.

Informal get together. Richard Fyfe showed some motion pictures taken at Alberta eyries.

Saturday morning.

Breeding Projects and Aquisition—Donald V. Hunter, Jr. This session included remarks and slides by Bob Hinckley on some zoo work on breeding.

Facilities—Richard Fyfe. The first part consisted primarily of remarks and slides by Fyfe on some breeding projects and facilities in North America and in Great Britain. A second part was a description by Bob McCall of the successful breeding of Prairie Falcons by a group in Saskatchewan with very limited facilities and finances.

Health and Nutrition (part)—David Graham, DVM. In this session Graham reviewed with slides the work of the RRF Pathology Committee and information on nutritional diseases of raptors.

Saturday afternoon.

Photoperiodism and Endocrinology—Tom J. Cade. Cade reviewed both of these areas and told of some recent work; the discussion included some comments on recent attempts at endocrine experiments as well as other problems.

Behavior (part)—R. Wayne Nelson. The first part of this session was some motion pictures of Fyfe's captive breeders which could be compared with those of wild birds shown the previous evening. The second part was a review and discussion led by Nelson of many behavioral problems attempting to relate the natural and artificial situations.

Saturday evening.

Artificial Insemination—James W. Grier. Grier presented slides illustrating successful work with Golden Eagles and led the discussion in this area.

General. Some time was spent by the group on plans of the Conference on Raptor Conservation Techniques.

Sunday morning.

Health and Nutrition (part)—David Graham, DVM. Graham conducted a slide based discussion of some other raptor disease problems.

Incubation and Development of Young—Richard Olendorff. Olendorff led an extended discussion emphasizing problems of artificial incubation.

Sunday afternoon.

Behavior (part)—R. Wayne Nelson. This session emphasized behavioral problems related to the release and establishment of captive raised raptors.

General. This discussion related to publication and other problems.

The following were recorded in attendance.

Andersen, William C.
Armbrewster, Jerry
Bond, Frank
Boyd, Lester
Buckland, Roger
Cade, Tom J.
Campbell, John A.
Collum, Robert O.
Cranson, Babette
Dobler, Roger
Eberly, Lee
Enderson, James
Evans, David L.
Fuller, Mark
Furcalow, Mike, DVM
Fyfe, Richard
Gorrell, W. Russ
Graham, David, DVM
Greenfield, Giles
Greir, James W.
Hamerstrom, Frances
Hamerstrom, Frederick
Hanson, Cliff
Harrell, Byron
Harrell, Joyce
Higgins, Nikki
Hinckley, Robert
Hittle, Gervaise
Hughes, David
Hunt, Grainger
Hunter, Donald V., Jr.
McCall, Robert
Mesch, Kenneth
Nelson, R. Wayne
Oar, Constance
Oar, Jack
O'Brien, Dan
Olendorff, Richard
Redig, Pat
Richards, Gerald L.
Sayler, Dale
Schwartz, Charles H.
Shultz, Albert W.
Shultz, Philip L., M.D.
Smylie, Tom
Snelling, John
Stoddart, John W.
Swartz, L. Gerald
Trefry, Philip A.
Trost, Charles H.
Weaver, James
Woody, Jesse L.

Publication Date of Fall Issue, 1972. Volume 6, Number 3, Fall 1972, of *Raptor Research* was published on March 19, 1973. Supplements C and D were published the same day.

Publication Delays and Publication Plans. Due to a variety of problems, publications have been delayed. The papers for the next three issues of 1973 are well along in production and will be published in as prompt a sequence as possible. The remaining supplements for 1972 will also be published in short order. Various changes in our procedures are being instituted to bring the publication schedule into agreement with the proper months.

RAPTOR RESEARCH FOUNDATION, INC.
in care of Biology Department
University of South Dakota
Vermillion, South Dakota 57069
U.S.A.

The **RAPTOR RESEARCH FOUNDATION, INC.** is a non-profit corporation whose purpose is to stimulate, coordinate, direct, and conduct research in the biology and management of birds of prey, and to promote a better public understanding and appreciation of the value of these birds.

Publication has been a major area of activity. From 1967 to 1971 *Raptor Research News* was published; in 1972 publication was continued under a new name, *Raptor Research.* A series of occasional longer publications was started in 1971, *Raptor Research Report. Raptor Research Abstracts,* initiated in 1972, is a quarterly bibliographic service.

The Raptor Research Foundation has had a number of informal meetings and in 1971 sponsored the first of its conferences on specific topics on raptors. This one was entitled "Special Conference on Captivity Breeding of Raptors," and another planned for 1973 is entitled "Conference on Raptor Conservation Techniques."

The interests of the Foundation are indicated by the titles of its committees: Editorial, Captivity Breeding, Population, Banding, Bio-telemetry, Pathology, Pesticide, Ecology and Ethology, Systematics, Education and Conservation, Bibliography, International Coordination, and Finance and Investment.

MEMBERSHIP

Membership in the Raptor Research Foundation is open to all who contribute. *Raptor Research* is sent to all who contribute a minimum of $3.00 per year; those who wish to receive both *Raptor Research* and *Raptor Research Abstracts* must contribute a minimum of $5.00. These minimal rates have been established to encourage all who are interested to join. Other activities are financed by the generosity of members who contribute more than the minimum. Such contributions are encouraged.

PUBLICATIONS

All previous publications are still available.

Raptor Research News each issue 50 cents.
1967-1969, Vols. 1-3, 4 issues each; Analytical Index, Vols. 1-3– 50 cents.
1970-1971, Vols. 4-5, 6 issues each; Vol. 5, issues 5-6 combined, $1.00.

Raptor Research Report No. 1, Richard R. Olendorff, "Falconiform Reproduction; A Review. Part 1. The Pre-nestling Period." February 1971, 111 pp., 6" x 9", $2.50 ($2.00 to members).

Additional copies of current issues of *Raptor Research* are $1 each. For price of additional copies of the Supplements, apply to Raptor Research Foundation.