

A CONTRIBUTION TO THE BREEDING BEHAVIOR OF THE
AMERICAN KESTREL IN CAPTIVITY

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INTRODUCTION

The American Sparrow Hawk or Kestrel (*Falco sparverius*), as with all diurnal birds of prey, has been bred in captivity with only marginal success. When recent productive attempts with this species by Willoughby and Cade (1964) and by Porter and Wiemeyer (unpublished report in B.P.I.E. 8:1-2, 1968) are considered along with the failures by many workers to obtain fledged offspring from pairs of several different species, it is apparent that the Kestrel adjusts more readily to captive paradigms. For this reason, the Kestrel is an excellent experimental animal for the behavioral research which is basic to the current movement toward domestication of the falconiforms. It is in quest of the eventual explanation of these fundamentals of falconiform reproduction, not the production of young raptors for sale or barter, that this paper is directed.

Relative to other raptors, Kestrels have advantages to the aviculturist besides their greater tolerance of open-caged life. Their small size decreases the amount of aviary space needed and the amount of food required. The force with which small birds fly into a wire cage is unlikely to inflict serious or permanent damage. The general lack of strength and the lesser degree of sexual dimorphism in the Kestrel relative to many other falconids is particularly important, since conflict often occurs in the early stages of a breeding project resulting in a severely injured or killed male. One of the greatest advantages involves the age of the birds before sexual maturity is reached. Kestrels are believed to be both physiologically and behaviorally capable of reproduction the summer following their birth, whereas larger falcons such as the Peregrine Falcon may require 3 to 5 years. This one advantage alone makes the Kestrel appealing for short termed (2 to 4 years) behavioral studies.

Very few disadvantages are apparent with respect to using Kestrels to study falconiform behavior. Cannibalistic tendencies of the parents toward very young chicks are best approached as a problem to solve rather than a disadvantage. The major criticism of Kestrel breeding studies is that such research is

not in the main stream of current investigation. This may be true in some respects, but such statements are easily countered by the idea that if the fundamentals were learned first from the Kestrel, progress with the larger species, such as the Peregrine Falcon, might be accelerated. Indeed, this is a serious oversight by certain men who continue unsuccessfully year after year to attempt to breed the peregrine. The basics have not been sufficiently elucidated in the captive situation!!

If, then, you manage to read this purposely detailed account aimed at basic description, you indeed have an interest in falconiform behavior. Some may criticize such lengthy coverage, but it is this investigator's viewpoint that as breeding projects become more successful, attention should immediately be turned to a behavioral approach, as opposed to a "how-to-do-it" approach. Complete comparisons between the captive and wild paradigms, and thorough disentanglement of all major aspects of the complex biological phenomenon we are attempting to harness should be the primary objectives of captive breeding projects for the next several years. Morally, little can be said for those who seek monetary gains from an infant biological field of endeavor prior to its maturity.

It is hoped, therefore, that the breeding of raptors in captivity will temporarily and in the near future remain a scientific endeavor as depicted by the Raptor Research Foundation approach, and that in the spirit of this undertaking more emphasis will be placed on raw description of falconiform behavior in captive situations. This will be a time consuming, sometimes unrewarding and boring task requiring mounds of paperwork and long hours in a blind, but such an approach will offer most to the sport of falconry, to the Foundation and to the cause of the natural sciences in general.

MATERIALS AND METHODS

A single pair of Kestrels was obtained in Washington State during the spring of 1965. An unsuccessful breeding attempt was made in the Spring of 1966. The details of this effort can be found in the Breeding Project Information Exchange No. 1, October, 1967, of the Raptor Research Foundation, Inc. A second attempt, the subject of this paper, with the same pair of birds was carried out on the University of Washington campus, Seattle, Washington, during the Spring of 1967. The birds were then 2 years old.

The aviary was 6 feet wide by 12 feet long by 6 feet high made of 2-inch by 2-inch boards and $\frac{1}{2}$ -inch mesh hardware cloth. The northwest and two thirds of the northeast sides were covered

with bamboo fencing to break the late winter winds. Similarly the southeast and one half of the southwest sides were covered with bamboo which could be raised or lowered depending on the wind, rain and sun conditions. The floor of the aviary was dirt with live vegetation which provided good perches. About one quarter of the roof in the northwest corner was covered with fiberglass sheeting. The nestbox and sufficient artificial perches were placed under this covering. The closest sidewalk was approximately 25 feet from the cage, but the site was relatively free from disturbance. One had to walk across landscaping to approach the pen from the south, or through dense brush and trees to approach from all other sides. A blind was constructed approximately 2 feet from the cage wire, allowing very close, detailed observation. The nestbox was built of $\frac{1}{4}$ -inch plywood and measured 19 inches high on a base 9 inches by 9 inches. A 3-inch diameter hole was cut about 10 inches from the base. The first 7 to 8 inches of the front consisted of a hinged door for easy inspection of the nest contents. A small perch extended from the nest hole and a larger perch was nailed to the base of the nestbox.

All food was either liberated in the pen or placed on a feeding block consisting of a $2\frac{1}{2}$ -foot 2 by 4 nailed horizontally to a 3-foot high 4 by 4 post. The bulk of the food consisted of raw beef heart and chicken parts supplemented with the commercial vitamin-mineral preparation Theralin (Lambert-Kay Inc., Los Angeles), and the vitamin ABDEC (Parke, Davis & Co.). Toward hatching time many live English Sparrows (*Passer domesticus*), mice and mealworms were given to prevent cannibalism.

No attempt was made to control climatic factors. The birds were placed in the pen on January 9, 1967, and thereafter were subjected to the rigors of a typical, wet and cold western Washington winter. Lighting, humidity, temperature, exposure to the sun, etc., were much the same as the birds would have experienced in the wild. The birds, captured in Washington, were being exposed to normal Washington climatic conditions, at least at the time for breeding when the wild birds would be expected back from migration.

From January 9th until mid-April the birds were fed once or twice daily and observed only occasionally otherwise. From April 17 until June 20 roughly 60 hours were spent in the blind making a detailed log of the birds' activities. The following is a condensation and discussion of pertinent observations.

OBSERVATIONS AND DISCUSSIONS

A. Introduction of the birds.

Prior to being released in the aviary on January 9 the birds had been tied close together either on their block perches or a screen perch. They were flown free for a time in August and September, 1966.

When placed in the aviary, as at the beginning of the unsuccessful attempt the previous spring, the female immediately established her dominance. The male suffered little damage other than a bloody cere, but it was necessary to put a small perch about 4 inches off the ground in the protected corner in order that he might perch off the ground. At first this was the only place he was observed, and the female would make abortive attacks on him if he left this perch even when this writer was in the pen. If he was placed on the feeding block and given a piece of meat he would immediately dive to his corner.

Ten days after being released in the pen the male still spent 95 per cent of his time on the low corner perch, but occasionally was able to gain a slightly higher branch in the early morning or late evening. By the end of January the female had stopped chasing him unless there was cause, such as he having food and she not. Approximately one month after introduction (February 10) the male seemingly had free access to all perches in the pen.

In the meantime the female had become very independent and wild when approached. At first she would accept meat from the hand, but with a month of freedom in the pen this was out of the question.

After observing the introductory sequence for two seasons, it is evident that definite preparation should be made for this phase of a breeding program. First, and perhaps most important, there must be ample perches in the pen or room, both low and high, to accommodate the male when being attacked by the female. Second, since the male establishes the initial territory in most or all falconiform species, it might be helpful to put the male into the pen first, allowing him to become acquainted with the paradigm and perhaps to develop some bond with the area such that he would be more likely to defend himself against an aggressive female when she is placed in the aviary. Third, coping the beaks and dulling the talons is a good idea.

Under the circumstances which existed both in this study and in the previous unsuccessful attempt, it is interesting to note the progressive, step-by-step attainment by the male

of available perches. It would be instructive to make close observations at this period in the cycle to ascertain if this represents an increased defense or offense on the part of the male, or a decrease in the aggression of the female. Casual observations and notes would indicate that it is the latter, since the male was never observed to fight back unless very hard pressed by the female.

B. Early nestbox activity.

The nestbox was placed in the aviary on February 26 after the birds had been observed perched close together for several days. Mutual roosting was the first indication of reproductive behavior observed, but within one or two days after introduction of the nestbox both birds were seen entering the box. Perhaps mutual roosting and nest-site selection would have begun simultaneously or nest-site selection would have begun first had those opportunities existed.

Early visits to the nestbox were quite short and the male seemed to take the initiative, often chattering from within the box. The female was silent during her visits. After emerging, if a bird flew to the side of the other, as was usually the case, each bird chattered softly for a brief second or two.

Visits to the nestbox gradually increased in frequency and length. On April 9th the male visited the nestbox 4 times in 30 minutes, being inside for over a minute on one occasion. At that time the male was considerably more active toward the nestbox than the female. When she visited the nestbox perch while the male was inside, he would chatter loudly. This occurred time after time during the observation periods.

A week later the birds were observed entering the nestbox for short periods (5 seconds or less), and upon leaving, each bird would fly directly at the other and turn at the last minute to another perch. Then, within 15 seconds, the active bird would return to the side of the other and chatter. This sequence might occur 5 times in 2 minutes.

On April 15 the first signs of the tail bobbing were observed in the male. This occurred during a sequence similar to that mentioned in the previous paragraph, but instead of the male (the active bird) flying to the female after the pause, the female immediately flew to him. This elicited sweeping movements of the male's tail and a slight squatting.

By April 21, the male often spent 3 to 4 minutes in the nestbox followed by 30 seconds or less standing in the nest hole peering out. He would chatter periodically from within

the nestbox, but the female usually ignored these activities. If he was outside and she flew to his perch or became active by flying back and forth across the pen, the male raised up on extended legs, bobbed his slightly spread tail, and extended his neck and head upward and forward. Finally he would fly to the nestbox and go in as the female flew back and forth between the nestbox perch and the opposite side of the pen 10 or more times in rapid succession. Each time she landed on the nestbox perch he chattered from inside the box. Often she stuck her head into the box and would almost go in, but would back out at the last minute. If she finally went in, both birds chattered loudly for 5 to 10 seconds. Upon leaving, the birds commonly flew to the same perch and sat quietly preening for several minutes. This entire sequence was observed again and again in mid-April.

C. Early courtship behavior.

It was at this time (April 21) that the first signs of reciprocal preening were observed. This began simply as occasional pecks by one bird at the head or neck of the other. There was no great force or escape reaction by either bird. Soon it was noted that the pecks were directed at the beak as if the birds were "billing."

On one occasion this led to a most interesting behavior. Both birds chattered softly at each other and the male bobbed his tail and squatted very slightly while reaching out with his beak to peck her beak several times. Then he squatted quite low and with his keel touching the perch rolled subtly from side to side, perhaps 10° to each side, with his wings partially open. This behavior was reminiscent of a killdeer trying to lead a predator away from its nest. All the while the male had his head turned toward the female appearing as if he was bowing before her. An abbreviated form of this display lacking the rocking from side to side was observed on a few other occasions. Its significance is difficult to imagine.

On the same day (April 21) and on a few previous occasions the female was observed to fly very fast toward the nestbox perch and to hit it hard as she landed. Then she would strike at it several times with one or both feet as if attacking it. Again the significance is not known.

One other interesting behavior was observed on April 21. Once when the female was in the nestbox, the male flew to the feeding perch and picked up a piece of meat in his beak. He began crying or screaming, as one familiar with young Kestrels might expect of a hungry, recently fledged bird. This continued as the female began peering out of the nestbox hole where she sat for almost a minute. When he picked up the meat

she began to feak or scrape her beak against the edge of the nest-hole. She flew to a perch and feaked some more. As is well known, feaking usually follows a meal, but the female had not eaten for some time. It is therefore suspected that in this case the feaking was in some way elicited by the behavior of the male, which continued to walk around on the feeding perch crying with the meat in his beak. Finally, the female flew to one of her usual perches and he brought the meat to her. He was still crying. It was evident that he was trying to get her to take the meat, since when she changed perches, he followed and continued screaming and presenting the meat to her.

It was May 1 before she was observed to take a piece of meat from him. On April 24 he was seen pecking at a piece of meat, but not tearing any off as he watched her fly back and forth across the pen. When she landed he took the meat to her, but she seemed to ignore him and he gave up as he had done many times before. He would then drop the meat under whichever perch he happened to be on. On several occasions, by the end of the day, all six pieces of meat given at noon lay below a single perch as evidence of his attempts to give her food.

He carried a whole mouse around for some time on May 1, and she made slight efforts to take it from him, but she did not. As soon as he ate his fill, however, she retrieved the remaining portion of the carcass and devoured it. An hour or so later she accepted a piece of meat from the male. They chattered loudly at the exchange, and the male left as the female ate.

D. Sexual experimentation and the onset of copulatory behavior.

Concurrently with the onset courtship feeding, the birds began what could be termed sexual experimentation. The female commenced to respond more markedly to the male's activities. In the afternoon of April 24 the male flew down from the nest-box and landed about a foot from the female. He walked toward her, chattering, and when he was beside her he squatted low and pushed his tail down as far as possible and still maintain balance on the perch. While he was in this position, the female stood high and bobbed her tail. Her efforts seemed more in an upward direction than downward. A few minutes later the same sequence occurred; the male squatted and lowered his tail and the female, standing next to him, extended herself, stood high and raised her tail to 20° above the horizontal. These movements, as will be described below, are very nearly those which occur during the copulatory act, and were therefore termed "sham copulation."

By May 1, when a bird entered the nestbox alone, it often spent 7 to 10 minutes there. Again and again the male went to the nestbox and spent several minutes, and upon leaving, flew to the female. Together they would go through the movements described above, still standing side by side. This was usually followed by preening for several minutes before the male would fly back to the nestbox and start the sequence again.

On May 4 the male tried to mount the female, but she hopped to a higher branch at the last minute. The birds visited the nestbox together considerably more often at this stage, but usually for no more than 1 to 2 minutes at a time. Simultaneous visits were generally shorter than single visits. On one occasion on this day the female spent several minutes pecking at the nesthole as if to enlarge it. This was observed several times on later days, but she was not too successful at tearing pieces off, since the nestbox was constructed of tough plywood. Besides observations through the nesthole of the birds turning in the nestbox, this was the only evidence of nest building. Not one stick or blade of grass was added to the nest.

The combination of courtship feeding and sexual experimentation was observed for the first time on May 8, and about a half hour later copulation was observed for the first time. The male flew to the nestbox, feeding block and then to the female with a piece of meat, all in a matter of 15 seconds or less. The female took the piece of meat and went through all the motions of copulation, continuing to chatter for several minutes in short bursts as she ate. Finally she flew to the feeding block, still chattering, and when the male flew to her side she went through the motions again. She still had the meat, but she was not actually eating it; rather, she was picking pieces off and flicking them aside as a falconer would expect of a satiated falcon. Whether this had relevance to the reproductive behavior is speculative.

As the minutes passed, both birds finally maneuvered to the same perch directly in front of the blind. The male then jumped squarely on her back as she stood high on her legs with head extended and tail raised making her body nearly horizontal. She tried to raise her tail higher, but it caught between two of his tail feathers and could not be raised. Finally the male managed to get his tail around to her side and passed it underneath while maintaining his balance by flapping his wings. Her tail was then raised far above the horizontal and her head was about 15° below the horizontal. This lasted 10 seconds or more before the male jumped back to the perch. The female remained in a horizontal, tail elevated position, chattering quietly for 5 seconds or more after the male dismounted. This was followed

by at least 10 minutes sitting idly, side by side, on the same perch. Several unsuccessful attempts to mount were made later in the afternoon, but each time the male lost his balance. Only abortive and otherwise unsuccessful attempts were observed for the next four days, but observation time was somewhat limited.

E. The peak of copulatory behavior and courtship feeding.

By May 13 copulation was observed very often, up to 10 times per hour. The pattern of behavior involved the following: (1) chitters by one or both birds, (2) a short visit to the nest-box by the male, (3) a flight by the male to the side of or directly to the back of the female, and (4) copulation. As the days passed this sequence became almost ritualized, but approaches not involving the nestbox were observed. It is very interesting, but of speculative significance, that without exception, matings occurred on the same perch, less than 3 feet from the blind, although many other perches were available.

Further observations concerning the act of copulation were made on subsequent days. The complete acts lasted from 6 to 15 seconds. The male did not simply pass his tail underneath and keep constant pressure, but varied the pressure by pushing hard with his tail and relaxing, repeating this slowly 3 or 4 times during each bout. Every time he pushed he chattered loudly. The female gave a continuous shrill cry. Preparation for copulation seemed to be more pronounced in the later stages, particularly on the part of the female. This was carried almost to the point of female solicitation. The slightest move by the male elicited a much more extensive response in the female. Often she would assume the copulatory position at a chitter or a change of perch by the male.

It is very important for the female to be prepared for copulation by being in the correct near horizontal position. Her leaning forward offers the male a flat place to land. If she sits normally with her body slanting posteriorly, the male simply slides off. The female's tail position is also important. If her tail is not raised after he mounts, his tail will simply slide across the top of hers instead of locking with it. This results in loss of balance by the male, because her tail acts as a pivot point for the passage of his tail underneath.

Courtship feeding also peaked at this time. The male would spend as much as 20 to 25 minutes carrying meat from perch to perch and back to the female evidently trying to get her to take it. When she was willing to eat, she watched him closely as he tore pieces off and ate them. She would take every third or fourth piece as they were presented to her. As a feeding bout continued she often reached down to his feet and took a bite or

two at first, and then would eat eagerly with the meat still in his foot. Finally, the piece of meat became small enough that her pulling obtained the remainder for herself. As she finished eating, the male usually flew to another perch and feaked. Such a bout might last 10 minutes or more.

A noticeable increase in the protectiveness of the nesting area occurred at this time. Both birds began screaming at my entrance into the pen, the male being somewhat more aggressive. He would sit on a branch, raise his hackles, fluff out his body feathers, spread his tail and scream. The female would not retreat and screamed even with food in her beak.

F. Egg laying.

On May 15 it was noticed that the female was acting quite peculiarly. She sat quietly most of the day with her eyes almost completely shut. Her wings drooped, nearly touching the perch, and she rocked slightly forward and backward as she breathed. When entering the pen to feed, she was subdued enough to take food from my hand which she had not done for several weeks; the nest defense mentioned above was entirely absent as far as the female was concerned. She was active whenever she had reason to be, however, but was very sluggish otherwise. Copulation was not observed in the morning; only three bouts were noted in the afternoon, but within a minute after they occurred she was asleep again. She spent almost one hour in the nestbox on one morning visit.

It was immediately suspected that egg laying was near. Not ever hearing or reading of this withdrawal in other birds, however, some apprehension remained concerning her health. It was noted that she was passing food from her crop, and that her digestive tract was working. Superficial mute examinations showed nothing abnormal.

Further observations supported the egg laying idea. When alone on a perch, she squatted several times and raised her tail slightly, spreading all the feathers around the cloacal opening as if attempting to defecate. The posture was similar to that observed when a falcon mutes, except she squatted instead of standing higher than normal. In addition, when perched, it was noticed that the feathers between the legs were fluffed out at all times, while the rest of her feathers were held tight. Her tail was held further away from her legs as if slightly raised. It was thought at the time that the female might be pulled down from behind by the weight of the eggs and she compensated for this by leaning forward. This would, in effect, raise the tail slightly. This analysis was made by comparing the postures of the male and female when perched together.

An egg was not present at 7:40 a.m. the next morning (May 16), but the male flew at me when I entered the pen, turning away only at the last minute. At 11:36 a.m. the female again squatted on the perch and bobbed her tail, backing up as if straining to mate. This behavior was very different from her preparation for copulation and it did not elicit a response from the male.

The entry in the log for 3:57 p.m. states that the female seemed to be more alert than the day before. She slept less and copulation was observed a little more frequently. An egg was laid sometime between 8:00 a.m. and 3:30 p.m. Observation notes before 8:00 a.m. and after 3:30 p.m. do not indicate that enough time was spent in the nestbox by the female to effect egg-laying. The 11:36 entry may indicate that the egg had not been laid at that time and the later entry concerning her alertness might indicate that it had. This is pure speculation, but one could logically place the laying between 12:00 noon and 3:30 p.m. It should be noted that copulation was observed at least twice after 3:30 p.m.

It appears that this female, at least, had some physical difficulty with the laying of her first egg. In fact, this continued through the laying of the second egg, but not the last. A generalization concerning this point cannot be made here, but pre-laying behavior is something to note in future investigations.

Eggs were discovered in the afternoon of May 16, and the early mornings of May 19th and 23rd. It is felt that the third egg was laid on May 22nd, indicating that the clutch of 3 eggs was laid in about 6 days.

So that things are kept in a reasonable sequence, it should be mentioned that the male moulted his first major feather, a primary, on May 18. The female began somewhat later but the actual date was not recorded.

G. The advent and progress of incubation.

The frequency of copulation seemed to decrease as egg-laying progressed. Copulation was observed after the first and second eggs were laid, but not after the third. Unfortunately, observation was impossible on May 20th and 21st, so much critical information is lacking. Perhaps due to the influence of the literature on this subject, a general concept of decreasing frequency of copulation as incubation begins has been explained simply as a decreased availability of the female for copulation, since she does the greater share of incubation.

In any event, incubation had begun in earnest by the morning of May 22, the day before the final egg was discovered, but it had not begun the night of the 21st, because the eggs were cold and the female was not incubating when checked after dark. Similarly, copulation was never observed from the morning of May 22nd onward, indicating the total phasing out of copulatory behavior by incubation, and heralding the next phase of the reproductive cycle which involved some very different and some very similar divisions of labor between the sexes.

One of the different roles of the male during incubation involved nest defense. Not until after the first egg had been deposited did the male strike the observer. The severity of this behavior increased as egg-laying and incubation proceeded. It became unsafe to turn one's back on him lest he scrape the back of your head with his talons. One was safe, however, if he backed out of the enclosure, always facing the bird.

A similarity between the role of the male before and during incubation was that he was the "keeper of the food." Just as he followed her from perch to perch carrying food and offering it to her at the peak of courtship feeding, so too during incubation. The only differences were: (1) the female was almost always in the nestbox so he took food there, and (2) while she ate, instead of feeding her or perching nearby, he spent his time incubating.

This is not to imply that the nest relief was in any way ritualized; rather this behavior was one of the least predictable, as it occurred in many ways. On one occasion the male would bring meat to the nest, but the next time he brought nothing. One could not be sure if the male would enter the nest before the female came out or not. There was no way to predict whether or not the female would come out at all when the male arrived. She did not come out about 80 per cent of the times he presented himself for nest relief. Time and time again relief attempts resulted in only an exchange of chitters. So often did the male visit the nestbox perch, it was felt that this behavior may have been a true artifact of the captive paradigm.

In spite of the seemingly random manner in which nest relief occurred, the attentiveness of the parent birds was nearly faultless. After incubation began in earnest, never were the eggs left uncovered during an observation period for more than three minutes, and this occurred only rarely. The male always took his turn on the eggs, and on at least two occasions he joined his mate inside the nestbox for at least 5 minutes at a time.

H. Hatching.

As hatching approached, the birds were given several live mice, sparrows and mealworms in an attempt to offset the cannibalistic tendencies experienced by Willoughby and Cade (1964). Both birds pursued the quarry with determination and dispatched it immediately. It was difficult to determine whether this endeavor played a part in the outcome of the project, but work by Porter and Wiemeyer (1968) indicates that live food might not be as important as first thought by this investigator.

The first signs of hatching were noticed about noon on June 17. When entering the pen to feed, peeps were heard from the nestbox. One egg was pipped and peeps could be heard from another. The pipped egg was completely open at 11:15 the next morning, but the others remained unpipped, and peeps could not be heard from one. At 8:20 p.m. on June 18th two eggs were hatched, so the second young emerged in nine hours or less.

Unfortunately, the eggs were not numbered at the time of laying so an exact incubation period could not be determined. If it is true that incubation began in earnest on the morning of May 22, the minimum period would be 26 days and the maximum 28. This is somewhat less than that reported in the literature, but one must realize that the incubation period depends on the attentiveness of the parents. As stated above, this pair was very attentive.

The third egg did not hatch and upon close observation did not contain an embryo.

I. Death of the young.

Due to personal matters, observation and close control of the project were not possible soon after the young hatched. When the young were five days old the supply of mice and sparrows ended abruptly and the diet was changed to beef heart. Undoubtedly the change of food and a change of caretaker disturbed the birds, and although there was no apparent decrease in parental care, one young bird was missing on June 28. The second young was removed from the nest and died two days later.

It is not known if the first young died of other causes and was then eaten, or if it was killed and then eaten, but the second young showed signs of rickets when it died at the age of 13 days. There was no feather development and the long bones were soft and bent. Brosset (1967) states that cold will result in abnormal development of the skeleton of raptorial birds, so this must be considered along with a change of food and management.

One further problem which may have affected the survival of the young was the nest material placed in the nestbox several months earlier. When the second young was removed from the nest, its entire mouth cavity was lined with the small wood chips used as a nest liner. Obviously, when the young were fed, pieces of wood stuck to the meat and were taken in. An accumulation of non-nutritious matter in the crop may well have limited the effectiveness of the food supply.

SUMMARY

Although this paper involves but a single pair of birds, it can be said with certainty that many behaviors thus far reported in the literature concerning wild raptors breeding will be observed in captive situations. In fact, the close observation afforded by captive studies may well reveal intricacies not previously reported, as well as information vital to the continued success of both wild and captive populations. It is therefore suggested that most avenues of scientific research be exhausted before monetary desires be satiated by the output of this infant field.

A pair of Kestrels (*Falco sparverius*) was housed in an open-caged paradigm from early January, 1967, until mid-June of the same year. During that time roughly 60 hours were spent in a blind observing the breeding birds.

During the introductory phase of the project the female became quite wild and established her dominance over the male by restricting him to a very low corner perch. The male was allowed access to higher perches in a progressive manner until he was permitted on all perches a month after the initial introduction. Suggestions are made concerning the successful introduction of raptors to captive breeding situations.

Early nestbox activity consisted of mutual roosting and nest-site selection, followed by a gradual increase in the frequency and length of nestbox visits. The male seemed to be more active toward the nestbox, and he showed the bodily movements of courtship more than a week before the female.

Early courtship behavior involved reciprocal preening, "billing," abortive flight displays and increasing occurrences of courtship feeding and vocalization. Other somewhat unexplainable observations were predictive of a rather pronounced period of sexual experimentation. Initially this was manifest by "sham copulation" which involved both birds perched side by side, the male squatting and lowering his tail and the female

standing high, her body extended and tail raised 20° above the horizontal. Later, several unsuccessful attempts to copulate were noted during the onset of copulatory behavior.

Each copulatory act lasted from 6 to 15 seconds with the male standing squarely between the wings of the female. The birds assumed the postures mentioned in the preceding paragraph as the male passed his tail around the side and underneath the female's tail. It was important that the female be properly prepared spatially for copulation, since refusal to assume the proper position resulted in a loss of balance by the male and an unsuccessful bout.

During the peak of copulation the act was observed 10 times during one hour. Each time there was general adherence to a definite sequence of behaviors to the extent of using the same perch during every observed copulation. The occurrence of courtship feeding peaked at about the same time as copulation behavior.

As egg-laying approached the female was observed to be very lackadaisical and appeared to be ill. Certain observed behaviors indicated that egg-laying was near and that the female was not weakened by disease.

This subdued behavior disappeared after the eggs were deposited. The clutch of 3 was laid in about 6 days. The frequency of copulation decreased as incubation began, probably due simply to the unavailability of the incubating female. The female did most of the incubation, but both birds were very attentive. Two eggs hatched 26-28 days after deposition. One of the young emerged from an unpipped egg in 9 hours or less. The third egg failed to hatch and showed no signs of development.

The young birds died at the ages of 10 and 13 days. The results of an inadequate diet, a change of caretaker and unsatisfactory nest material are postulated as the probable cause of failure at that point in the reproductive cycle.

Author's Note. This report was hastily written without consideration of much of the recent material on captive breeding of raptors. If ideas presented herein are implied to be new, and really are not, I apologize to the person whose observations I should have substantiated.

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