CAPTIVE BREEDING OF PEREGRINES: Suggestions from their Behaviour in the Wild.

by R. Wayne Nelson
Department of Biology
The University of Calgary
Calgary 44, Alberta, Canada

INTRODUCTION

The breeding of Peregrine Falcons (*Falco peregrinus*) in captivity is not yet easily accomplished. While perhaps somewhat over one-half dozen successful efforts (yielding captive-bred fledglings) have been made, many other efforts have been unsuccessful. As the declines in breeding falcons in the wild continue and spread (Cade and Fyfe, 1970) the urgency to develop and perfect captive breeding techniques with these birds becomes ever greater.

The successful efforts with captive breeding of the large falcons to this time have indicated some of the conditions under which the birds will breed. The conditions that those birds were kept in obviously provided the essential features that stimulated those birds to breed, but the lack of success by other pairs of birds held under broadly similar conditions suggests that perhaps the successful pairs to date represent only the very tolerant extreme, and that the birds that did not breed were deprived of features of the natural environment essential for reproduction. If we attempt to duplicate more closely those features of the wild falcons' environment which appear important to them, we might be able to establish a captive environment in which a greater number of the captive pairs would be able to carry out the full sequence of behaviour patterns that precede the laying of fertile eggs.

It is in the hopes of hastening the perfection of captive breeding techniques that my observations on *F. p. pealei* breeding in the wild on the British Columbia coast are reported here, and suggestions that derive from them are made.

The behaviour of the various species of birds of prey in the wild should be indicating to us what features of the wild environment we should be trying to duplicate in the hawk house. The behaviour of the birds in captivity, if we take the

time to observe them to any extent, should also indicate to us at what stage in the breeding cycle breakdown in breeding actually occurs. Why the behaviour of the birds of prey in the wild and in captivity has been largely ignored to date is something of a mystery, especially when the behaviour can apparently tell us such a great deal about the birds.

Many of the following observations are based on a continuing study of the behaviour of British Columbia coast Peregrines (Nelson, 1970). I have studied the 'courtship' behaviour closely only in one wild pair to date, but the activities of that pair can be considered reasonably 'normal' since they led to the production of fertile eggs and to the fledging of a young falcon. I will briefly describe some of the important behaviour patterns during the two months prior to egg-laying, and will indicate how I think that the captive breeding situation might be made more stimulating for the birds. The fact that the falcons I have studied are coastal birds may have some bearing on what behaviour they exhibit and what environmental factors are important to their breeding in the wild and in captivity. Despite this possibility, I think that when the non-coastal falcons are studied in detail, great similarities will be seen between the general behaviour of the coastal birds and those elsewhere. Some of the behaviour patterns (e.g. 'courtship feeding') are found in many many species of birds.

The first portion of the breeding cycle may best be termed the "pre-incubation phase." All the essential behaviour sequences of this phase must be carried out successfully if fertile eggs are to be laid, just as the essential parts of incubation must occur if the eggs are to hatch. Because the acquisition of fertile eggs from captive falcons appears to be a (if not **the**) major difficulty in captive breeding of the large falcons at present, my remarks will mainly concern the 2-3 month period that preceeds egg-laying.

PRE-INCUBATION PHASE

By considering the courtship behaviour of the falcons in the wild, we may be able to understand more clearly what factors are necessary to 'force' falcons to breed in captivity. As was said by Enderson (1967), it will be by providing the correct conditions for captive birds that they will be literally forced to breed.

Lighting. Various people have experimented with artificial

lighting to induce moult in raptors at different times of the year, and considerable success has been seen (Mihalovits, 1965; Simonyi, 1968 (BPIE 6); Hunter, 1970 (BPIE 16); and others).

Similarly, Willoughby and Cade (1964) were able to stimulate American Kestrels (*F. sparverius*) to breed, and produce fertile eggs, in December to February at Syracuse, N.Y. (when temperatures were sometimes below freezing in the unheated buildings) by changing only one factor in the buildings: the daylength (photoperiod) for the Kestrels was suddenly increased from 8 hours light and 16 hours dark, to 18 hours light and 6 hours dark. Fyfe (1968 (BPIE 4)) induced his captive arctic Peregrines to "migrate north" by increasing their daylength. Kendall (1968), using artificial light to lengthen the daylight period by about one hour, was able to bring his captive Prairie Falcons (*F. mexicanus*) into breeding condition slightly earlier than otherwise might have been expected. It is obvious that photoperiod is an important 'lever' in trying to bring the captive birds to breed. There is another aspect of the lighting that appears to be equally important, however.

Beebe (1967) and Schramm (Peterson, 1968) obtained fertile eggs from Peale's Peregrines in naturally-lighted buildings, and Waller's (1968) Peregrines were also (apparently) in naturally-lighted buildings when they produced young falcons. But, although these efforts with natural lighting have "let nature take its course," they have certainly not been duplicating nature very closely. While the length of the day has an effect in stimulating the falcons to breed, in buildings with sky-lights or windows it is likely that the effective daylength is shortened considerably in the darkened interior. Also, the brightness of the light in the enclosures in which the falcons were living certainly could not have been as great as that out of doors. A simple test with a camera lightmeter in most buildings will tell us that the indoor illumination is greatly inferior to that outside, even in overcast conditions.

Koehler (1969) records that the brightness of the enclosures had an effect on the laying dates and fertility of her American Kestrels' clutches, and, moreover, pointed out that while clutches in the outdoor pens were fertile–

> "in 1963 and 1964 only the second clutches of the pairs breeding indoors were fertile. Those first clutches, which were forceably delayed about four weeks by putting the pair together too late . . . were fertile too."

Koehler (1969) also noted that there is a considerable difference in the preference for sunshine exhibited by wild males and females of various raptor species:

> "The birds in the wild, however, especially the males, spend many hours soaring during the display season. . .far more in contact with the sun's rays than in the pens. . . The females tend to spend much of their time sitting by the selected nest site."
>
> "The urge to fly of the captive males during this period is greatly intensified and their restlessness a trial to the observer. In normal day length, there appears to be a threshold of light necessary for attaining full reproductive capacity—especially of the males. This threshold seems to vary from species to species."

In coastal Peregrines the same thing seems true. I have observed the male soaring much more often than the female, and the male is also more often seen to be **Prominent Perching** on a snag or in an exposed treetop. While such behaviour of the male may also have an 'on guard' function, this behaviour largely ceases once incubation is underway, at a time when it might be thought that 'guarding' in this way would be even more important than earlier. Instead, when not incubating, the male takes up rather inconspicuous positions on the cliff, or in nearby trees. There seems, therefore, to be some other function for this Prominent Perching behaviour in which the male selects exposed and brightly lit areas during the pre-incubation phase.

Unpaired captive females of a number of species of birds of prey have laid eggs when fed very well and left relatively undisturbed on natural daylengths—even in buildings (Beebe, 1967). The fact that females of a number of captive pairs are laying eggs that are infertile suggests that the males are not stimulated sufficiently to carry out their part of the courtship and copulation requirements. By removing the first clutches soon after they have been completed, and causing the female (at least) to recycle, and lay again, sometimes fertile clutches have been obtained (Beebe, 1967; Kendall, 1968; Koehler, 1969; and others). Probably the extra two weeks or more of increasing daylengths (by natural lighting), and perhaps additional brightness, have stimulated the males into the necessary sexual development, so that the second clutches have been fertile. Or, possibly the 'broody' activities of the female with the first clutch stimulates the male to develop pair-bond behaviour.

The fact that Peregrines in the wild do not as a rule lay

infertile clutches should be sufficient to tell us that some factor(s) are not operating correctly for the males in many of the captive situations in which infertile clutches are being laid. Apparently when first clutches are infertile there is inadequate stimulation for the males.

While positive proof may be difficult to obtain at present, the evidence from coastal Peregrines and American and European Kestrels (*F. tinnunculus*) strongly suggests that while the female is triggered into breeding condition primarily by increasing daylength, the male requires both sufficient day length and sufficiently bright light stimulation before he comes into complete breeding condition.

Very bright lighting (but with some areas of shade) in the breeding quarters would seem to be a logical (and simple) step toward creating an environment in which the falcons' basic requirements for breeding would be better satisfied. A white interior (see Kendall's photos) would aid this end. It would be wise to try to subject the male to brighter light than the female, by rigging extra lights near his favourite perches, which could be turned on (possibly automatically) when he perched there.

Willoughby and Cade (1964) brought their Kestrels into breeding condition with single 150 watt bulbs in the center of the birds' 12' X 6' X 8' high rooms. Upon putting their Kestrels suddenly onto the long daylengths (16 or 18 hours), it took from 43 days to 63 days for the first eggs to be laid by the pairs of Kestrels—and many were fertile. This shows that for Kestrels that illumination was adequate.

With larger falcons (and those of more northern origin) in larger enclosures, we should be giving the birds daylengths considerably longer, and the lighting should be reasonably bright—at least resembling that found out of doors. Birds should not be exposed to heavy doses of ultraviolet light because of the possibilities of developing skin cancers and 'snowblindness.' Incandescent bulbs should be sufficient.

Automatic timers (some with automatic dimmers) have been used by Fyfe, Kendall, and others, with considerable success. Willoughby and Cade (1964) kept a 7.5 watt bulb burning constantly in their Kestrels' rooms so that the birds could regain their perches at night, because if the artificial day ended very suddenly the birds could become quite alarmed at being caught away from their night perches. A dim light should be left on for at least fifteen minutes after the main lights in the falcon room are extinguished for the night, so that the birds might easily regain their night perches before total darkness sets in.

Temperature. As mentioned above, Willoughby and Cade (1964) had Kestrels breeding in rooms that had temperatures "frequently below freezing." The air temperature apparently does not greatly affect the laying of fertile eggs. One might, however, expect a great likelihood of egg or nestling chilling at low temperatures and it is unlikely that nestlings could survive very long at temperatures below or near freezing.

Depending on the number of nestlings in a brood, at some point between one and 2½ weeks of age the adult female Peregrine is physically no longer capable of covering her offspring. At this age severe chilling could kill them. One should attempt to give the birds conditions approximately the same as those found during the natural incubation and nestling phases where the birds originated. Those were the conditions which the individual birds had evolved to tolerate and survive in.

Overheating may be more of a problem than chilling, with the adult birds at least, and possibly with nestlings as well. On the B.C. coast I have watched an incubating female Peregrine suffering greatly in bright sunshine while covering her eggs. The temperature in my blind (which was also in the sunlight on the cliff-front) reached a maximum of only 68°F that day, but the falcon panted strongly, fluffed her head and wing feathers, spread her wings slightly, and occasionally placed one foot out to the side—all these (apparently) being means by which she was attempting to cool herself. Her incubating activities were also interesting, for during this time of heat stress on these few 'warm' days, she appeared to be treating the eggs much more roughly than she normally did. So, *pealei*, at least, suffers in the direct sunlight when incubating. It should be noted, however, that most of the ledges chosen by *pealei* seem to be shaded for most, if not all, of the day. On the particular ledge at which the female was seen to be stressed, the incubating bird was exposed to direct sunlight from about 9:30 a.m. until 3:00 p.m. if the sun was shining.

Size of Quarters and Courtship Activities. The breeding of American Kestrels at the Patuxent Wildlife Research Center was mostly carried out in large (50' X 20' X 6') wire mesh netting outdoor pens (Porter and Wiemeyer, 1970). Kestrel reproduction has also been brought about in rooms of 12' X 6' X 8' high with one 150 watt bulb as the illumination, although only two young were fledged from 18 eggs hatched (Willoughby and Cade, 1964)—possibly due to a poor quality food supply.

For larger falcons, Kendall's (1968) quarters for his Prairie Falcons in 1968 was about 10' X 14', X 8' high, and Beebe's (1967) quarters for Peregrines was about 12' X 18', X 8' high.

While there must be some size of an enclosure below which courtship will be inhibited, apparently nobody has attempted to determine what such size requirements might be. Some of the present facilities are probably too small to allow the behavioural interactions between the male and female which seem to be important in bringing about reproduction. The sizes of the quarters in which successes have been obtained give some indications of what is needed.

The courtship activities of wild falcons suggest that a great deal of space is required. One cannot expect a captive tiercel to safely carry out **Power-diving** displays (also termed Sky-dancing), nor expect the male and female to be both airborne to allow **Charging** of one bird at the other in pretend attacks, when they are confined in a small room. Buildings of adequate size to allow such aerial displays are beyond most people's means. So, while we must utilize small buildings, we should keep in mind that the falcons do exhibit such aerial behaviour during the period of courtship, and that the significance or importance of such (presumed) courtship behaviour patterns in successful breeding are inadquately appreciated at present. The successes to date show that enormous quarters are not absolutely essential, but the quarters should be as large as possible without creating difficulties in other areas such as providing adequate illumination.

Courtship activities in the wild falcons are not performed very frequently during any one day. Although activity can be exceedingly rapid, there is a very great deal of total inactivity. For this reason it is not surprising that captive falcon breeders have not yet recorded many details of the behaviour of their falcons during this phase, although Olendorff (1968) described in detail the behaviour of his captive American Kestrels. Beebe (1967) has noted an interesting display exhibited by the male Peregrine shortly before egg-laying, and Kendall (1968) recorded some posturing by his Prairie Falcons. These writers and others have mentioned various calls given by the birds in this phase.

As daylength increases from February through April, the wild falcons on the B.C. coast progress through several obvious phases of activity as they approach the time of egg-laying. I will first outline the more obvious and seemingly important of these activities, and will then suggest how they

may be important factors to consider in the designing of breeding quarters.

At six weeks before the eggs were laid, the pair of *pealei* that I studied in 1969 began flying about together near the nest cliff. The male began **Prominent Perching** and occasionally **Power-diving** nearby, and the pair began attacking intruding eagles as a pair.

Four weeks before eggs were laid the male's interest in nesting suddenly became very evident. **Cliff-racing** by the male involved flying at a fairly rapid speed close to and along the length of the cliff, and often he turned back to race in the other direction along the cliff. This might be seen two or three times in a 4-6 hour observation period. At this time too, **Food-transferring** (the so-called "courtship feeding") began, with the female slightly in advance of the male in her interest in this activity, for on the first few times it was seen to occur, the female was seen chasing the male when he had food, and he did not seem to be willing to give it up to her.

Male-ledge Displays also began about four weeks before egg-laying. In these displays the male flies to a prospective nest ledge and gives **Eechip** calls (he may go to other ledges on occasion, but he seems to have a favourite ledge). He also settles onto the scrape and shuffles about, but these actions seem to be totally ignored by the female for a few days. At this time the male also begins **Passing and Leading** (he usually chooses a time when the female is perching in the general area of the cliff-front, or when she is flying towards the cliff area). In this display, the male races close past the female at high speed, and continues on towards the prospective nest ledge. Sometimes she actually follows him to the ledge which is probably exactly what the male intends her to do. If she does not follow him, the male lands at the ledge and usually carries out actions of the Male-ledge Display. If she does follow him to the ledge, sometimes he departs immediately, and sometimes he seems to give the actions of the Male-ledge Displays in her presence. From this time onwards the female spent considerable time on or immediately beside the prospective nest ledge.

I observed Male-ledge Displays for several days before the first Passing and Leading. On the first day that Passing and Leading was observed, the female followed the male to the chosen ledge once. Passing and Leading ceased once the female was spending some time at the ledge, on and off during the day. However, the male continued to perform his Male-ledge Displays at times when the female was not at the ledge, until close to the date of egg-laying.

About a week prior to egg-laying, the male began **Mock-attacking** the female. At this time the female was spending much of the day on the ledge. In Mock-attacking, the male would suddenly come into the nest ledge vicinity at an incredible speed, aiming roughly horizontally at the female on the nest ledge. A split-second before he might have 'pan-caked' himself onto the cliff or the female, he would suddenly pull steeply out of his 'attack' and veer off along the cliff and out of sight. The female, during this very brief encounter, would utter a few Eechip calls as the male appeared racing at her. Such Mock-attacks could be performed either a few minutes or a few hours apart. They probably function to synchronize the pair in their sexual development.

The actions observed by Beebe (1967:68) in his captive Peregrines very shortly prior to egg-laying, seem to have been an amalgamation of Male-ledge Displays (Eechip calling, Head-rotating, Bowing, and shuffling about in the scrape) and either or both of Passing and Leading and Mock-attacking ("This was followed by a quick take-off and rapid flight around the room, past the female, and back to the nest ledge where the entire procedure would be repeated"). Both of Olendorff's (1968:81) Kestrels, about one month prior to egg-laying, were observed to enter the nestbox for a very short period of time, and "upon leaving, each bird would fly directly at the other and turn at the last minute to another perch." This activity seems to be somewhat similar to the Dive Display mentioned by Willoughby and Cade (1964) in which the wild male Kestrel dives close to the female as she perches in a tree. The similarity between the observed behaviour of the wild and captive Peregrines and Kestrels suggests that there is some necessity that these behaviour patterns be carried out for normal breeding to occur.

Behavioural observations of this type should be put to use in the captive breeding projects. They are not "curiosities" but instinctive patterns that the birds are highly motivated to perform. They can tell us what stage of the cycle the birds are at. And the behaviour patterns can indicate to us what aspects of the captive environment may be inhibiting the birds from progressing in sequence through the rest of the breeding cycle.

To allow for Passing and Leading, and for Cliff-racing and Mock-attacking to occur (even if only at slow speeds in the confines of a room) the best place for nest ledges would seem to be half way along a long wall—not in a corner. If the ledges are placed in corners of the falcon room, the smaller male

could be 'trapped' by the stronger female if she came to the ledge while he was there. Also, a ledge in a corner would make it difficult for the male to Mock-attack the female on the ledge and turn at the last second to avoid collision with her or the ledge or wall. By placing ledges in the middle of a wall, at least the male could fly past the ledges, from one end of the room to the other.

It is desirable that the falcon room should be as tall as possible. Richard Fyfe has mentioned to me how a pair of birds placed in a room with a higher ceiling seems to be much calmer—especially with perches which are placed quite high in the room. Aside from giving the birds a greater 'peace of mind,' a room with height may aid in giving the male added speed and stimulus in his courtship flights.

The larger the quarters, the more maneuverability the birds will have, espcially if they are large falcons.

Dividing the Quarters. One aspect of Peregrine courtship that I have not yet seen in *pealei* in the wild is that of Mutual Roosting, perching of the pair side-by-side, mentioned by Cade (1960) for arctic Peregrines. This is not to say that it never occurs in *pealei* in the wild, but it seems to occur very seldom, if ever. In the coastal falcons it is not common that the pair spends many hours in close proximity to one another.

Early in the pre-incubation phase especially, it would seem advantageous to offer the captive pair the alternative of not having to be in the immediate presence of the mate all day long. A simple means of offering the birds some sort of solitude if they 'desire' it would be to place a partition (like a broad, thin pillar) in the middle of the breeding chamber, with perches placed on it and on the surrounding walls so that the birds could perch out of sight of each other if they so desired. Such visual isolation might also be stimulatory to both birds by giving them the chance of a 'sudden' and 'surprise' approach to the mate around the corner. Brehm (1969) partitioned his Goshawk (*Accipiter gentilis*) breeding quarters, (if the birds wished it) and a means of exercising. . .and success. Another important consideration is that a central partition would allow a circular flight path in the room and an illusion of greater available space than there actually is.

Placement of Perches to Facilitate Courtship. The positioning of perches in the falcon room may not be as insignificant a matter as one first might think. If there is any

kind of dominance relationship established in captivity, it will probably be in favor of the larger female. In the wild it seems to be in favor of the male, except when the pair is close together at the ledge or at copulation. Various authors in *Raptor Research News* and elsewhere have noted how the females of various species seem to actually harass the males early in the season or when first introduced to each other, but eventually tolerate them in the room. Placement of perches might be done so as to enable the male to establish a dominant or equal relationship with the female, for example by placing perches for him just the exact distance down from the ceiling that they would be attractive and 'safe' for the smaller male, but so that the female would find them uncomfortable to use because of lack of head-room. Some perches should be in shadow, others in bright light.

Also, the positions of perches in the room could permit the male to fly past the nest ledges, from a perch high at one end of the room to a perch at the other end of the room. People should keep all of these factors in mind when contemplating how best to 'force' the birds to behave naturally in the room.

Types of Ledges, their Placement and Sanitation. Traditionally, a table or bench covered with some material has been offered as a nest ledge for the captive falcons. In the wild, such exposed ledges (and floor-level sites) would very seldom be used. Have you ever seen an eyrie of a wild falcon in which the sun could pour fully onto the ledge for the full length of the day? The falcons seldom, if ever, choose such sites if there are any alternatives. In fact, various authors have noted how many ledges are overhung, even in pot-holes or small caves. We should be offering the captive birds just such alternatives so that they can do the choosing, so that they can choose the ledge which to them offers the best situation, the best feeling of security.

In a brightly lit room, several nest ledges should be offered to the birds—some fully exposed to the bright lights, some entirely shaded, and some very shaded and even cave-like. It may be that such a simple thing as a dark and 'private' nest 'cave' might be sufficient extra stimulus to trigger the male and/or female into the appropriate breeding behaviour and condition. Willoughby and Cade (1964) found that the blocking of captive Kestrels' nestbox holes depressed their development somewhat. We may be accidentally causing similar inhibition of the larger falcons by providing the birds with ledges which are just not 'right'—hence the birds do not

come into proper breeding condition.

If a person had a reasonably large room, it might be most interesting to give the birds very real choices by providing them with a variety of high, middle-elevation, and floor-level ledges, of three types at each level–(1) open ledge with sod and grass; (2) open ledge with dirt and/or sand; and (3) a recessed, shaded, 'cave-like' ledge with dirt and/or sand. Since the birds sometimes dig deep scrapes, four or five inches of packed material should be placed on the ledges. Such a set of alternatives would probably show us what types of ledge material and 'privacy' the birds prefer (fine sand is probably too loose and dirty a material on which to rear tiny nestlings).

Ledges should measure a minimum of about two feet from front to back, and three feet wide, on the basis of ones I have seen in the wild. Enderson (1968 (BPIE 3)) noted that captive falcons, in landing at the ledge, can cut the bottoms of their feet by skidding on the ledge material against the solid floor of the ledge. Falcons in the wild often seem to land at a grassy or mossy part of the ledge, and walk to the scrape from there, or, less often, land rather gently by dropping almost straight down the last few inches onto the ledge. Enderson has suggested that the fronts of ledges should be provided with a cushioned landing pad of some cushioning fabric (see also Kendall's photos). Sod and grass, or moss, might be used as well, instead of the landing area being simply of solid wood or rock.

There is a suggestion (Porter and Wiemeyer, 1970; Porter, in letter, Oct. 1970) that contaminated nestboxes or nestbox material of Kestrels from one year may be the cause of death of embryos in eggs the following year. In many reports in the literature it is stated that a number of species of birds of prey either build onto their stick nests, or use different nest sites from one year to the next. It is possible that digestive tract contaminants (bacteria) from the nestlings in the nest one year may be able to survive overwinter and kill embryos in eggs laid at the same ledge the following year (or on the same nestbox litter, or in contact with the nestbox walls, in the case of captive Kestrels). The frequent use of alternative ledges of nestholes by various raptors, and the building upon the tops of old stick nests each year by others, may have evolved because of the selective advantage to the birds of avoiding this sort of mortality factors. So, as a precaution, ledge material should be removed at the end of each season and fresh material provided. A simple matter such as this could be critical in avoiding loss of eggs in later years.

Feeding and Caching. Falconers tend to feed their birds very well through cold weather, but to cut down slightly on the food when warmer weather arrives. In the spring, in the wild, this is exactly the opposite of what happens, especially for the female.

The behaviour of wild falcons suggests, as Beebe (1967) postulated, that it is essential that the female be very well fed if she is to lay eggs. In fact, as egg-laying nears, it is quite evident in wild *pealei* that the female is doing none of the hunting, and that the male is catching enough food for both himself and his mate. Also of possible importance is the fact that the male usually eats the heads of the prey items before presenting them to the female for her (or later, for the nestlings) to eat. In other words, the female receives few, if any, heads during that time prior to egg-laying (as long as two weeks prior to laying) when she is being supported by the male, and also on through incubation and into the nestling phase. Since it is known for chickens that extra calcium in the diet (in the form of crushed oystershell) yields eggshells of greater thickness, there may be a connection between a diet of chicken heads and/or necks for captive birds and the observations a few people have made that captive bred nestlings have had great difficulty getting free of the eggshells.

Since the female in the captive situation is usually dominant over the male, the partitioning of the breeding quarters may enable the male to be fed without his feeding being seen by the female. If he is slipped food through a small trap-door that is out of view of the female, he could eat it before the female knew he had any food that she could steal from him.

The male must be allowed the opportunity to take food to the female, in 'courtship feeding,' when he is ready to, an option open to the male in the wild. If the birds are given food in an undivided room, the female may get and eat the food first, and the male will be deprived of the stimulus to be gained from presenting food to her. A partitioned room, with small trap-doors by 'feeding ledges' would allow the human being some choice as to how and when to present the food to the birds. The birds could be fed if the male and female were in the different sections of the room. Or the food could be given to the male first, and if he did not take the extra to the female when he finished eating, then the female could be slipped some food through the other small door into the section she was in—or she could simply be allowed to find the extra food later where the male had left it in his area.

Peregrines seem to cache a fair proportion of their food in the wild, and later retrieve it. The male *pealei* often goes to a cache to get some food, eats a bit of it, and only then flies to and offers the rest to the female. Waller (1968) noted that his Peregrines cached excess food in different parts of the room, and Kendall (1968) mentioned that his Prairies cached food in a hole in a log, from which they could not retrieve it! There is room for experimentation here, to try to devise a way of giving the birds a chance to cache food in a place from which the human being can retrieve it if it gets very 'high.' It may be possible to get the birds to use a short hollow pipe, placed by a ledge against an outside wall of the room, for caching or disposing of old or unwanted food items, or to use a ledge (possibly with rocks or very long dry grass on it for concealing the food) for caching food which the birds wish to use later. Ingenuity could devise other methods of getting old food items out of the bird's room. There should be no necessity for one to have to enter the room to take the food in view of the birds.

In any event the birds should be provided with a great deal of food, preferably whole birds of natural origin, and reasonably clean of biocide contamination. Berry (1968) has suggested caution be used in feeding frozen food, although changes his Goshawk underwent during laying (rapid weight loss, and weakness) were "more probably from lack of fresh water immediately before laying."

The Lethargy Near Egg-laying. Olendorff (1968) may have been the first to detect the astonishing lethargy which besets female falcons in the few days prior to egg-laying. In Peregrines the period may extend for as long as a week prior to laying. During this time the female appears to be ill, as she dozes for a great deal of the day and spends very little time doing anything active. Even after having read Olendorff's (1968) account of the "withdrawal" of his female Kestrel just prior to egg-laying, when I first observed this behaviour in a wild female Peregrine I felt certain she was ill.

Olendorff noted that his female Kestrel, when she became lethargic, "was subdued enough to take food from my hand which she had not done for several weeks; the nest defense. . .was entirely absent as far as the female was concerned." The wild Peregrine showed a similar lack of defense of the cliff area in this period. Approach by the male in Mock-attacking or for Copulation, however, would suddenly (although only briefly) bring the female Peregrine into an alert condition.

Female lethargy is mentioned because people engaged in captive breeding may become greatly alarmed by the female's lack of activity, thinking that she may be ill when in fact she probably is not. Very close watch must be taken during this time, however, to be certain whether her dullness is due to impending egg-laying or some other reason such as acutal illness. If she has been eating well, if the pair (or at least the female) has been observed engaging in some of the courtship activities such as nest-scraping, and if the male is healthy, one could assume that she was, in fact, readying to lay eggs.

Water. Berry (1968) has suggested that ample fresh water may be very necessary for egg-laying to proceed without difficulties. He noted that his Goshawk drank a great deal during laying.

At hatching, moisture seems to be critical. Schramm (in Peterson, 1968) wrote regarding his Peregrines (*pealei*):

> "There is a very noticeable change in attitude during the last couple of days before the eggs hatch. The parents are very much more aggressive at this time and the falcon (female) takes many more baths in the always available water."

There is considerable evidence from other wild species that the moisture on or immediately around the eggs is extremely important at hatching: for example–for Mallard (*Anas platyrhynchos*) (Mayhew, 1955:46); Bobwhite Quail (*Colinus virginianus*) (Johnson, 1968:85); Sharp-tailed Grouse (*Pedioecetes phasianellus*) (R. L. Brown, pers. comm.); murres (*Uria* spp.) (Tuck, 1960); and Osprey (*Pandion haliaetus*) (Welty, 1962:302). For the latter, Welty states:

> "The Osprey. . .is known to shake water from its wet feathers over its eggs in warm weather. This action may function both to cool the eggs and to prevent excessive water loss."

It would seem extremely important to offer the captive birds of prey ample clean water. Some sort of siphoning system could be easily arranged to allow the person caring for the birds to change their water daily without entering the falcon room. Some effort should be made to ensure that the birds do bathe. In artificial incubating of raptor eggs, these factors should also be kept in mind.

Age at First Breeding. In 1969 I saw two pairs of wild *pealei* in which the males were adult and the females were only one year old. This implies that it is possible for pair bonding to occur prior to a Peregrine's first birthday. Neither

of these two pairs laid eggs or raised young in 1969 but at the same two sites in 1970 there were only adult birds present, and I am fairly sure that at one of the two cliffs the female was the same bird as in 1969 when she was moulting from immature into adult plumage. Each of the sites produced two flying young in 1970. This suggests very strongly that female Peregrines in the wild WILL breed successfully around their second birthday.

I mention these two instances of wild Peregrine females breeding successfully when apparently only two years old, because I know that many think that it may take up to four or five years for Peregrines to come into breeding condition.

We should have realized years ago that the plumage of the Peregrine should indicate when the bird will be of breeding age. Since the immature plumage is mostly, if not entirely, lost when the bird is about one to one and one-half years old, the bird should be capable of breeding in the season of its second birthday, when it first has the adult plumage. But I do not know whether the same holds true for the other large falcons in which plumages seem to be more alike between adults and immatures. I would suggest, then, that everyone attempting to breed any of the large falcons should have the quarters and the birds entirely prepared to breed as they near their second birthday.

Introduction of the Pair. I have only a few remarks to make about this rather important aspect of the captive breeding program.

In wild Peregrines (at least in times prior to usage of DDT), various writers (e.g. Green, 1916; Hickey, 1942) noted that if a member of a pair died, a new mate was acquired almost immediately (apparently from a local floating surplus of birds, which may no longer exist), and the incubating of the eggs or the raising of the young proceeded almost as if nothing had happened. It seems that if the two members of a prospective pair are in the same daylength in the breeding season, they can and will pair up without too much difficulty. In a room, however, there may be some difficulty at first, in that the two strange birds cannot retreat very far from each other if they wish to.

Willoughby and Cade (1964) acquired a "new wild pair" of Kestrels in late November, put them into a room with a long photoperiod, and had them lay eggs in late January—and one egg hatched in late February. Porter and Wiemeyer (1970) have noted that they have successfully paired Kestrels "when both sexes were placed together simultaneously in a

pen new to both of them," and also when a new male was placed into a female's pen and vice versa. Kendall's (1968) Prairie Falcons were introduced to each other, free in their room, in November, and produced a fertile second clutch in the following April. The suggestion from all this is that a long acquaintance of the pair with each other and with the room is not imperative, as long as the conditions in the room are reasonably correct. If the birds are not imprinted to human beings (see below), and if they are both subjected to adequate illumination (as well as increasing daylength or long daylength), pairing should not be difficult. In fact, the birds should almost welcome the arrival of a member of the opposite sex of the same species!

Imprinting and Disturbance. A considerable number of raptors have been held in captive breeding projects but have not laid eggs. In addition there are some pairs which have produced only infertile eggs, even when caused to recycle and relay several times. Aside from the numerous aspects discussed earlier, disturbance of the birds which we are hoping will breed in our falcon rooms seems to be of great importance in many cases. Few of those who have written on the subject of captive breeding have mentioned disturbance as being critical—possibly because these writers have had some success, and so their birds were not overly disturbed. Yet the risk that the birds will become imprinted onto human beings instead of their companions as mates is very real and serious.

It has been mentioned above, and elsewhere, that at certain stages of the 'courtship' proceedings the male will begin presenting food to the female, and that this is critical for egg production. If a human being goes into the falcon room to provide food, which is the female falcon to consider as her mate—the person who has fed her every day since she was taken from the wild—or the male falcon which has never fed her before in her life? She might well be confused by it all, and imprinted onto the human being as her mate, considering the tiercel to be just a companion of no sexual significance. Equally, the tiercel could treat the human being as being a parent falcon which still continues to feed him.

Some writers on raptors, most notably Hamerstrom (1968 (BPIE 5)) have mentioned how a female bird of prey will consider the human food-provider as its mate, and how even some tiercels consider the human being as the mate. When (as with her Golden Eagles, *Aquila chrysaëtos*) the two birds, one male and one female, both imprinted to a human being

are put together, they may attempt to kill each other. In my own experience I have known a silent, apparently non-imprinted female Prairie Falcon that became a classical 'screamer' when one year old, and eventually she became sexually imprinted to her trainer, preferring to defnd the place where she was usually flown against other raptors (even at great distances) instead of hunting, even though she was not exceedingly well fed. Yet, when offered a nest ledge, this Prairie Falcon did not lay or even form a scrape. It appears as if we must be extremely careful not to get the captive breeding birds used to human beings as food providers.

Those who are seriously attempting to breed these birds in captivity should attempt to determine just what upbringing is best for creating a pair of falcons which will breed in captivity. First, Beebe (1967) has suggested that it may be best to raise eyasses in an environment similar to that in which they will be expected later to breed—that is, raise them in a breeding chamber, possibly with the aid of foster parent birds of prey. Second, it would appear to be best if the association with human beings is minimal from the beginning. The success of the Patuxent researchers with Kestrels—many of them totally untamed—suggests that there are advantages in leaving the captive breeding birds alone.

It may be argued that most of the efforts with the large falcons which have been successful to date have involved birds which were trained in falconry, and hence the birds had an attachment to men. While this may be true, the proper testing of the other alternative—that of breeding birds which have never been tamed or trained in falconry—does not yet seem to have been seriously tried.

The Kestrels at Patuxent, some of which were themselves bred in captivity, seem to have done extremely well at breeding without any vigorous exercising (and, of course, the attendant risk of being lost) as in lure-flying. The problem to date seems to have been that those people fortunate enough to have Peregrines, thinking that the birds would not breed until three, four or five years of age, have desired to fly them for the first year or two. Few people have tried to test the very obvious likelihood that birds which have not been flown in falconry will breed as (or more) easily in captivity, and at much younger ages. The intense desire of the holders of falcons to at least exercise them out of doors (and I share that desire, too) may well be holding back the success of the captive breeding efforts by simply making the birds too reliant (imprinted) on human beings.

Actual disturbance of the birds in their breeding quarters

may also be critical. It is true that the successful efforts to breed falcons in captivity to date have apparently involved some, or considerable, intrusion by human beings into the quarters, and Beebe (1967), Waller (1968), and Schramm (Peterson, 1968) all mention how they were vigorously attacked by their captive Peregrines at some stage of the breeding cycle. At some point, if the birds are in breeding condition, they seem to take on a very aggressive and protective attitude against human beings, that is, they seem to 'resent' the intrusions.

There has been little mention of how frequently the birds were disturbed in their quarters in most of the written accounts of the successful and unsuccessful efforts. It does not seem to have occurred to most people that it might be important whether the human beings simply left the falcons' food on a perch—or actually hand-fed them, or whether the human beings spent long hours with the birds (to ensure that they remained 'tame'). In the successful efforts, it may well be that the birds were allowed just enough solitude and privacy (i.e. were almost ignored), that they actually became 'wild,' and as a result of this solitude they came into breeding condition.

Brehm's (1969) and Herren's (1970) successes at breeding Goshawks and European Sparrowhawks (*A. nisus*) respectively were with birds which were virtually undisturbed by human beings in their breeding quarters.

The birds of prey in the wild can suggest how much disturbance they can withstand. In two different seasons I observed that Bald Eagles (*Haliaeetus leucocephalus*) attempting to nest quite close to *pealei* sites failed to even reach the incubation phase, let alone produce any young, apparently because of the frequent harassment by the falcons. I have learned that by visiting the top of a Peregrine's nest cliff in the weeks just prior to egg-laying, the human visitor can sufficiently disturb the falcons as to cause them to shift to another nest cliff as much as half a mile away (although their actions at the time of the visit to the cliff-top would not suggest that they were being disturbed). And I have also found that visiting a nest ledge before the clutch is complete can cause the falcons to shift to another ledge and lay the remainder of the clutch there. In summary, wild falcons (and eagles) actively respond to intrusions upon their domain prior to and during laying by seeking another nest site (or by failing to reproduce at all because all adjacent sites were occupied). If disturbed in a falcon room, with nowhere to retreat to, the risk of the breeding cycle coming to a halt

would seem to be high.

Porter and Wiemeyer (1970) suggest that frequent inspection of nestbox contents was the cause of many of their captive Kestrels laying eggs in both of their nestboxes and incubating poorly in 1966. They (and Dr. Porter, in letter, Oct. 1970) have also noted that some Kestrels in pens near peripheral fences (hence, subject to disturbance by the passage of people nearby) layed few or no eggs in some seasons.

If the birds in breeding projects are not already imprinted to human beings, but are actually trying to pair up with their feathered mates, is it really very surprising if the birds do not progress quite to the egg-laying stage if human beings enter the quarters? With no alternative nest sites elsewhere to shift to, the captives may simply halt their seasonal sexual development before laying eggs. The birds must be extremely motivated to breed if they will do so concomittantly with the frequent intrusion of human beings into their rooms. Unless the birds are relying on the human in a direct way (e.g. feeding from the hand), they may flee or attack, suggesting that they 'resent' the intrusion. It would be better to leave the birds entirely alone through this part of the season, so that they could develop a relationship with each other rather than continuing an ambivalent relationship with people, and so that they could have an undisturbed 'territory' of their own.

How to Effect Isolation. Such a situation of total isolation for the captive breeding birds is not at all impossible to create. The few disadvantages should be viewed as challenges to be overcome. The probable advantages of such isolation for the birds far outweigh any disadvantages which might be pointed out.

Some of the innovations which are needed for equipping an isolated falcon room have already been mentioned. Small trap-doors at several places in the room, placed adjacent to padded 'feeding ledges,' would allow placing of food into the room without any human being being seen by the falcons. A large piece of fabric might be placed on the inside of the trap-doors so that in opening the small door and placing food onto the ledge, the keeper's hand and the food would be hidden, the food only becoming visible as the fabric 'fringe' was falling back into place. In this way the falcons would associate no human being, and not even human hands or a glove, with food. Small drop-chutes could be improvised so that even trap-doors would not be necessary—so that all the

falcon could see would be the sudden (and preferably silent) appearance of food on the feeding ledges.

Water could be presented and cleaned by means of hoses and siphons placed through the walls into the basin. A low-level trap-door could be provided adjacent to the water basin so that if it became excessively fouled it could be discretely removed, cleaned, and carefully placed back into the falcon room.

There may be no fool-proof method of retrieving old and foul food remains from the falcon room. The wild falcons seem to simply fly off with, and drop, prey items which have been picked clean. They may sometimes also cache them and never retrieve them. Some form of 'drop-chute' into which the falcons could cache old food items, and which would convey the remains outside the falcons' room, would be most convenient if it could be devised.

Observing the falcons in their room is a rather simple matter. I have found that one-way glass, or two-way mirrors, are indispensible in blinds in the field, and Herren (1970) used such means to observe his captive European Sparrowhawks. From the brightly illuminated side of the glass (the falcons' side) it appears opaque or as a mirror, but viewed from the observer's side (which should be poorly lit) the glass appears as a slightly darkened window. The birds can be viewed with ease, yet are quite undisturbed. Several such windows could be placed into the walls of a falcon room to allow the human observers to see the entire interior of the room. Because the falcons might attack their own images in the small mirrors (about 4 X 8 inches is adequate), they sould be placed at positions and angles so that a perched bird cannot see its own image or that of its mate; i.e., the only chance a bird should have of seeing a 'foreign' bird in a mirror should occur when the bird is in flight. Such mirrors offer many advantages over tiny peep-holes, are fairly inexpensive, and might even allow careful photography of the birds if the interior was reasonably brightly lit. Usually such mirrors require the area on the mirror side to be illuminated about twice as brightly as the side from which the person would be watching—otherwise the falcons would be looking through glass. With a dark cloth covering one's head and shoulders and the window, a person can still be in a brightly lighted area, and yet safely look into the falcon room without being seen. With such devices, people with falcons could learn a very great deal more about how their birds were (or were not) behaving through the breeding season.

INCUBATION PHASE

Much of what has already been mentioned above applies in this phase as well. A few observations of incubating wild falcons should be mentioned, however.

Treatment of the Eggs. The shuffling of adult falcons on the eggs occurs often enough to sometimes make the observer very fearful for the safety of the eggs beneath the active falcon. Very often through the day the incubating bird will change position on the eggs, rapidly shuffle its feet while incubating, and occasionally push an egg back beneath its body with its beak. Exactly how such frequent activities of the incubating falcon, and the resultant movements of the eggs beneath it, relate or compare to the seemingly overly gentle treatment of eggs in an artificial incubation machine remains to be discovered.

It is not yet known how long eggs of the birds of prey can safely remain uncovered at cool temperatures. Beebe (1967) and Lawson and Kittle (1970) suggested that raptor eggs may be very susceptible to chilling. While the adult birds are very attentive in the wild, occasions do occur when the eggs are left uncovered for many minutes–yet they do not appear to suffer by it. To illustrate the point, I will list the times in minutes for which the *pealei* clutch I was watching on May 17, 1969, was uncovered. The temperature ranged from a low of about 45°F at the beginning of the observation period (3:00 a.m.) to about 60°F at the end of the period (noon). Mainly the female was incubating during this time. The durations of time for which the eggs were uncovered, due solely to natural causes, were 3, 7, 2, 1¾, 3¼, 7, 1½, 3¾, 5, 3¼, 3¾, 3, 3, 2¾, 10, 3¼, 4½, and 7¼ minutes. It does not appear as if brief uncovered spells are of serious consequence to Peregrine eggs. (Is it possible that the difficulties Lawson and Kittle reported in artificial incubation could have been a result of daily candling–that the bright light passing through the eggs could have caused mortality?)

Disturbance. Wild Peregrines on the coast, when incubating, do not seem perturbed by constant very loud sounds such as the pounding of surf and the noises of high winds. But they become alert and alarmed at distant strange sounds such as clanking noises made by people on board a ship half a mile away from the nest ledge in thick fog. Unusual sounds will bother them; but they seem capable of habituating to common sounds, even loud ones.

Captive falcons can still have their eggs candled for fertility when held in 'isolation' without being disturbed greatly. Herren (1970) has mentioned how, when the adult birds were feeding, he removed a broken egg from his European Sparrowhawks' nest by reaching in through the space where the one-way glass rested. Apparently the birds did not observe his actions as they were feeding. Small doors at the back of each nest ledge might prove adequate for removing eggs for candling when necessary, and for returning them to the scrape. The timing and method of actually doing so would have to be precise to avoid alarming the birds (possibly, at a moment when both birds were away from the ledge, the rooms could be blackened and the eggs removed by such a small door for immediate candling, then replaced and the lights turned back on). Alternatively, the birds might be visited at 'night' in the dark, and the eggs might be carefully removed from under the incubating female for candling and replacing.

NESTLING PHASE

Dividing the Quarters and Harassment of Adults. In the wild, when the nestling Peregrines are nearing flying age, adult *pealei* literally 'make themselves scarce.' The reason for this is fairly obvious whenever they bring food to the nest ledge—they are mobbed by the well-grown young. If the adults perch nearby the nest ledge, they are screamed at almost continuously by the nestlings. And once the young falcons are flying, the adult birds effectively hide themselves from them for long periods. Here is an additional reason for having a partition or wide pillar in the middle of the falcon room—it would allow the adult falcons a chance to get out of view of the large and screaming young. Though they will occasionally feed the young through the day, or at least give them food at the ledge for the young birds to rip up for themselves, the adults should be able to 'hide' for part of the day, and this they can be enabled to do if they are provided with some perches out of view of the nest ledge on which the noisy youngsters will be.

It would be best if young falcons were removed (possibly by night) from the parents shortly before they are capable of flying, to prevent undue harassment of the adults by fledglings screaming and chasing them about all day long in the confines of the room. Porter and Wiemeyer (in letter, Dec., 1968) and Dr. Koehler (in letter, Dec., 1968) have pointed out to me that fledgling kestrels do not seem to

harass their parents a great deal, and the former have mentioned that the fledgling American Kestrels learn to take food from the feeding tray in their enclosures within a few days of first flying, and hence do not chase and beg from the parents a great deal. The larger falcons may be somewhat different. It hardly needs stating that during the nestling and fledgling phase, just as earlier in the season, the captive falcons should be provided with great quantities of food to ensure that food shortage does not cause any conflict between adults and young.

THE FUTURE

Secrecy and Sharing. While *Raptor Research News, Hawk Chalk*, and the NAFA *Journal* have published much information on the captive breeding efforts of a number of people, there is still a dearth of information on the conditions necessary for successful and repeated breeding of the various birds of prey in captivity. Of course the perfection of the techniques will take time, but it appears as if, for various reasons, valuable time is actually being wasted at present. There are more than a few people attempting the captive breeding of Peregrines, and other large falcons, who have (for various reasons) not felt inclined to present their methods, ideas, or findings for the aid of others who are struggling toward the same end.

Failures (as much as successes) should be written up and distributed as soon as possible as a warning to other people what conditions to avoid. The printing of such information will aid everyone involved with these birds by saving time—other people will not repeat the same mistakes. Comparison of the failures with the successes can teach us a great deal.

There is not yet a positive and fool-proof method of raising and then breeding in captivity any of the large falcon species or subspecies. Those few people who have succeeded must be considered at present to have been very fortunate—(1) fortunate in having tolerant birds which would breed in conditions (of space, lighting, disturbance, etc.) in which most others would not breed, or (2) fortunate in, largely by chance, having duplicated the natural conditions which allowed instinctive behaviour patterns to be performed adequately—but not yet able to determine exactly what the correct conditions in fact were. If the methods were simple and uncomplicated, and known, a number of people would be breeding and raising a number of birds each year. This is

not yet occurring. I have a great deal of respect for the pioneer work of those who have tried to breed birds of prey in captivity. These birds can be bred and raised in captivity.

In this article I have tried to apply my observations on the behaviour of wild Peregrine Falcons to the question of how to best produce captive-bred Peregrines. I hope that those with Peregrines in captivity will achieve greater success by trying out these suggestions from the behaviour of the wild falcons, and that this article will encourage others to share their experiences so that very shortly we all may know how to breed successfully these magnificent birds and save them for posterity.

CONCLUSIONS AND SUMMARY

Because a majority of the efforts at captive breeding of Peregrine Falcons, and other large falcons, are not meeting with success, it is suggested that we consider the behaviour of the falcons in the wild, and compare it with the behaviour seen in the captive falcons. By doing this, it may be possible to determine at what point(s) in the breeding cycle the breakdowns are occurring.

It appears to be true that those few pairs of falcons which have bred successfully in captivity either (1) represented a tolerant extreme of the species, or (2) were subjected to certain specific conditions which allowed them to breed—conditions which have not yet been fully recognized and described. It will be many years before the correct set of conditions are placed together by chance if we change only one factor each year in our efforts to get the birds to breed reliably: we could change lighting one year, humidity the next year, divide the quarters the next, and so on, looking for the 'correct' set of conditions with which to 'force' the birds to breed. By using the behaviour of the species in the wild as a guide, the captive breeding efforts should now aim toward all at once presenting the captive falcons with the maximum possible stimulation to breed.

In the wild, the male seems to lead the female on through much of the courtship phase. In captivity, the opposite is often the case: the male is inhibited or slowed in his sexual development. Infertile first clutches are occasionally found in captivity.

The brightness of the falcon room may be critical to the development of the male as 'spring' comes near. The captive falcons should receive light stimulation (intensity and daylength) similar to that found where the birds would breed

in the wild.

A number of factors should be provided so as to give greater stimulation to the prospective breeding pair of captive falcons:

(1) A long photoperiod; at the end of the day the lights should dim gradually, or a small bulb should burn through the night, to allow the birds to take their perches for the night.

(2) Bright illumination, resembling that found out of doors, with some areas of shade for the birds if they wish to use it.

(3) A reasonably spacious breeding quarters to allow for some of the courtship flights of the tiercel.

(4) A partition in the middle of the quarters to allow the pair to be out of view of each other or out of sight of the nestlings if they so desire. Such a partition would provide some solitude, a means of 'surprise' for the birds (by enabling one to suddenly come into the view of the other), and a circular flight route around the quarters.

(5) Perches should be placed in such a way as to allow courtship flights past the ledges. Placement of perches may also aid in equalizing the dominance relationship within the pair.

(6) Ledges of various types and at various elevations should be offered, some brightly illuminated, some in dark recesses, to allow the birds to make the choice of which might be most stimulating to them. Some ledges should be placed along the middle portion of a wall to allow flights to go past the ledges from one end of the room to the other.

(7) Food should be provided in such a way that the male might be allowed to feed first, out of sight of the female. This would permit him to take the food to the female if he was so motivated. Ample food should be provided so that the birds can feed when they wish throughout the day.

(8) Imprinting of the birds to human beings should be avoided at all costs (unless artificial insemination of the birds is intended). Imprinting to the human food-provider may be one of the major factors preventing many pairs from breeding.

(9) Isolation of the falcons from disturbances (especially from people entering the breeding quarters) should, in itself, prove to be very stimulating for the birds. Intrusions by people may be responsible for lack of laying or improper development of courtship in falcon pairs. The breeding quarters can be fitted with adequate means for feeding, watering, and viewing the birds, and probably could also be

fitted with devices for removing old and unused food, and for removing eggs for candling.

Several other factors should be borne in mind:

(1) Peregrines, and possibly the other large falcons also, appear to breed successfully in the wild by their second birthday.

(2) The introduction of the members of the pair to one another and to their room need not be a dangerous undertaking–if the two birds are not imprinted to human beings, and if they are both on increasing or long photoperiods.

(3) The lethargy of the female, as laying nears, should be viewed with hope, and not treated with fear.

(4) Water for bathing and drinking appears to be important near the time of laying and hatching. The water should be clean.

(5) The ledge material should be changed at the end of the season so that fecal contaminants from one brood cannot damage a clutch the following season.

To date, while there have been some very important discoveries made by a number of those involved with captive breeding, much time has been wasted through a certain degree of lack of communication–and people are repeating the same techniques that have already been proved unsuccessful by others. The people involved with captive breeding should be making greater efforts to use the available channels (especially *RRN*) for communicating their ideas and discoveries to others, so that as soon as possible a majority of the pairs set up for breeding will be producing young Peregrines each season.

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