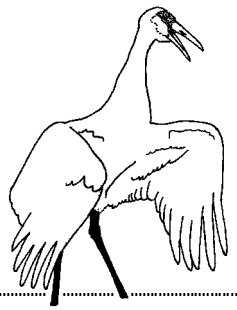
CHAPTER 6

Behavior Management



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Management of crane behavior varies with use, age, and reproductive condition. We discuss five management classes: chicks, subadults, breeding birds, cranes for public display, and release birds. Cranes are individuals, and management practices that are beneficial to one crane may be harmful to another. Because management of these classes and individuals overlap, a combination of behavioral management techniques often works best for individual cranes.

This chapter emphasizes crane **social behavior** and how it affects captive management. Ellis et al. (1991) described the non-social (maintenance) behavior of all species. Because most body maintenance behavior patterns are superficially alike for both calm and highly stressed cranes, we discuss below only the few maintenance actions that suggest a crane is stressed. Studies of crane social behavior that include illustrations of displays are Allen (1952) on the Whooping Crane; Archibald (1974a) and Katz (1979) on the Hooded Crane; Masatomi and Kitagawa (1975) on the Red-crowned Crane; Poulsen (1975) on Siberian and Common Cranes; Voss (1976, 1977), Nesbitt and Archibald (1981), and Tacha (1981) on the Sandhill Crane; and Ellis et al. (*In prep.*) on all species. Previous papers describing behavioral management of captive cranes include Archibald (1974b), Kepler (1976, 1978), Archibald and Viess (1979), and Derrickson and Carpenter (1980, 1987).

Techniques in Behavior Observations

Observing cranes in the same context and at the same time each day reveals seasonal changes in social patterns and abnormalities suggesting health problems. Data collection can be as simple as merely noting abnormalities or social problems, or as complex as a bird-by-bird tabulation of behavior details on form sheets. **Daily observations** are essential in monitoring the pairing and social interaction of cranes in the same pen or adjacent pens.

Blinds (Fig. 6.1) set up near cranes allow for longer-term observations of relatively undisturbed (by humans) behavior. Cranes behave more normally when people are not in view, so blinds are a valuable supplement to daily observations not just for research, but also in the management of pairs. Because some cranes remain disturbed by observers in nearby blinds, it is crucial to locate blinds with care and use one-way glass if necessary to enable the observer to be invisible to the crane.

Fig. 6.1. *Brian Clauss enters an elevated observation blind.* Photo David H. Ellis

Remote monitoring (Fig. 6.2) via closed-circuit TV (CCTV) is valuable for observing pairing, breeding, or egg laying of cranes without risking them noticing the observer. Cranes seem to adjust quickly to cameras mounted high in a pen corner (although they notice cameras that move or make noise). CCTV allows for the most undisturbed watching of cranes and is ideal for making videotapes that can be replayed at high speed and searched for significant behavioral patterns, such as copulation and nest building. For cranes that break eggs, long-term egg vigils are made easier by CCTV. CCTV allows for a second look to determine if first impressions can be confirmed by review of videotapes.

FIG. 6.2. *Closed circuit television camera monitors Whooping Crane.* PHOTO DAVID H. ELLIS

Aggressive Displays

Cranes that have red caps or bare skin on their heads expand the cap (**Crown-expansion**), extend their wattles (**Bare-skin-expansion**), or suffuse the bare skin with brighter color to supplement their displays (Fig. 6.3). Cranes with completely feathered heads elevate head plumage to increase the apparent size of their heads. These head displays are low-intensity displays when they appear alone, but they are also used as elements of many other aggressive displays.

Cranes have several low-intensity displays that are used to intimidate or repel intruders. Most of the displays described below apply to all cranes. The nomenclature for these activities follows Ellis et al. (*In prep*.). We will describe the displays in increasing order of intensity. In perhaps the lowest intensity display, a crane raises its head to full height and extends its neck upward and slightly forward in an

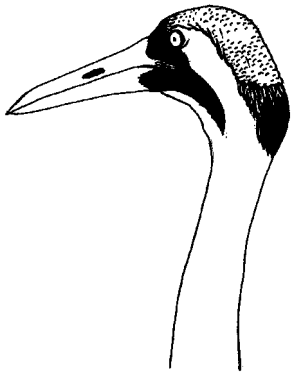


FIG. 6.3. *Crown expansion: Whooping Crane.* ART BILLI WAGNER

Alert-posture. When in this posture, and during many of the social displays that follow, most cranes perform Crown-expansion or Bare skin expansion. The crane may then begin a ritualized display walk (**Horizontal-strut** or **Vertical-strut**) with the bill slowly bobbing up and down in time with exaggerated, rhythmic steps (Fig. 6.4). The toes are rigidly fanned and extended during the Vertical-strut. The crane may either turn its bill away from the intruder (**Crown-present**) or direct its bill downward toward the intruder. In higher intensity strutting, the crane either increases the speed of the walk or lowers its head (sometimes nearly to the ground). Common, Hooded, Whooping, Black-necked, Sandhill, and Siberian Cranes (listed in descending order of feather elevation) raise their tertial feathers into a bustle during display walks (Fig. 6.4).

FIG. 6.4. *Strut (vertical): Eurasian Crane.* ART BILLI WAGNER

Another low-intensity threat is the **Ruffle-bow**, in which the crane elevates its feathers and slowly, at first, ruffles its plumage until at length the whole body is rapidly shaking (Fig. 6.5). This display is much like the maintenance **Ruffle-shake**. All species perform the Ruffle-bow, and the Blue, Demoiselle, and Wattled Cranes use this as their principal display. Sandhill Cranes end the Ruffle-bow by throwing the head downward, then preening the breast or tibiotarsus. The Whooping Crane tucks the bill high at the end of its Ruffle-bow (Fig. 6.6). All cranes have a **Ritualized-preen** display in which they place the bill between the back and one wing (Fig. 6.7). Siberian Cranes lower the primaries of one wing and do not move the bill during the display. Other cranes do some rudimentary preening movements and periodically raise their heads to look around. Several species stamp their feet (**Stomp**) a few times in conjunction with the Ruffle-bow or Ritualized Preen. The Red-crowned Crane often Stomps, then arches its head back and raises its wings above the back until its head is nearly between the wings over the back (**Arch**). The Whooping Crane version of the Arch we call the Butterfly (Fig. 6.8). The Red-crowned Crane and its nearest relatives (see Chapter 1) sometimes raise their wings slightly during more intense versions of the Vertical-strut. The Brolga, Sarus, and White-naped Cranes have an exaggerated downward bow as part

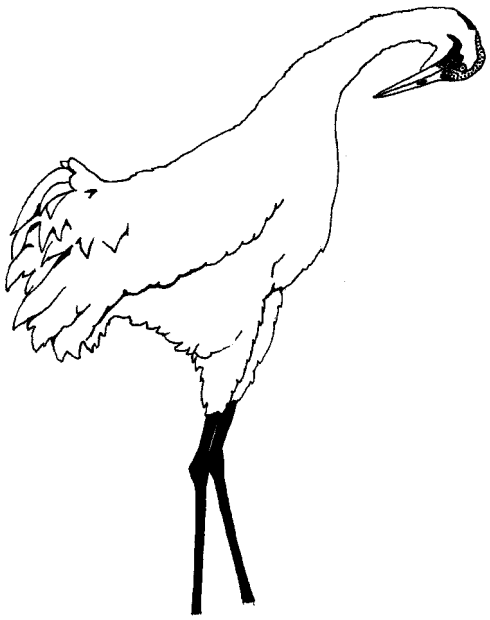


Fig. 6.6. *Ruffle-bow-up: Whooping Crane.* Art Billi Wagner

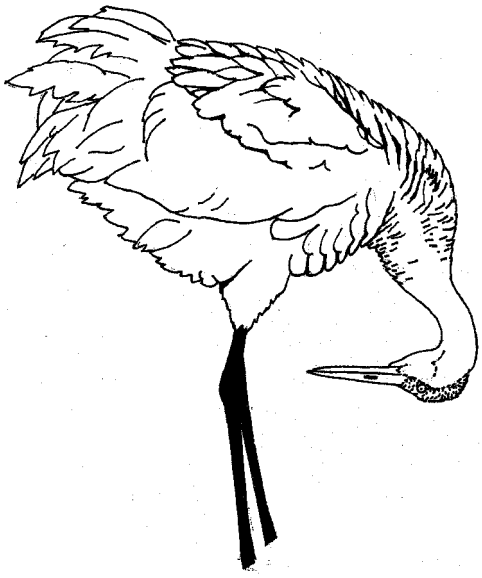


Fig. 6.5. *Ruffle-bow-down: Sandhill Crane.* Art Billi Wagner

Fig. 6.7. *Ritualized Preen: Whooping Crane.* Art Billi Wagner

of the Ruffle-bow. After the ruffle, they usually bow deeply forward, then do a Ritualized Thigh Preen or elevate the head far over the back.

We believe that the most aggressive display is the **Crouch**. In this display, the crane lowers to lying posture with its wings slightly to mostly spread and its bill in front, usually touching or probing at the ground. After performing the Crouch, cranes sometimes **Rush** an intruder by springing up suddenly and charging headlong, flapping their wings and gliding over the ground rapidly if the intruder fails to depart. The crane terminates the Rush with either a Stomp and Ruffle-bow, or by **Attacking** the intruder. Otherwise, cranes usually end the Crouch display with an Arch (Red-crowned) or Ritualized-preen (Siberian, Sandhill and others).

Methods of **Attacking** (Fig. 6.9) include spearing the opponent with the bill (**Bill-stab**), **Leaping** in the air and slashing the intruder with the inner toenails (**Jump-rake**), and thrashing with the wings (**Wing-thrash**). Cranes sometimes use stealth to approach an intruder: they circuitously walk closer and closer while feeding, then abruptly Rush the intruder (crane, human, or other animal). Rushes can also lead to aerial pursuit as a territory owner drives away an intruder, sometimes slashing at the intruder with its feet even during flight.

Aggressive cranes may also bill-spar with one another, spreading their wings and Bill-stabbing at their opponents while standing erect. This may or may not lead to Jump-raking. Cranes also **Hiss** loudly while bill-sparring. A minor form of Attack is to peck at or grasp the wings or tail of a subordinate to displace it.

Vocalizations can indicate fear or aggression, and like the Unison-call, help drive away intruders and maintain pair bonds (Archibald 1976a, 1976b). Pairs **Unison-call** (Fig. 6.10) after repelling intruders. **Guard-calls**, which are short blasts separated by several seconds, also help to defend the territory (Archibald 1976b). See Archibald (1976a) and Chapter 11C, especially Fig. 11C.1, for more details of these vocal displays.

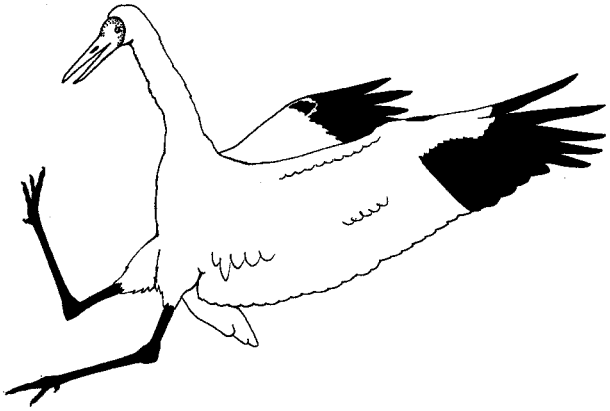


FIG. 6.9. *Jump-rake: Siberian Crane.* ART BILLI WAGNER

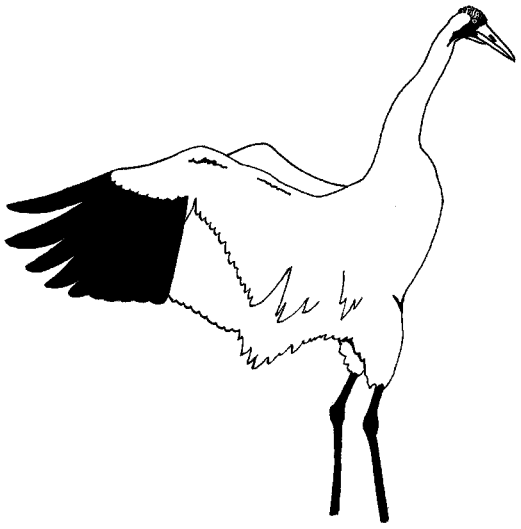


FIG. 6.8. *Butterfly: Whooping Crane.* ART BILLI WAGNER

FIG. 6.10. *Unison-call: White-naped cranes.* ART BILLI WAGNER

Dancing consists of bouts of Rushing, Flapping, Leaping, Tuck-bobbing (Fig. 6.11), gaping, and feather or stick tossing. Dances last from several seconds to a few minutes and are usually pair-related. However, young cranes often dance in apparent appeasement of dominant cranes. Sometimes Dancing includes sham Bill-stabs and Jump-rakes, but in stable pairs, physical contact is usually not present. Many other elements of aggressive displays (e.g., Crown-expansion) are evident in Dances.

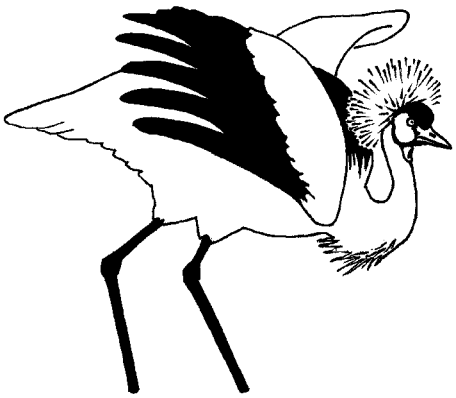


Fig. 6.11. *Tuck-bob: Gray-crowned Crane.* Art Billi Wagner

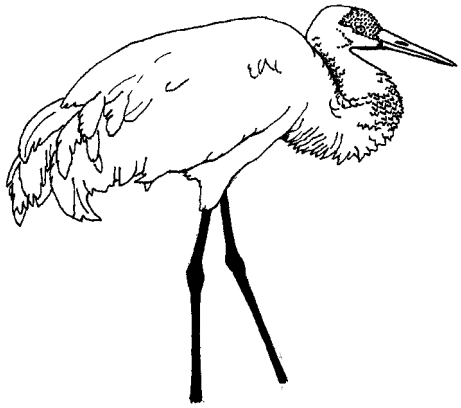


Fig. 6.12. *Cower: Sandhill Crane.* Art Billi Wagner

wings slightly (the elbow is lifted away from the flank), and give purring calls. Chicks often perform this display. When adult cranes Cower, they are probably reverting to chick behavior to placate a dominant crane or person. Often a submissive crane will spread its wings with the trailing edges drooped and turn its back to a dominant crane (or human) as in the adult female's **Pre-copulatory Display** (Fig. 6.13). This behavior is not limited to one sex and is often seen in chicks and subadults.

Submissive Behavior

Submissive displays and fleeing behavior are useful indicators that a crane is stressed by its environment. Some captive cranes run away when a person or dominant crane approaches and may push at the fence as if to walk through it. The crane may also nervously pace the fence, rake its feet along the fence in a climbing manner, and drag its neck and bill along the fence. These disturbance-related activities can cause physical damage, especially abraded wrists, and even more seriously, broken bills.

A submissive crane (Fig. 6.12) usually retracts its neck and adopts a hunched posture (**Cower**) with its head and neck feathers fluffed, and its crown, wattles, and/or bare skin patches contracted. Frequently, subordinate cranes lower their heads, spread their

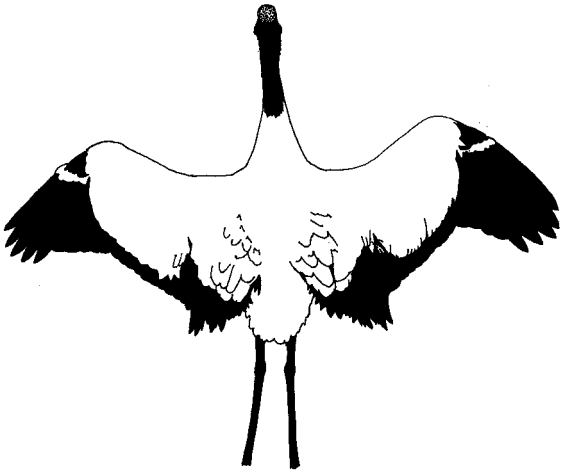


Fig. 6.13. *Pre-copulatory display: female Black-necked Crane.* Art Billi Wagner

Behavioral Management of Chicks and Subadult Cranes

This section provides a summary of the management of young chicks; other details are provided in Chapter 5. Chicks have strong social needs. Most species are gregarious, and nearly all cranes flock during the non-breeding season. Flocking probably results in increased survivorship and in foraging advantages. Cranes three months to three years old should be socialized with conspecifics so that they develop normal social behavior. Combine cranes in groups of two or more in pens that are at least 100 m^2 for two cranes and proportionately larger for larger groups. The group will establish a dominance hierarchy (Derrickson and Carpenter 1980) based on the size and sex of the cranes, with males and larger cranes typically being more dominant (Kepler 1976).

Parent-reared cranes will try to establish **vocal contact** with their parents after separation and will also try to reunite if allowed. Place such cranes at least 200 m away from and out of sight of their parents until they integrate into a social unit with other colts. Parent-reared crane chicks are typically fearful of people. As such, they should be habituated to humans if they are to remain in captivity (Archibald and Viess 1979). Frequent, nonstressful encounters with humans will help calm them down (e.g., provide a food treat when entering the pen). Placing wild colts with tame cranes will also help.

In grouping colts, avoid penning cranes together that are likely to be paired later. Cranes treat their penmates as siblings and may refuse to pair with them later. It is wise to keep intended mates separate until they are at least 18 months of age.

Cranes that are 6 months old or older often becomeaggressive towards theirpenmates,particularly those of the same sex. Groups should be reorganized when excessive aggression appears. However, it will help to place two food/water stations at opposite ends of the pen so submissive cranes can eat and drink. Even then, watch for Cowering cranes that are afraid to go to the food. In large pens with 10-15 birds, a third station may be needed. Submissive cranes that are regularly attacked by penmates should be removed.

Chicks spend much time practicing flying when they are two or more months old and need an unobstructed area at least 15 m long for exercise. They may be wing clipped after they fledge. Opinions vary on whether permanent flight restraint (see Chapter 11E for details) can prevent males from balancing properly during copulation and thus limit fertility. Many pinioned and tenotomized males fertilize their mate's eggs. However, in captive Red-crowned Cranes (the heaviest crane), full-winged males had higher rates of natural fertility than pinioned males (Belterman and King 1993).

Keep subadult cranes in genetically and behaviorally compatible groups (2 to 16 individuals) until they are paired. When pairs form in group pens, extreme aggression often appears, with the dominant pair often monopolizing food or water and occasionally killing pen mates. If the new pair in a group pen is desirable, move the pair to a breeding pen. If the pair is unwanted, remove one or both cranes to reduce aggression.

If sex is known, juveniles can be grouped by gender, however, same sex groups can also be aggressive, and homosexual pairs can form in such groups (Archibald 1974b; Kepler 1978; Derrickson and Carpenter 1987). Early sexing increases the chances of early reproduction through behavioral management.

Behavioral Management of Breeding Cranes

Cranes have pronounced species specific variation in nesting phenology (see Chapter 3). Their captive management should reflect species differences and allow for individual variation as well.

Annual Behavior Cycle of Breeding Cranes

Cranes exhibit seasonal cycles in social displays especially in activities related to pairing and those involved in rearing young. It would be helpful to have data on seasonal trends for all species of cranes in your colony, but such is available only for the Whooping Crane and Mississippi Sandhill Crane as described below. Also, Katz (1979) presented somewhat similar data for two pairs of Hooded Cranes from late February through early June.

For boreal species, display intensity ebbs in winter, but on warm days in late winter and early spring, display frequency and intensity increase. As the breeding season approaches, vocal and visual behavior

related to pair-bonding, territorial defense, and breeding is increasingly evident. There is also good evidence for decreases in performance of some displays during the molt and during the incubation and chick rearing period when the adults tend to be more secretive. The intensity and frequency of several vocal and visual displays again increases in fall, suggesting an autumnal recycling perhaps in response to a photoperiod mirroring that for spring. Thereafter, performance tendency wanes through the early months of winter.

In the following paragraphs, we will show some general trends in this annual cycle and compare behavior trends for the migratory Whooping Crane with those of the nonmigratory Mississippi Sandhill Crane. Male-female differences will also be emphasized. These generalizations are presented because of their usefulness in crane husbandry. Also there are seasonal cycles in non-social behavior such as the increase in fall food intake (or at least body weight) especially evident in northern latitude breeding cranes (Swengel 1992).

Our data on social displays derive from a 15-month period during which we conducted a standard morning "walk-through" in the crane colonies at Patuxent and recorded the responses to an approaching human. Because hand-reared cranes responded to the approaching human as though he was an intruding crane, for hand-reared pairs we were able to evaluate seasonal trends merely by recording all social displays as we walked through the colony. Our walk through the colony did not elicit social displays in cranes reared by crane foster parents (except for fleeing behavior) so parent-reared cranes were eliminated from the comparisons shown below. Data were used for 12 male and 12 female Whooping Cranes and 9 male and 7 female Mississippi Sandhill Cranes. All data were taken on form sheets as an observer (who was familiar to the cranes, but who avoided entering their pens) approached to within ca 2 m of the pen between 0.5 and 3.5 hours following sunrise.

As for all species with a red cap, Whooping Cranes, and to a lesser degree Mississippi Sandhill Cranes, expand the red, bare-skin areas and present this area toward approaching intruders (Fig. 6.3). For both species, Crown-expansion and presentation values are high throughout the year, except during incubation or molt when a crane is trying to be inconspicuous. Crown contraction at other times signals fear or illness. The Whooping Crane exhibited two peaks. Females of both species cycle in concert with their mates, but they, on average, expand to a lesser degree than males.

The Unison-call (Fig. 6.10), a form of antiphonal duet given by both members of a pair, can be performed throughout the year and is given primarily in response to conspecific intruders (Walkinshaw 1973a; Archibald 1976b). Well-coordinated, frequent Unison-calling signals that a pair is properly bonded. Duetting is also believed to be important in the synchronization of the crane breeding cycle (Voss 1977). In the Whooping Crane pairs studied at Patuxent, the Unison-call was heard with some frequency all months of the year (Fig. 6.14), but was highest between October to April and lowest during the July molt. Unlike our Whooping Cranes which did not breed during the study year, our Mississippi Sandhill Cranes exhibited a strong peak from June through August when they did breed. This periodicity suggests the importance of the Unison call as a territorial display while breeding (Mississippi Sandhill Crane data) and also in reinforcing the bonding of a pair during migration (Whooping Crane data).

Contact- or Flight-calling was entirely absent in our pairs of the non-migratory Mississippi Sandhill Cranes, but our Whooping Cranes exhibited a strong peak in March and April and a minor peak in September (Fig. 6.15). The Contact-call communicates a bird's disposition to fly and is probably important in synchronizing long distance movements of the pair. Contact-calls may be given synchronously

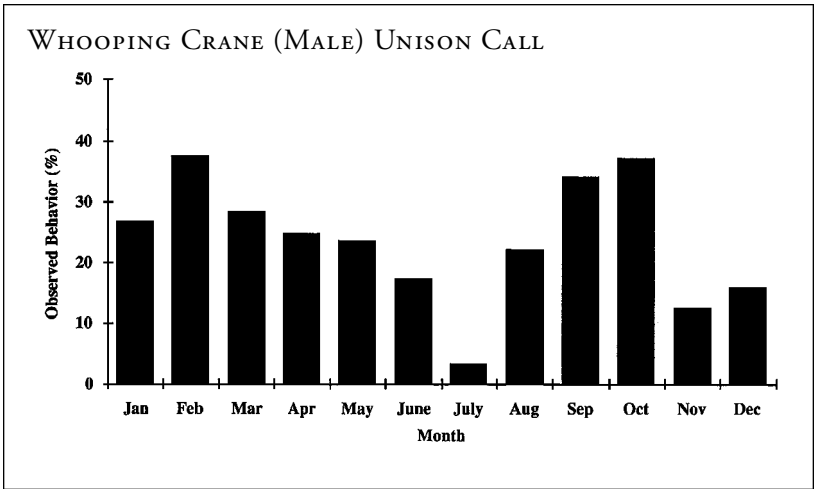


Fig. 6.14. *Seasonal pattern in Unison-call performance for Whooping Cranes.*

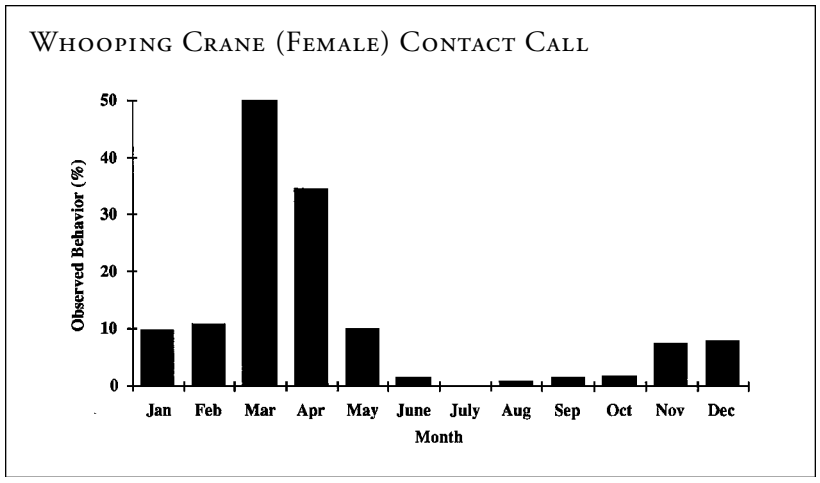


FIG. 6.15. *Contact-call performance by month for female Whooping Cranes.*

by males and females or singly by either sex. The male trend (not shown) closely paralleled the female trend (Fig. 6.15).

Contact-calling is often accompanied by a highly stereotyped Pre-flight posture (Fig. 6.16) wherein the neck is extended up and far forward. Both ethons had similar performance trends in both species.

We have observed, but not quantified, that the intensity of flight related behavior patterns is directly related to the length of the migration; being greatest in Siberian Cranes, followed by Whooping, Hooded, Red-crowned, White-naped, and Greater Sandhill Cranes. In captivity, the intensity of migratory restlessness seems also to decrease with age.

The Guard-call or Alarm-call is normally given in response to a distant disturbance such as an unfamiliar human or other alarming stimulus animal. In both Mississippi Sandhill and Whooping Crane pairs, the Guard-call is given less often than the Unison call, and seldom during the early part of the breeding season.

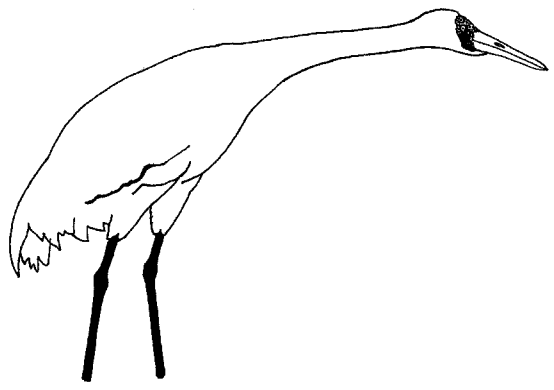


FIG. 6.16. *Pre-flight Posture: Siberian Crane.* ART BILLI WAGNER

The average distance between members of a pair is another indicator of the strength of the pair bond, especially during migration and nesting. During the incubation period, however, the non-incubating parent seems to avoid the vicinity of the nest causing a peak in the average distance between mates.

Both sexes of both species of cranes performed the exaggerated, rigid-toed, high-stepping that we call Strut. When Strutting, the body axis is either rotated down and forward (Horizontal Strut) or elevated anteriorly (Vertical Strut, Fig. 6.4). During a Strut performance, Crown-expansion and presentation also occur. Although both species and both sexes Strut, in the Mississippi Sandhill Cranes, the males normally Horizontal Strut with their mates walking (Unison walk) in tow. Male Whooping Cranes typically Vertical Strut while their mates remain stationary and perform ritualized Preening or some other social display. For the male Mississippi Sandhill Crane, Strutting exhibited a single peak (Fig. 6.17) in midsummer. Strut was without peaks and much less frequently performed in the Whooping Crane.

Crouch is the display that shows the strongest male-female and species differences. For Crouch, a crane flops onto the ground and lies as if brooding young while aggressively billing the surrounding vegetation. Female Mississippi Sandhill Cranes may perform Crouch any time of the year (Fig. 6.18), but a strong peak is evident when they are rearing young. Male Mississippi Sandhill Cranes and either sex of Whooping Cranes seldom perform this display.

Probably all species show some unique seasonal trends. For example, most cranes lay eggs in spring or summer, however, many wild Wattled Cranes lay in winter (Johnson and Barnes 1991) and their captive counterparts lay eggs from fall to spring (Beall 1985). Gray Crowned, Black Crowned, Blue, and Demoiselle Cranes may also lay eggs in indoor winter quarters (K. Kawata, Detroit Zoological Park, Royal Oak, Michigan; R. Lastavica, Omaha Zoo, Omaha, Nebraska; and P. Strasser, National Aviary, Pittsburgh, Pennsylvania, personal communications).

Some performance trends are probably common to most or all cranes. For example, we hypothesize that cranes (captive and wild) vocalize less once the eggs

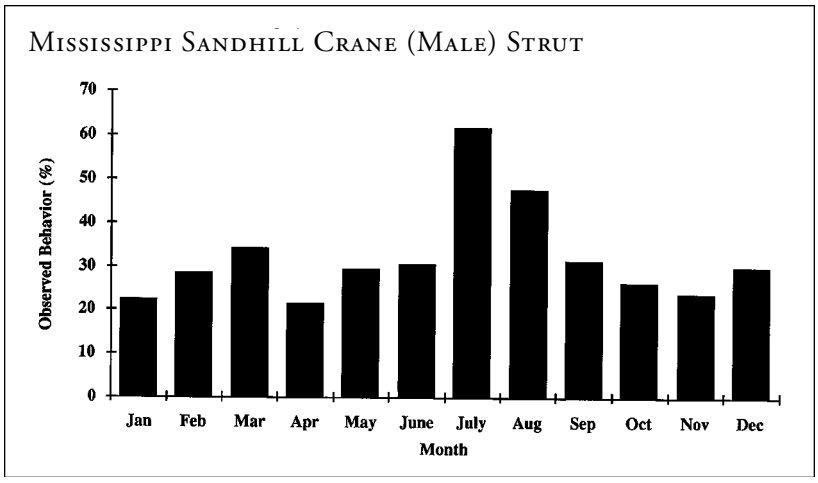


Fig. 6.17. *Monthly performance levels in strut for male Mississippi Sandhill Cranes.*

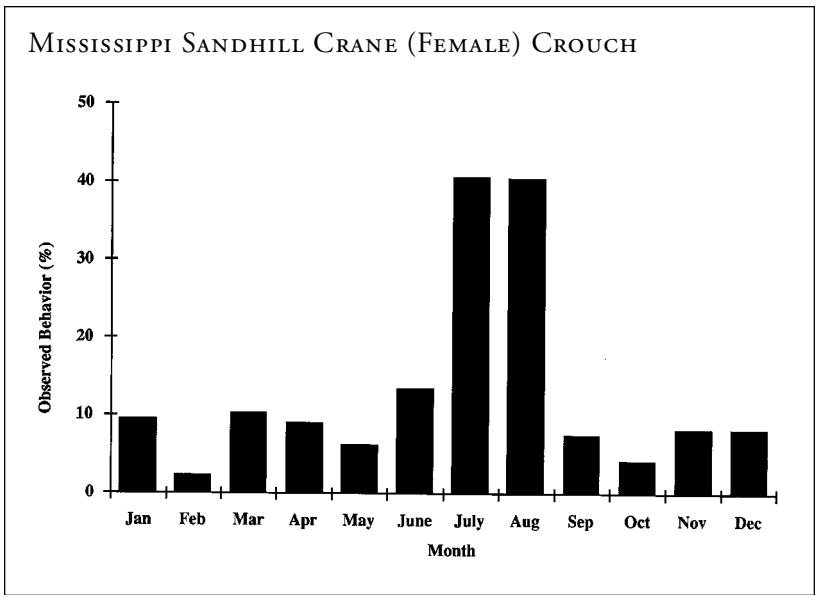


Fig. 6.18. *The annual cycle in Crouch performance for female Mississippi Sandhill Cranes.*

are laid. Katz (1979) found what appeared to be reduced calling in captive Hooded Cranes as the egg-laying season approached. Probably all species of cranes (captive and wild) begin copulating 2 to 5 weeks before egg laying, even those that are still migrating (Littlefield and Ryder 1968; Walkinshaw 1973a; Littlefield 1985). Captive pairs build nests a few days or weeks before egg laying. By watching for the onset of nest building, a colony manager may know when to begin artificial insemination (AI) to fertilize the first eggs.

Surprisingly, in our walk-through study, we failed to find strong seasonal trends for such activities as Dancing and Pre-copulatory display for either species, and Strutting was seasonal only in male Mississippi Sandhill Cranes.

Allspecies ofcranesfeed,brood, anddefendtheir young,andsome pairsofmostorallspecies are extremelyaggressive when raising chicks.Allcranesbecomemore sensitive todisturbancewhenincubating and rearingchicks. Mostcranesshow somebehavioralchanges associated withthemolt. Mostundergoan annualorbiennialsimultaneousmolt ofall flightfeathers(Blauuw 1897; seeChapter 7 forphysiologyofmolt andcharacteristicsofjuvenalmolt). African Crowned Cranesand Brolgas, however, moltcontinuously; Demoiselle Cranes andmost Sandhill Cranesmolt sequentially. Themoltis physiologically stressfulandisaccompanied by a decreaseinperformance valuesofsocialdisplaysduring the timethatthebird is flightless. Such changesare probablyadaptationsfor survival. Becausecranes(evennormallyaggressive individuals)become very shywhenmolting,minimize humancontactduringthistime. Thefemalemayevenbecomethe dominantmemberofthepairwhile themaleismolting. Watchmolting cranescarefullytoforestall penmate aggression. In grouppens,moltcan destabilize thedominancehierarchy. Moltcanalsocausecranestoappearill.

By knowing behavioral norms for each sex and species, it is possible to promote survival and productivity in captive colonies.

Pairing Cranes

Pairing cranes can begin in the birds' second year. Well-established pairs remain together for many years. When pairing subadult cranes (i.e., 3 years of age), be aware that new pairs are frequently ephemeral. Pairs should not be viewed as permanent until they remain stable for several months and/or reproduce. Wild, subadult Florida Sandhill Cranes usually associate with several potential mates before a firm bond is

established (Nesbitt and Wenner 1987). In choosing potential pairs, be mindful that birds of similar age pair more readily: young cranes are sometimes intimidated by older adults. Potential mates should not be genetically related nor should they have been reared together.

Potential mates should be placed in adjacent pens ideally with a common door to allow herding of a crane from one enclosure to the other without capture. Close contact can be encouraged by placing food and water near the fence dividing the two pens. Pairing pens should be arranged so that concealed caretakers can observe the birds and quickly enter the pens if necessary to separate the birds.

Pairing stages were summarized by Mirande and Archibald (1990) as follows. The first sign of pairing in the wild is one crane following another. In captivity, pairing is evidenced when the birds frequently stand side-by-side. As pairing continues, the behavior of the two birds becomes progressively synchronized. They feed and rest simultaneously. Synchronized displays, such as threats, Guard Calls, and Unison-calls may also indicate pairing; however, such behavior can also indicate intense intrapair aggression or aggression toward caretakers. A crane may interpret its intended mate's aggressive displays as sexual attraction, but when the birds are placed together, the aggressive crane may attack. To prevent injury, keep an over-aggressive male in the pen adjacent to the female; she may thereby be stimulated to lay eggs without risk. For AI pairs with aggressive males, this is sometimes the best strategy, even long term.

Although cranes (even chicks) sometimes **dance** solo or in larger groups, dancing is also associated with pairing and is believed to synchronize mates for successful copulation. Lack of dancing between two cranes can indicate that pairing is not occurring. As a pair bond strengthens, the male generally becomes more defensive of the enclosure than does the female. The ultimate indication of successful pairing is copulation. Pairs that are well bonded should at least attempt to copulate, although some will be unsuccessful because of wing injury, etc.

When it is time to **move the cranes into the same pen** for the first time, move the more dominant bird (usually the male) into the subordinate crane's enclosure. This provides the subordinate bird with a psychological advantage because the pen is its territory. Watch the birds constantly at first and separate them immediately if excessive aggression is observed. Dancing strengthens the developing pair bonds, especially when the female continues to dance after the male begins to run and flap in mock Rushes. In unpaired birds or unstable pairs, dancing can intimidate the subordinate crane. If one crane keeps dancing while the second crane flees, the first crane may chase the fleeing crane and attack. Death or serious injury can result if the cranes are not immediately separated. A single attack can negate weeks of progress in the pairing process.

Cranes can be further manipulated to promote pairing by brailing one wing of the dominant bird before placing it in the enclosure of the submissive crane. The brail stresses the crane, reducing its aggression. Dominance in cranes is related to height; more dominant birds are generally taller than submissive ones. However, the dominance of a submissive crane can be increased by providing a **mound of earth** 0.3 to 0.5 m high near the fence separating the cranes. Displaying cranes will often stand on such mounds. By this simple manipulation, the dominance of a subordinate crane may be increased.

If cranes seem compatible, they can be left together during the day with hourly checks. When Unison-calls and dancing do not lead to aggression or intimidation, the pair is considered to be solidly mated and can be trusted to occupy the same enclosure at all times.

For cranes, some action patterns are "contagious." For example, if one bird yawns or flaps its wings there is a good chance that one or more penmates will do likewise. If one crane is extremely aggressive towards humans, its penmates will often become aggressive. By pairing cranes with different behavioral traits, characteristics of one crane can be encouraged in the other. Parent-reared cranes become much tamer and adapt to captivity better if penned or paired with hand-reared birds. Conversely, hand-reared birds can become less attached to humans if integrated with parent-reared mates.

Some paired cranes that have not bred can be induced to become more confident and better bonded if a crane chick is placed in an adjacent pen. Sometimes the pair attempts to adopt the chick (as evidenced by their passing food items through the wire to the chick, brood calling, and by their lack of threat displays); others will try to kill the chick or ignore it.

Stress and Disturbance

Crane pairs are healthier and breed better when disturbance is minimized (Mirande et al. 1988 unpubl.). Pairs are normally less stressed when: (1) their pens have visual barriers separating them from neighboring cranes; (2) routine tasks are done on a regular schedule; (3) the same people perform these tasks; and (4) the breeding area is closed to certain kinds of vehicles (aircraft and large trucks) and activities (pen repairs and construction) during, and three months prior to, the breeding season.

Some cranes breed well without **visual barriers** between neighboring pairs, but pairs should at least be separated by empty pens to prevent fighting through the fence. Sandhill, White-naped, Red-crowned, and some other species have bred well without visual barriers, but Whooping, Sarus, and Siberian Cranes need them.

Cranes breed best when they have a large, secure **territory**. Breeding pairs need at least 100 m^2, but 300 m^2 is preferable. They often benefit from a shelter in which to retire from view or gain protection during inclement weather. Trees or bushes in the pen may provide **natural cover**. Some pairs breed better if they have a secluded spot for nesting. Satisfy their need to build nests by providing dry twigs or coarse grasses (fine or moist vegetation will mold more rapidly).

If AI is intended, line **capture corners** with nonabrasive cloth such as tennis netting for 3-6 m in each direction from the corner. At ICF, discarded 2 m tall conifers (old Christmas trees) are used to line these corners.

Stress can be reduced by taming cranes. The process involves conditioning birds to human activity through providing treats (favorite foods), avoiding direct eye contact, announcing your approach by calling when still far away, and other techniques as discussed in Chapter 5.

Pair Bonds

Well paired cranes perform synchronous activities and stay near one another most of the time. If a male is excessively dominant or if the female is dominant over the male, the pair may never breed (Derrickson and Carpenter 1987). Several circumstances can result in weak pair bonds. If one member of a pair is excessively submissive to the other or if one mate prefers a neighboring crane, the pair bond can be weakened. An unstable pair bond can result in one crane injuring or killing its mate.

Some pairs are compatible but never lay eggs; this occasionally occurs with birds that were paired when very young. Such birds seem to view each other as siblings. For these pairs, pair-related displays and territorial defense are less intense.

The "**Location-call test**" is a good means of testing the strength of a pair bond. This requires that the male be removed from the female by at least 100 m, but within earshot. If both cranes perform the loud, single-note Location-call, and promptly answer the calls of their mate from a distance, the pair bond is probably genuine. If either member of the pair fails to Location-call or fails to respond to the other crane's Location-calls, the pair bond is probably weak and the pair should be dissolved.

If a closely bonded pair is to be divided and new pairs formed, Location-calling can seriously delay or prevent the re-pairing process. It is wise to postpone introducing the new intended mate until a week or more following separation of the old pair. Former mates must sometimes be separated by a great distance (1 km or more) to facilitate pairing them with other cranes.

Sometimes **wild cranes harass captive pairs** which can result in captive males redirecting aggression toward their mates. In these situations, pairs may need to be separated until the wild cranes leave. The pair can generally be safely reunited after a few days.

Wild cranes occasionally **switch mates** even though neither member of the pair has died (Littlefield 1981; Nesbitt and Wenner 1987). Young cranes frequently form ephemeral pairs in the wild and may take years to form permanent pairs (Bishop 1984; Nesbitt and Wenner 1987). Pairs that produce offspring are much more likely to persist (Nesbitt and Wenner 1987). In wild Florida Sandhill Cranes, re-pairing efforts vary by sex: males quickly find new mates, while females may take several years to re-pair (Nesbitt 1989).

Hand-reared cranes that are overly attached to humans can often be made to breed if they are given a suitable mate, and if thereafter they have minimal contact with humans. Once the pair has eggs, its pair bond is often strengthened, and further bonds to humans are weakened by the pair's mutual defense of the eggs or chicks.

Before including birds in an AI program, allow young pairs to attempt copulation for one or two breeding seasons. Flightless males that are unable to fertilize eggs due to unilateral wing impairment may

be clipped on the whole wing to improve their wing symmetry and thus help them balance. Allowing the pair to raise a chick may also synchronize their reproductive cycles or strengthen their pair bond, thereby increasing the chance of fertility in the future.

Parent-reared cranes may be more likely to copulate than hand-reared ones, and cranes hand-reared in groups may be more likely to copulate than birds that were hand-reared alone (Derrickson and Carpenter 1987). However, most hand-reared cranes that are socialized with others as colts learn to copulate when they become adults.

If a pair does not produce fertile eggs after one or two years of management as described above, it may be necessary to re-pair them or initiate AI (Chapter 11A). In **using AI**, it is important to disturb the birds as little as possible. Some cranes will not lay eggs when they are regularly handled for AI. One strategy for such cranes is to wait until the female starts laying eggs, and then initiate AI. Normally, the female is not so stressed by this handling that she fails to lay more eggs. This strategy is less useful with Wattled Cranes, which frequently lay one-egg clutches. For those Wattled Cranes that are adverse to AI, one insemination 4-10 days before the next egg is expected can often produce a fertile egg (Monica Tuite, unpubl. data). The best AI schedule depends on the particular female's laying history (see Chapter 3). Inseminating a nervous female a few days before she is scheduled to lay her second and subsequent clutches, **but not repeatedly between each clutch** , can improve the chances of getting several fertile eggs while **minimizing disturbance** . Finally, be sure that egg searches and other visits to the pens of shy cranes are performed quickly and, if possible, use binoculars to scan the pen from a distance.

Behavioral Management of Cranes for Display

Cranes on public display normally receive more disturbance than other captive cranes. Because many cranes will not breed while on display, it is best to exhibit only those birds that are of low genetic value. Display cranes should tolerate human visitors but not be aggressive towards them. Extremely aggressive cranes are dangerous to caretakers and the public, and may damage themselves in their attempts to attack people. To reduce the chance of injury to birds and visitors, design display pens so that the public cannot come closer than 1 m to the cranes.

Cranes on display adopt a daily schedule timed to periods of human visitation. They direct many of their social displays toward the public, and most remain within public view.

Several management practices can encourage exhibit cranes to breed. Caretaker entrances should allow servicing so that a portion of the pen is left undisturbed by keepers and the public. Performing some activities out of sight and with minimal contact encourages breeding. Cranes on display feel safer when they have a "sanctum" where they can go out of sight of humans. This hiding place can be an indoor shelter, a sheltered corner, or a patch of dense foliage ca 1.5 m tall.

Novel pen designs can also improve the display value of cranes. Elevated overlooks or moats allow people to view cranes unobstructed. These designs, however, require that the cranes be flightless.

Mixed species exhibits are attractive, but because cranes are solitary nesters, they are unlikely to breed when there are more than two cranes in one display. The dominant pair will too often defend most of the pen, driving the remaining cranes from its territory. Such pairs may even breed. However, dangerous encounters are likely whenever a breeding pair is penned with conspecifics. The only situation in which a breeding pair can coexist peacefully with other conspecifics is when the pen is very large. Patuxent maintains three pairs of Florida Sandhill Cranes in a 2 ha enclosure. The dominant pair normally defends more than half of the area while leaving enough room for the two subordinate pairs to escape and breed.

Behavioral Management of Cranes for Release

This section summarizes the management of cranes destined for release. For more details see Chapters 5 and 11D.

Parent-reared and hand-reared cranes for release are managed very differently. Parent-reared chicks develop normally and require no special training. Chicks reared by hand, in isolation from human contact, should be allowed to see and hear conspecific adults so that they learn to socialize and breed

with conspecifics. Normally, hand-reared chicks are handled by costumed human caretakers (costume-rearing).

Costume-reared chicks can be taken to the release site when they are as young as 10 weeks (Horwich 1986). Young cranes exhibit the behavioral plasticity important in rapidly learning new survival techniques. Horwich (1986, 1989) released his costume-reared cranes in early fall to coincide with the period when wild cranes are the most gregarious. Other studies also suggest that captive-reared cranes integrate better with wild cranes if released in early fall (Mitchell and Zwank 1987). Whatever the rearing method, cranes should be released gently over a period of weeks (**gentle-release**) to give them time to acclimate (Horwich 1986; Mitchell and Zwank 1987). If the chicks are costume-reared, this acclimation period can also be used to introduce them to natural foods.

Release pens should be large enough to allow cranes to move comfortably away from mammalian predators outside their enclosure. Pens used in successful releases of Mississippi Sandhill Cranes have been 0.5 to 2 ha (1-5 acres) in size.

Imprinting, Attachment, and Behavioral Development in Cranes

CONTRIBUTED BY ROBERT H. HORWICH

There have been few studies of crane imprinting or early development (Voss 1976; Layne 1981). Most imprinting research in the 1960's focused on the short-term effects of imprinting on social preferences. Domestic fowl (*Gallus domesticus*) and domestic ducks (*Anas platyrhynchos*) rapidly restrict their filial attachment and following response to their parent, human caretaker, or to other stimuli encountered shortly after hatching. This learning phenomenon has been called **filial imprinting** (Bateson 1978). Many studies (Hess 1973; Hess and Petrovich 1977) show that there is a "critical" period when precocial birds imprint on a parental model.

An accumulating body of evidence indicates that relatively **early experiences** have profound effects on sexual choice later in life (Immelmann 1972; Bateson 1978). This evidence indicates that exposure to social stimuli at certain age periods can reverse the preference of early filial imprinting (Gallagher 1976, 1977; Vidal 1976, 1980).

Filial Imprinting and Parental Care

Cranes exhibit imprinting patterns similar to domestic fowl. Imprinting probably begins in the egg about 2 days prior to hatching, when chicks begin answering the parents' brood calls. Chicks follow the adult on the first day and are often away from the nest by day 1 or 2 (Walkinshaw 1973b). Parental attachment is complete within the first 3 days and becomes stronger during the first 2 weeks.

Attachment is reinforced by a radical change in parental behavior at hatching. This includes increased brood calling, brooding, preening the chick, preening the adult's brood patch, and feeding the chick. This behavior encourages imprinting and the development of a following response by the chick during the first week, the initial sensitive period of development (Hartup and Horwich 1994).

Brooding of the chick occurred only during the first week in our study of Sandhill Cranes. Preening the chick, although rarely seen, was done by the female while brooding. Wild cranes may brood chicks that are up to six weeks old (G. W. Archibald, ICF, personal communication). The female invites the chick to brood by extending the wrist joint laterally while calling loudly and pointing her bill into or preening the opened cavity. The moving bill tip is very attractive to crane chicks, and probably induces the chick to accept brooding. Pecking the parent's bill, the chick's greeting, is a ritualized feeding behavior. It was elicited in puppet-reared chicks by extending the puppet's bill toward the chick (Fig. 6.19). A stereotyped bill presentation by White-naped Cranes also elicited the bill peck. A similar feeding posture occurs in wild Sandhill Cranes (Layne 1981).

Sexual Imprinting

Sexual imprinting is a form of learning which shares many characteristics with filial imprinting, but which also influences mate choice at sexual maturity. There are many instances of birds sexually imprinting on humans or other bird species (Immelmann 1972), but studies have shown that the process is reversible if cross-fostered or hand-reared birds are introduced to their own species during or before the end of the sensitive period.

FIG. 6.19. *Siberian Crane chick greeting puppet head.*
PHOTO DAVID H. ELLIS

Vidal (1976, 1980) neatly delineated two imprinting periods in chickens. He noted an early sensitive period for learning the following response and a second sexual imprinting period at 30-45 days. Cockerels exposed to a model at this later period became sexually imprinted on it despite their earlier training to follow a different model.

Proper sexual imprinting is critical in crane reintroduction programs. Although the rearing of Whooping Cranes by wild Sandhill Crane parents has produced a small wild population of Whooping Cranes in the Intermountain West, these cranes are not breeding (Ellis et al. 1992a). **Cross-fostering** is believed to have resulted in imprinting problems preventing the Whooping Cranes from breeding with their own species. The recent discovery of a Whooping-Sandhill Crane hybrid at Bosque del Apache National Wildlife Refuge (Pratt 1993) and unusual behavior by cross-fostered females (Mahan 1992; Swengel, personal observation) confirm this.

Imprinting Stimuli

Newly hatched precocial birds can be imprinted on a wide variety of objects in the absence of their natural parents, indicating that early parental recognition is largely acquired (Lorenz 1937, 1970; Ramsay 1951; Spalding in Jaynes 1956). However, there are some innate preferences (Hinde 1961; Gaioni et al. 1978). Initially, vocal cues seem more important than visual ones (Ramsay 1951; Gottlieb 1971), and there may be other innate preferences for certain colors and forms (Jaynes 1956; Schaefer and Hess 1959; Salzen and Meyer 1968).

As part of our reintroduction study (Horwich 1986, 1989; Horwich et al. 1992), we reared crane chicks with a stuffed crane model that emitted brooding calls, fed chicks using a crane-head puppet (Fig. 11D.2), and led them while costumed and using the same puppet emitting the same calls (Fig. 11D.1). Although the main goal of costume-rearing (see Chapter 11D) was to imprint crane chicks on a crane-like substitute, we also hoped that use of the costume would allow us to control the birds after release while leaving them still fearful of uncostumed humans. The costume, although not overly crane-like, broke up the human gestalt by de-emphasizing the head, face, and hands while emphasizing the crane head and voice. Although the chicks reared with the costume did not show affinity to humans, they did not exhibit much fear either. Before release, an uncostumed person could approach within 3 m of the mildly wary chicks, but after associating with wild cranes for 2 weeks, the chicks' flight distance in response to human approach had increased to 100 m (Horwich et al. 1992). Fear of humans can, of course, be taught (see Human Avoidance Conditioning in Chapters 5 and 11D).

At 4-8 weeks of age, our chicks were given choices of stimuli in an attempt to assess the early effects of filial imprinting (Horwich and Owen unpubl.). For all chicks, the most important stimulus was the moving puppet head. They responded quickly by pecking the bill. It was clearly chosen over a mounted body or a vocalizing speaker.

The moving bill tip directs chicks of all ages in feeding (Hartup and Horwich 1994). When feeding a chick, White-naped Cranes sometimes drop and pick up an insect as many as 15 times before the chick will accept it. This motion was very attractive to chicks, who eventually picked up insects on their own. The parental bill attracts the chick, and the chick greets the parent by purring and pecking the extended bill. Later, juveniles watch the parents' bills probing the ground, and probe the same area. Bill movement is also very attractive in other precocial birds (Tinbergen and Perdeck 1950; Hailman 1967; Johnson and Horn 1988).

We tested the chicks' responses to various parts of the crane puppet head during their first few weeks. None of the main puppet features (red patch, head, or eye) was consistently important to the chicks. Chicks exposed to a mounted body for only a short period tended to choose the puppet, while those exposed to the body for a longer period of time tended to choose the body. This observation follows the general rule that the longer the exposure, the stronger the preference (Bateson 1978). Sound is another very important stimulus for other precocial birds (Gottlieb 1971). Our results indicate that crane chicks are most responsive to brood calls during the first 3 weeks.

These experiments provided information for use in captive rearing. Although red is often used for feeding dishes or for rods dangling in the food bowl to induce feeding in young chicks (Kepler 1978), the red patch of the puppet head did not interest the chicks. The red patch is used in aggressive displays in Sandhill Cranes (Voss 1976). However, when combative Sandhill Crane chicks were separated by the puppet head, they redirected their attacks at the red patch of the puppet (Erickson et al. 1988).

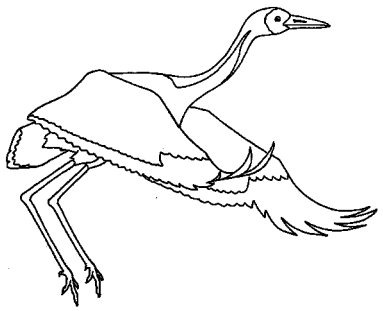
By dangling a puppet-like head in the food dish (Fig. 11D.2), we taught chicks to feed themselves (Horwich 1986; Erickson et al. 1988). By pecking repeatedly at the moving beak tip, they eventually pecked the food below it. This gradually changed to ritualized pecking of the beak tip before feeding until, finally, they pecked only the food. At Patuxent, a taxidermic mount of a crane head (suspended from the ceiling with its bill contacting the food and manipulated from outside the pen; Fig. 5.10) proved effective in teaching Whooping and Sandhill Crane chicks to eat (Ellis et al. 1992b).

Behavioral Cycles and Reattachment Periods

Quantitative studies of bird and mammal behavior have shown that parent-young attachment and many other activities follow a cyclic pattern, with two or more cycles occurring in young animals before fledging or weaning (Horwich 1974, 1987; Ellis 1979). This has been termed a **regression** or **reattachment period** (Horwich 1974). This concept is fundamental to understanding ontogeny and sociality in mammals (Horwich et al. 1982) and birds (Ellis 1979).

After the initial attachment period, there follows a period of gradual independence from the parent. After spending 60% of their time next to a surrogate parent during the first 2 weeks, Sandhill Crane chicks gradually entered a more independent foraging phase at 4-8 weeks of age. At fledging (11-14 weeks), they reattached to the costumed parent, stayed near it much of the time, and pecked its feathers. The intense sociality exhibited during this reattachment period induced the costume-reared chicks to rapidly join wild cranes following release (Horwich et al. 1992). This period seems equivalent to the sexual imprinting period (when the initial attachment can be reversed) in chickens, as identified by Vidal (1976) at 4-6 weeks when the adult plumage was largely complete.

Periodic regressions may be in synchrony with seasonal activities, as seen in mammals (Horwich et al. 1977; Horwich et al. 1982) and cranes (Horwich 1987; Horwich et al. 1992). The initial close bond of parent and chick during the first month protects the chick when it is most vulnerable and needs parental feeding. As the chick grows stronger and can feed itself, it begins a period of independent foraging, during which it follows its parents at a greater distance. The chicks regress by increasing contact with the parents at fledging time when they would otherwise be most likely to become lost if they fly far from their parents (Horwich 1987). This renewed bonding may also involve species and sexual identification. They exhibit a second reattachment period just before and during migration (Horwich 1987; Horwich et al. 1992). Many other bird species, both migratory and non-migratory, as well as mammals, show this same cyclic gregariousness (Nievergelt 1974; Guiness et al. 1979). Besides functioning to keep cranes on the correct migration route, this reattachment or gregariousness may allow orphaned chicks to learn the route from flock mates in the absence of their parents.



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