

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).

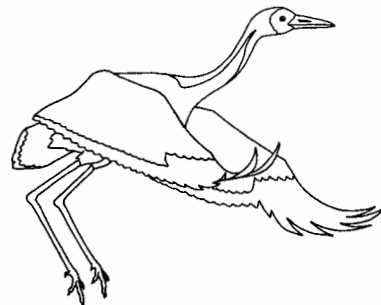
Behavioral Cycles and Reattachment Periods

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; Guinness 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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