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BREEDING BEHAVIOR OF ISOLATION-REARED SANDHILL CRANES

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Abstract.—During 1988–1990, 38 isolation-reared, color-marked, radio-tagged Greater Sandhill Cranes (*Grus canadensis tabida*) were released into the wild at the Seney National Wildlife Refuge (Seney NWR) to develop reintroduction techniques for Whooping Cranes (*Grus americana*). The objective of our study was to ascertain whether these puppet-reared cranes displayed normal behavior and to record details of nesting activity. During 1992 and 1993, 17 cranes (11 males, 6 females) were detected at Seney NWR or at more easterly sites in Michigan's Upper Peninsula. We were able to monitor six male cranes; the others had non-functional radio transmitters. In 1992, all six were paired with wild females, but none nested. In 1993 four pairs nested, all in palustrine habitat dominated by sedges (*Carex* spp.) and cattails (*Typha* spp.). Two nests had two eggs each and one nest had one egg. The fourth nest flooded and no eggs were present when it was checked. Two chicks hatched on 24 May, one on 14 June. None survived past 1 wk. Sex of incubating cranes was known for 360 h of observation made between 0600–2200 h, 25 Apr.–13 Jun. 1993. Males incubated for 239 h (66%) of the total samples, females for 121 h (33.4%). Males incubated mostly (77.7%) between 0900–1800 h, females mostly in early morning (0600–0900 h) and late afternoon (1900–2200 h). We conclude that, unlike cranes reared by the cross-fostering technique, isolation-reared male cranes exhibited normal reproductive behavior. The reproductive behavior of isolation-reared female cranes also must be evaluated.

COMPORTAMIENTO REPRODUCTIVO DE *GRUS CANADENSIS TABIDA* CRIADAS EN AISLAMIENTO

Sinopsis.—Entre 1988 y 1990 se liberaron 38 individuos de *Grus canadenis tabida* reproducidos aisladamente, marcados con colores y montados con radiotransmisores en el Refugio Nacional de Vida Silvestre de Seney (Seney NWR) para desarrollar técnicas de reintroducción que sirvan para *Grus americana*. El objetivo de nuestro estudio fué determinar si estas aves criadas con muñecos de manos manifestaban conductas normales y para registrar los detalles de la actividad de anidaje. Se detectaron 17 aves (11 machos y 6 hembras) en el Seney NWR o en lugares más orientales en la península superior de Michigan entre 1992 y 1993. Pudimos seguir seis machos; los otros tenían radiotransmisores que no funcionaban. En 1992 los seis se aparearon con hembras salvajes, pero ninguno anidó. En 1993 anidaron cuatro parejas, todas en habitat palustre dominado por *Carex* spp. y *Typha* spp. Dos nidos tuvieron dos huevos y otro tuvo uno. El cuarto nido se inundó y no había huevos presentes al examinarse. Dos pichones eclosionaron el 24 de mayo y uno en junio. Ninguno sobrevivió sobre una semana. El sexo de las aves incubando se desconoce en 360 horas de observaciones hechas entre 0600 h y 2200 h entre el25 de abril y el 13 de junio del 1993. Los machos incubaron por 239 h (66%) del total de muestras, las hembras 121 h (33.4%). Los machos incubaron mayormente (77.7%) entre 0900h y 1800h, las hembras principalmente

temprano en la maãna (0600–0900 h) y tarde en el día (1900–2200 h). Concluímos quye, a diferencia de aves criadas con la técnica de los padres adoptivos, machos criados en aislamiento exhibieron un comportamiento reproductivo normal. El comportamiento reproductivo de hembras criadas aisladamente debe también ser evaluado.

To develop methods for introducing captive-reared cranes into wild and migratory populations, biologists isolation [puppet]-reared Greater Sandhill Cranes to fledging, then placed them in open-topped pens for gentle release on Seney National Wildlife Refuge (Seney NWR) in the Upper Peninsula of Michigan. For 38 chicks released in 1988–90, minimum survival 1 yr later was 84%, and minimum return rate to the Upper Peninsula was 74% (Urbanek and Bookhout 1992a). During 1992–1993, 17 cranes were detected on Seney or at more easterly sites in the Upper Peninsula. Among the 17, eight carried functional transmitters, and six could be monitored. Sex determination was made by chromosomal analysis before the cranes were released (Urbanek and Bookhout 1992a) and confirmed by the unison call (Archibald 1976). All six cranes (all males) paired with wild cranes and established territories in 1992–1993. However, the final measure of the success of the isolation-rearing, gentle-release technique is whether these cranes exhibit normal breeding behavior, which includes nesting, incubating, and producing fledged chicks. In this paper, we discuss nest and nest site characteristics, nest attentiveness, and chick survival for four isolation-reared male cranes and their mates.

METHODS

In spring and summer of 1992–1993, six isolation-reared sandhill cranes with functional solar-powered radio transmitters were monitored hourly or daily to ascertain if they were breeding (other isolation-reared cranes were observed opportunistically). We used the triangulation method (White and Garrott 1990) to identify locations of a crane and a 15–60X spotting scope to observe color bands. Crane locations were marked on 1:24,000 U.S.G.S. topographic maps with Universal Transverse Mercator (UTM) coordinates, or recorded on 1:10,000–1:12,000 aerial photographs to identify breeding territories. Because most crane territories at Seney NWR were located in emergent wetland (palustrine) or in scrub-shrub (Cowardin et al. 1979) habitat surrounded by trees, identification of color bands was difficult except when birds were on their feeding grounds—open hayfields or mudflats. Therefore, we followed mainly one pair of cranes each sampling day. Each crane pair was observed every third or fourth day after it was first detected on nest; on the fourth or fifth day, the observation sequence was repeated. The sample duration was one hour, except on rainy days when we could not monitor the cranes. We recorded the time and duration of breeding behaviors, such as copulation, unison call, and incubation. When a crane sat on a nest, the transmitter was under the crane's body so that the solar batteries were discharged, and the radio signal was reduced both in frequency and strength. At the same time we used the scope to ascertain incubation and to attempt to locate the mate if it was color banded. The incubation time

budget of male cranes was computed according to both the radio signal and observation. If the radio-tagged male crane was observed feeding alone during the nesting period, the female crane was assumed to be on the nest. The time of day and sex of the bird were recorded. Characteristics of the reduced radio signal allowed detection of onset of incubation early in the incubation period.

Measurements of nests (length, width, and height above water) and habitat variables were made as soon as possible after nest outcome was known. Water depth was measured in cardinal directions 3 m from the center of the nest. The dominant (according to coverage) herbaceous vegetation within 56.5 m of the nest and the height, number of stems, and species of trees within 5 m of the nest center were recorded. We classified nesting habitat as cattail (*Typha* spp.) marsh, sedge marsh, or scrub-shrub if that type covered at least 50% of total area within the 56.5-m radius. If the nest was on the edge of a wetland and adjacent to a forested upland or hayfield, the nesting habitat was classified as wetland.

RESULTS

Copulation.—We observed only one copulation (crane pair 4). It took place at B pool marsh at Seney NWR, outside the home range, at 1920 h on 23 Apr. 1992.

Nesting characteristics.—Four isolation-reared Sandhill Cranes (mated to wild cranes) built four nests in 1993. All nests were located in palustrine habitat without tree canopies. Dominant vegetation around the nests was cattail ($n = 1$) and sedge ($n = 3$), and dominant shrubs were willow (*Salix* spp.), leatherleaf (*Chamaedaphne calyculata*), or alder (*Alnus rugosa*). Three nests had dead trees within 5 m of the nest center, the number ranging from one (crane pair 4) to seven (crane pair 2) trees. Tree diameter varied from 3.3–27.4 cm. Water depth around the nest varied from 10–22 cm (for detail information on habitat use see Duan et al., in press).

Width of the four nests averaged 92.8 ± 4(SE) cm × 88.0 ± 3.4 cm as measured at the top of the nests, and 109.8 ± 3.7 cm × 105.0 ± 5.1 cm at the bottom. Nest height averaged 21.9 ± 2.4 cm above water. Nests were constructed of nearby materials, three (cranes pairs 1, 2, and 4) of sedges, and one (pair 3) of cattails. Twigs were commonly a part of nest materials.

Incubation.—All isolation-reared males shared incubation with their mates. The earliest date of incubation observed (24 April) was of crane pair 1. The latest incubation record was of crane pair 3; they started incubation on 14 May and their chick hatched on 13 June. We observed cranes for 360 h between 0600–2200 h from 25 April to 13 June. Among the 360 h, 239 (67%) were of males on the nest and 121 (34%) were of females on the nest. Males incubated mostly between 0900–1700 h, females mostly in early morning or late afternoon (Fig. 1). For crane pairs 1 ($n = 69$; male = 50, female = 19) and 3 ($n = 96$; male = 58, female = 38), males incubated mostly from mid-morning to mid-afternoon. For crane pair 4 ($n = 77$; male = 52, female = 25), the male incubated mostly

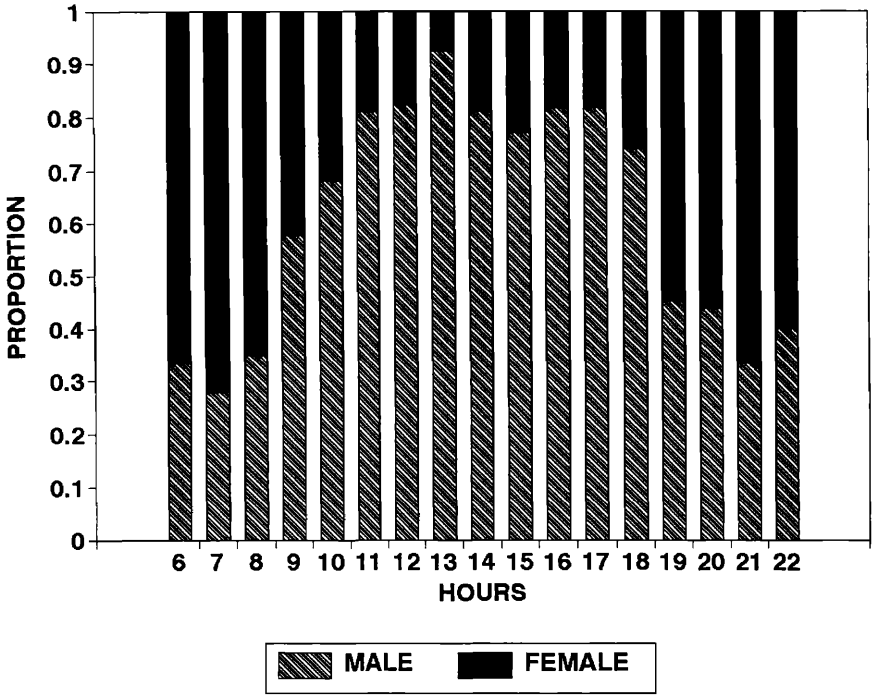

FIGURE 1. Estimated proportion of time spent on nest by isolation-reared male and wild female Sandhill Cranes between 0600–2200 h at Seney NWR, Michigan, 1993.

in morning and at mid-day. For crane pair 2 (n = 118; male = 79, female = 39), the male incubated mostly from noon to evening. We recorded 39 male and female incubation switches. Highest incidence of change occurred at 0900–1000 h (23% of switches observed) and 1800–1900 h (23%). Switches were observed as early as 0700 h (n = 1) and as late as 2000 h (n = 3). Samples were taken near evenly during 0800–1900 h with lowest sample size at 1900–2000 h (n = 20) and highest sample size 1600–1700 h (n = 27).

Chick hatching and survival.—Two nests had two eggs each, and one had one egg. One nest was flooded by rain and there was no egg when we checked the nest. We do not know the clutch size of that nest. Pair 1 abandoned their nest because of our visit to the nest early in incubation. Two chicks hatched in the nest of pair 2 on 24 May and one chick hatched in the nest of pair 3 on 14 June. The chicks of pair 2 disappeared on 30 May, 1 wk after hatching. We believe the loss of the two chicks was to predators. The chick of pair 3 drowned on 15 June after a storm. No chicks survived in 1993.

Distraction.—Three of the four males remained on the nest at our first visit, and all three showed distraction behavior when we approached

closely (about 20 m). We did not check the fourth nest until it was flooded by a heavy rain, so the distraction behavior of that crane was not observed.

DISCUSSION

Breeding.—The male of pair 4 was less than 2-yr-old when he was observed copulating in 1992. Although he did not nest that year, he nested in 1993 and was paired with the same female both years. Two years was the earliest age at which a wild, male Sandhill Crane was observed to attempt breeding in Florida (Nesbitt 1992). Ages of the four nesting cranes we observed were 3–5 yr; the earliest reproductive success for Greater Sandhill Cranes nesting in the Great Lakes region was 3 yr, and mean age at first reproductive success was 4.3 yr (Nesbitt 1992), so the isolation-reared cranes were not unlike wild Great Lakes region Sandhill Cranes in this regard.

Nesting.—Four of the five cranes monitored in 1993 nested, all in palustrine habitat dominated by cattail and sedges without tree canopies. The four males had been released in the eastern portion of Seney NWR, which is dominated by cattail or sedge marshes, the habitats most wild cranes at Seney NWR select for nesting (Urbanek and Bookhout 1992b). Male cranes have the tendency to select their breeding territory close to their natal area. Nest dimensions were in the range of measurements collected from Michigan's wild Sandhill Cranes nesting in cattail and sedge marshes: 113.2 × 98.2 cm (Walkinshaw 1965a) and 82.1 × 66.8 cm (Urbanek and Bookhout 1992b).

Incubation.—The four males we observed were on the nest about two-thirds of the total incubation period under observation. Females did not carry radio transmitters, so we do not know how many hours they were on the nest. But clearly it was impossible for both male and female to leave the nest for a long time, because it was still very cold in early morning and late evening in April and May at Seney NWR. For the released cranes, males incubated 66% of daylight hours. Male isolation-reared cranes incubated mostly (78.2%) from 1000–1800 h, and about 73% of total female incubation samples were recorded in early morning (0600–1000 h) and evening (1800–2200 h) (Fig. 1). We did not know if the male cranes incubated at night, because the transmitters were non-functional after the solar battery became discharged after sunset. Several times we saw crane pairs 1 and 3 standing near their nests when females were on the nests after sunset but before it was very dark. This suggested females incubated at night. We made five observations between 2100 and 2200 h on crane pair 2, and on all five occasions the male was on the nest; two times the male was on the nest the next morning. This suggested that the male may have incubated at night.

Other studies showed that wild male cranes shared incubation with females; the males incubated mostly from mid-morning to mid-afternoon, and females incubated in early morning and evening (Littlefield and Ryder 1968, Nesbitt 1988, Walkinshaw 1965b). Nesbitt (1988) reported that male Florida Sandhill Cranes incubated 52% of the time during daytime.

We recorded 39 male and female incubation switches, the peak of changes occurring at 0900–1000 h and 1800–1900 h. Crane pairs 1, 2, and 3 made only two changes each day. Crane pair 4 usually made three changes each day. Littlefield and Ryder (1968) reported that male Greater Sandhill Cranes in Oregon incubated more frequently (54.4%–69.5% of total) during daylight periods in June. They observed two nests in which male and female incubation switching occurred, and in both instances only two nest changes occurred—in the morning at 0920 and 1010 h, and in the afternoon at 1747 h and 1904 h.

The earliest incubation we observed was on 25 April for crane pair 1. The latest incubation was recorded for crane pair 3; their chick hatched on 13 June. The duration of incubation stage for the four pairs of cranes therefore was about 7 wk. The peak hatch of wild cranes occurred 21–22 May in 1986 and 23–24 May in 1987 at Seney NWR; earliest hatching date was 11 May 1986 and latest hatching date was 7 Jun. 1987 (McMillen 1988). Before McMillen's study, Walkinshaw (1981) reported the Upper Peninsula hatching date was 22–23 May, ranging between 16–17 May and 27–28 May. The peak of initiation of incubation therefore was 22–24 April, and the incubation interval of wild Seney cranes was mid-April to first week of June in 1986–87. Isolation-reared crane pairs 1, 2, and 4 incubated at peak season, but crane pair 3 nested at late season.

The distraction behavior (for details see Johnsgard 1983:12–16) occurred during defense of the nest or chicks by adult cranes. Three of the isolation-reared male Sandhill Cranes (1, 2, and 3) exhibited the behavior when we first visited their nests, demonstrating that these cranes, like wild male cranes, exhibited appropriate defensive behavior.

Crane pair 1 abandoned their nest because of our intrusion early in incubation. Boise (1976) mentioned that disturbing cranes during nesting and early incubation causes a high rate of nest desertion by adults. Nesting by crane pair 1 was considered to be their first attempt, so we were not surprised that they deserted. No chicks survived in 1993. All four pairs were first-time nesters, and lack of experience likely caused the poor survival rate.

The isolation-rearing technique used at Seney NWR produced male Sandhill Cranes that migrated successfully along traditional migration corridors used by wild Seney Sandhill Cranes, that returned to their natal site, and that paired and mated successfully with wild female Sandhill Cranes. In contrast, the cross-fostering technique is inappropriate for use in establishing breeding populations of whooping cranes (Drewien et al. 1989). Cranes hand-reared in isolation from humans (isolation-rearing) and captive parent-reared sandhill cranes survive well after release (Archibald and Archibald 1992, Ellis et al. 1992, Urbanek and Bookhout 1992a, Zwank and Wilson 1987). However, in studies involving nonmibratory Mississippi Sandhill Cranes (*G. canadensis pulla*), the survival rate of isolation-reared birds released into the existing wild population was higher than that of captive, parent-reared cranes released similarly (Ellis et al. 1992). Our findings demonstrate that the isolation-gentle re-

lease technique was successful for migratory Sandhill Cranes. If migratory populations of Whooping Cranes, or any other species of migratory crane, are to be established, the techniques used at Seney NWR should be applicable.

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