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EASTERN GREATER SANDHILL CRANE SYMPOSIUM

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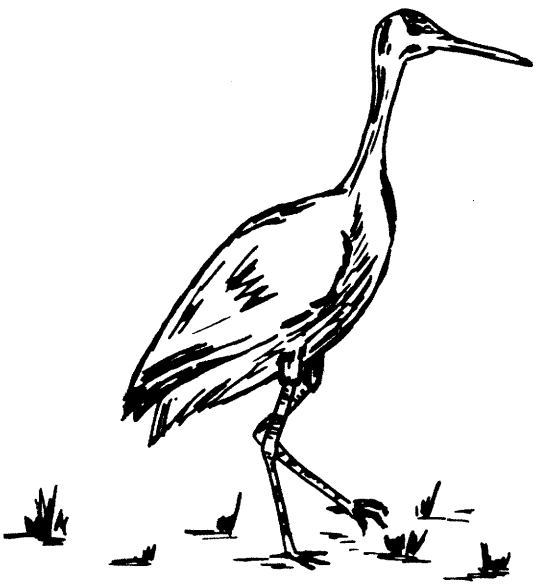


HOWARD JOHNSON'S MOTOR LODGE
MICHIGAN CITY, INDIANA

October 24-26, 1977

EASTERN GREATER SANDHILL CRANE SURVEYS AND PUBLIC INVOLVEMENT FOR WETLAND CONSERVATION

Elizabeth Blomquist, Connie Richard, Steve Schmidt, Juneau, Wisconsin 53039

Abstract: During a one year period from June 1976 to June 1977, a two part survey involving volunteer observers and wetland owners was conducted in Columbia County, Wisconsin.

The survey for sandhill cranes was conducted by 218 volunteer observers over a period from March 19 to April 15, 1977. Observers located themselves on Township Section corners in and around pre-located wetlands of Types III, IV, V, VI and VII. Observers recorded the number of cranes heard and/or seen during each observation.

The second part of the survey consisted of a questionnaire sent to 25% of the county's wetland owners.

Survey volunteers accumulated 534 man-hours locating 312 sandhill cranes at 166 observation sites in Columbia County. More than 99% of the observations were made in Type III, VI and VII wetlands.

Of the 224 people contacted with the wetland owner questionnaire, 70% responded after two mailings. In general, 56% of the wetlands were drained, with significant acreages currently going into agricultural production. Only 2% indicated participation in the Soil Conservation Service Waterbank program. Concerning public wetland ownership, 54% thought it acceptable. Eighteen percent indicated sandhill crane nesting activity in their wetlands.

Judging by the enthusiasm created for and by this study, it is possible to see this concept being used to create a county or statewide wetlands monitoring and conservation network not only to the benefit of the sandhill, but to all game and non-game wildlife.

Paper not available for printing.

AGONISTIC BEHAVIOR OF THE GREATER SANDHILL CRANE

Karen S. Voss, 2331 17th Avenue NW, Rochester, MN 55901

Abstract: The greater sandhill crane (Grus canadensis tabida) has evolved a number of displays whose function seems to be to avoid physical conflict, while determining dominance in social encounters. These displays are performed in a very stereotyped manner, and can be easily recognized in the field. Many are primarily visual displays, while a few contain both visual and vocal components. These displays are described, as well as the behavior of submissive cranes in agonistic encounters.

The kinds of threat displays performed by cranes in flocks differs from those of cranes on nesting territories. The more elaborate visual displays are performed primarily in flocks, where there is little visual isolation, and high crane densities often result in intense agonistic encounters. Fewer displays are performed on nesting territories, and vocalizations are a more important part of displays, since distance and vegetation provide visual isolation.

INTRODUCTION

The Greater Sandhill Crane (Grus canadensis tabida) has evolved a number of displays whose function seems to be to avoid physical conflict while determining dominance in social encounters. These displays are performed in a very sterotyped manner, and can be easily recognized in the field. They may be performed individually, or in certain sequences. Most are primarily visual displays, but some contain both visual and vocal components. Some are clearly evolved from certain foraging or preening activities, and are performed in a very ritualized manner, with no actual preening or foraging taking place. The evolutionary origins of other displays, also very sterotyped in their execution, are not obvious.

The threat displays of the Greater Sandhill Crane are described in this paper, as well as ambivalent behavior, actual attack, and the behavior of submissive cranes in agonistic encounters. The agonistic behavior of cranes in flocks differs from that of cranes on nesting territories and these differences are discussed.

ACKNOWLEDGEMENTS

The Chapman Memorial Fund, the Sigma Xi Society and the Davis Fund of the Department of Zoology at the University of Wisconsin provided essential funding, without which this study would never have been completed.

Department of Natural Resources personnel at Sandhill Wildlife Demonstration Area and Necedah National Wildlife Refuge, especially J. Updyke, helped me locate wild cranes and allowed me to observe them within the refuges.

Dr. E. Beals, my major professor, provided help and advice throughout my graduate school career.

Finally, I owe a tremendous debt of gratitude to Dr. George Archibald, Director of the International Crane Foundation. He introduced me to the cranes in 1972, and has been a continual source of help, encouragement and information ever since. Through him, the facilities of the International Crane Foundation have been available to me for the conduction of all my observations on captive cranes.

METHODS

Subjects

I observed both captive and wild sandhill cranes to obtain most of the detailed descriptions of the behavioral patterns described. I made observations primarily on two G. c. tabida chicks in 1973 and one chick in 1974 at the International Crane Foundation, Baraboo, Wisconsin.

During the spring and summer of 1974, I observed two pairs of nesting cranes from a blind built approximately 2.5 m above ground level on the edge of a marsh in the French Creek Wildlife Area, near Portage, Wisconsin (Fig. 1). Pair A nested approximately 300 m from my blind and could be closely observed. It was possible to distinguish the male from the female of this pair by individual differences in feather coloration on the head. This pair did not hatch any eggs. Pair B nested approximately 400 m from my blind, and could not be so easily observed because of taller surrounding vegetation. They hatched one chick which apparently died several days later. A third pair, pair C, whose nest was not visible from my blind, was observed frequently with a single chick. The territories of pairs A and B (Fig. 1) were determined by marking approximate locations and movements of the cranes on a map during each observation period.

During the fall of 1974, families were observed in fall flocks at Sandhill Wildlife Demonstration Area (WDA), and Necedah National Wildlife Refuge (NWR). Observations were made from a blind approximately 20 m from a corn baited area at Necedah NWR, as well as from public observation towers at both areas.

Apparatus and Procedure

Observations of wild cranes were made with 8 x 40 binoculars, and a 15x to 40x spotting scope, and I occasionally used binoculars to observe captive cranes. I recorded as many behaviors as possible on Super-8 movie film using a Vivitar 100 PM movie camera. Most of the figures were drawn from these films. I also made written descriptions of most behavior repeatedly in field notebooks. I recorded a number of vocalizations, using a Uher 4000 Report-L tape recorder at 7.5 inches per second, and sonographed them with a 6061-13 Sound Spectrograph, Kay Elemetrics Corp., at 7.5 i.p.s. using the wide bandwidth (300 Hz.).

THREAT DISPLAYS

Red Crown Expansion (Fig. 2a, b)

Adult sandhill cranes have red papillose skin, covered with short black bristles, extending from the culmen back over the forehead and crown. The bare red skin can be pulled back to cover the entire crown area almost to the base of the skull. At the same time, the tissue beneath the bare skin becomes engorged, and swells above the surrounding head area. This effect may be enhanced by sleeking of the surrounding feathers of the head and neck (Fig. 2b). Expansion of the red area occurs under many stressful situations. It is a part of all threat displays, but also accompanies other behaviors that contain agressive components, such as dancing, unison calling, and copulation. It is markedly absent in a submissive bird when in the presence of a clearly dominant conspecific.

Prior to the post-juvenal molt, the crown of young sandhills is covered with tawny feathers. These feathers are lost during and after the post-juvenal molt, and the skin on the crown gradually becomes pinkish, then red. The age of development of adult red head coloration varies widely in both captive and wild cranes (Lewis 1974:176). However, the expansion of the crown area was observed in 16-week-old chicks before any development of red head coloration.

Adornment Display (Fig. 3a, b)

The adornment display varies depending upon the aggressiveness elicited by the stimulus. When giving a low intensity adornment display the crane stands with its body horizontal or slightly above horizontal, and its neck either vertical or curved forward then upward. The beak is horizontal, or pointing slightly downward, and the red crown is expanded. The tertial feathers, which are long enough to completely cover the tail, are raised so that they form a vertical fan. Under a high intensity stimulus (Fig. 3b) the crane will bend forward so that its body is tilted downward at an angle of up to 30 degrees, its neck is curved downward then forward, and its beak is pointed straight downward. The red crown is expanded, and both the tertials and the posterior portion of the folded wings are raised. This display may last several seconds to several minutes, and is often given first in a sequence of displays.

Adornment Walk

The adornment display may be incorporated into a very ritualized walking display. The body is held in the same posture as in either the high or low intensity adornment display. The bird then walks at a rate of about one step per sec., either walking toward the crane being displayed to, or semi-circling around it. When semi-circling, the expanded red crown is tilted toward the other crane, so that a maximum amount of red is visible to it.

Low Bowing Display (Fig. 4 a-c)

This display is often given just after landing (Fig. 4a), (especially when landing in or near a flock of cranes), when chasing another crane, and almost always following copulation. It may be given while running, walking, or standing still. If running, the wings are often flapped vigorously, apparently to help in gaining speed; alternatively, the wings may remain folded. In any case, the body is between 5 and 20 degrees above horizontal, the neck and head pointed straight downwards, and the feathers at the base of the neck and upper back are conspicuously raised (Fig. 4b). The red crown is expanded. Whether walking, running or standing, this position may be held 5 to 10 seconds, then the crane abruptly stands upright (Fig. 4c). Frequently, a few jabs at vegetation (ritualized foraging) will precede standing upright. This display was first observed in captive chicks at 11 weeks of age.

Foraging Display

The crane stands, with its body angled 10 to 20 degrees below horizontal, and its head lowered so that the tip of the bill is near the ground. The red crown is expanded, and the tertials may be raised. The crane may pick up and drop bits of vegetation, yank or jab vigorously at the vegetation with its bill,

or simply stand, bill down, without actually touching the vegetation. The display may last several seconds to several minutes, the longer bouts involving vigorous jabbing and yanking at the vegetation.

Body-wing Shaking Display (Fig. 5a, b)

The crane stands upright with its body horizontal and its neck vertical, the red crown expanded (Fig. 5a). The display begins with erection of the feathers on the neck, back breast, abdomen and wing surfaces. The crane raises a loosely folded wing slightly off the body at the shoulder, then lowers it to slightly below the normal folded position. Opposite wings are flapped alternately. At first, each wing flaps about once per second, but the rate quickly increases so that after 3 to 4 seconds, it is not possible to count individual wing flaps, and the total impression is of the bird shaking or "ruffling" rapidly from side to side. During this display, the neck may be outstretched forward, or retracted with beak pointing downward (Fig. 5b). After 0.5 to 10 seconds, the crane stops body-wing shaking, lowers the feathers of the body, and returns to an upright standing position with its body horizontal and neck vertical, the red crown still expanded.

Preening Display (Fig. 5 c-f)

The body-wing shaking display is also incorporated into a number of display sequences. After body-wing shaking, the crane may go directly into ritualized leg, breast, or abdomen preening, or foraging. When preening is incorporated into the display, as shaking beings, the neck is retracted so that the head is just above the back (Fig. 5b), then swung in one continuous movement forward and downward and under the breast, so that the tip of the beak touches the feathers of the upper leg or the abdomen in ritualized preening (Fig. 5c, d). As the beak touches the feathers, shaking stops, and the crane lowers the erected feathers of the body. The crane may immediately raise its head and neck to a vertical position (Fig. 5e, f), or the ritualized preening may transpose to real preening, when the crane actually nibbles and pulls at its feathers. After several seconds, the crane may lift its head and stand upright, or preening may continue on other parts of the body such as back, wings, or neck.

In the body-wing, shaking-foraging display, as shaking beings, the crane lowers its outstretched neck forward and downward, pendulum like, until the tip of its beak touches, or nearly touches, the ground just in front of its feet. This position may be held for up to five seconds, then the feathers of the body are lowered and the crane very quickly raises his head and neck. Occasionally, this display transposes to actual foraging, in which case the crane may not raise its head at the end of this display.

Crouch Display (Fig. 6 a-c)

This behavior was first observed in captivity in 11 week old chicks. It occurs in the presence of conspecifics and was never observed in the presence of possible predators such as dogs or hawks.

The crane stands, body horizontal, neck retracted and curved downward, beak pointing downward, red crown expanded (Fig. 6a). He then bends his tarsal joints, lowers himself to hock posture (Fig. 6b), then immediately to

sitting posture (Fig. 6c). The base of the neck touches the ground, but the rest of the neck is more or less vertical, with beak pointing downwards. The wings remain loosely folded, and may be held slightly away from the body at the wrists. The tertial feathers are raised. The crane may hold this position 0.5 to 30 seconds, and then stand up. Threat displays may then cease, or the crouch may be followed by continued red crown expansion, and other threat displays, such as adornment or body-wing shaking.

A crouch display was observed once given by a wild bird. Two pairs approached each other, all giving adornment displays, then one crane ran at the other pair while low bowing. They retreated immediately in neck retracted submissive posture and the charging crane performed a partial crouch threat (his tibiotarsal joints did not actually touch the ground before he stood upright). In this instance, the crouch display was directed towards two clearly submissive cranes. Archibald (pers. comm.) believes this display is derived from incubation posture.

Spread Wing Display (Fig. 7)

This display was first observed in captive six week old chicks, and seen most frequently in chicks less than six months old. It was seldom seen in adults, although Harvey et al. (1968) described this display directed by an adult crane towards a Blue Goose. The crane stands with its body above horizontal, its neck vertical or slightly forward, beak pointing downward. The feathers of the head, neck and body are sleeked and the crown area is expanded, even in chicks which have not yet developed red crowns. The wings are held horizontally outward from the body, either fully extended or drooping at the wrists. The crane may either stand or walk about, facing the stressful object. Spread wing posture may be maintained for several seconds to several minutes, and was elicited in captive cranes by clearly dominant conspecifics, dogs, and a captive red-tailed hawk. I did not observe this display in wild cranes.

Unison Call (Fig. 8)

The unison call is an elaborate visual and vocal display given by crane pairs. Unison calls are given at all times of the year and under many different circumstances. On territories, they are given most frequently just prior to nesting, in association with other territorial defense activities. Walkinshaw (1965) reports that in areas where nesting densities are high, pairs unison call much more frequently than isolated pairs. Often nesting pairs will unison call repeatedly from shortly before until shortly after sunrise and again at about sundown. In addition to being a threat display, the unison call is essential to pair bond formation and maintenance and in synchronization of the male and female reproductive cycles.

The male and female may stand within 1 m of each other, or be 100 or more m apart, both with red crowns expanded. The body is slightly above horizontal, the neck is vertical and wings are folded. Both cranes often raise the tertials, the male to a greater degree. According to Archibald (1975, p. 40-42), the female usually begins by emitting a short, high, unbroken introductory call, followed by the male's long, lower, broken introductory call (Fig. 8). Then both begin a regular series of calls in synchrony. For each of the male's

longer, lower calls, the female emits two higher, shorter calls, beginning an instant after the male's longer call has begun. The female's beak is horizontal between calls and is repeatedly raised to about 45 degrees above horizontal with each of her short calls. The male's beak is nearly vertical while calling and may either remain vertical between calls (in intense agonistic encounters), or be lowered to about 45 degrees above horizontal between calls.

Guard Call (Fig. 9a, b)

This call is similar in structure and function to the unison call (Archibald, 1975). It is an ascending then decending call (Fig. 9b), similar to a single component call of the unison call, but differs in that it is given singly, independent of preceding and following calls. It may be given by either male or female and may be given in a series so that it sounds very much like a unison call. It may often precede or follow the unison call in agonistic encounters, thus overlapping it in function. While the unison call is often given when a crane pair is strongly defending its territory or in high intensity agonistic encounters in flocks, the guard call is more likely to be given when there seems to be a greater element of fear or a greater tendency to flee. In captivity it was seldom given in response to conspecifics, but often given at the approach of dogs, strange humans, or a hawk or crow flying overhead. Cranes often walk or stand in alert posture (Fig. 11) when guard calling. Captive chicks developed this call at nine to ten weeks of age. It is similar in temporal pattern, but higher in frequency than the adult call (Fig. 9a).

ATTACK

Occasionally one crane will attack another with or without preliminary threat displays. Attacks were observed several times in captive cranes. Wild cranes in fall flocks were observed fighting twice, both times in an area where there was a high density of cranes. I never observed actual fighting on nesting territories, although Littlefield and Ryder (1968) report observing bodily contact on several occasions.

Chasing and Kicking (Fig. 10 a-e)

Attacks include chasing (Fig. 10a), where the attacker runs toward the attacked crane, neck outstretched at about 50 degrees above horizontal. Chasing is often followed by kicking (Fig. 10 b-e). As the crane approaches the attacked crane, it flaps its wings and jumps 1 to 2 m into the air so that its body is vertical and legs thrust forward (Fig. 10b), then downward at the other crane (Fig. 10c, d). One or both cranes may jump and kick like this until one or the other retreats.

Upright Pecking

Two cranes may stand facing each other approximately 1 m apart, each with its body and neck angled up at 40 to 50 degrees above horizontal. The wings may be partially or fully opened. The crane may then peck at the other's head, neck, or back. Upright pecking is also often followed by kicking. This posture is very similar to the spread wing display (Fig. 7), but occurs only when two cranes are in very close proximity, and is usually a part of actual fighting.

AMBIVALENT BEHAVIOR

Alert Posture (Fig. 11)

The crane stands or walks, neck extended vertically upward, and its movements appear tense rather than relaxed. The feathers of the body are held much closer to the body than they are normally, so that the neck appears thinner than normal, and the wrists stand out prominently rather than contributing to the normal smooth contours of the crane's body. Alert posture was observed ten times in captive cranes and eight times could be directly attributed to the approach of dogs or strange humans, or the flight of a hawk or crows overhead. Two times the immediate cause of this behavior was not known, although cranes in adjacent pens also gave guard and alarm calls and appeared tense. Twice alert posture was followed by preflight posture, then flight. Masatomi and Kitagawa (1975, p. 863) believe this behavior results from two opposing urges: to stay and to flee. Guard calls very frequently accompanied this behavior in captive and wild cranes.

SUBMISSIVE BEHAVIOR

This section includes the behavior of the submissive crane in agonistic encounters. The red crown is always contracted.

Neck Retracted Submissive Posture (Fig. 12a, b)

The crane stands with body horizontal and neck retracted so that its head is near the base of the neck. The bill is more or less horizontal, or pointing slightly downward and the red crown is contracted. The wings are loosely folded and the body feathers are slightly elevated so that the crane appears slightly fluffy (Fig. 12a). Chicks may raise their back and tertial feathers much higher than adults and hence appear much fluffier. When walking in neck retracted submissive posture, the crane is very relaxed and loose jointed with no sign of stiffness in its gait.

This posture was first observed in chicks at about six weeks of age. Chicks often assume this posture when near their parents, particularly when food begging. This position is almost always assumed by the submissive bird, whether immature or adult, in any threat encounter. When families interact chicks of both families, whether dominant or submissive, usually remain in neck retracted submissive posture. In feeding flocks, where some individuals are constantly displaying, other individuals are almost constantly in neck retracted submissive posture while foraging.

Fleeing

A submissive crane may flee from an aggressive crane. The crane runs with the body 0 to 30 degrees above horizontal. The neck is usually retracted into an "s"-shaped curve, but may be extended forward at about 45 degrees above horizontal. The wings may be closed or flapped to provide added speed. A crane may flee for 1 to 10 m or more. Fleeing may be followed by flight or by neck retracted submissive posture if the pursuing crane ceases chasing.

Wing Spreading Posture

Chicks in captivity began assuming the female copulatory wing spreading posture at about six weeks of age. This posture was assumed only when a chick was approached by a human with which he was very familiar or a clearly dominant sibling. The context under which this posture was assumed seems to indicate that it may have been used as a submissive posture by the chick. This posture was not observed in wild chicks.

THE OCCURENCE OF THREAT DISPLAYS

Agonistic Encounters on Nesting Territories

The display given by crane pairs on their territories differ noticeably from those given by cranes in spring and fall flocks. Crane density is much less on territories and visual isolation is much greater. Many of the more elaborate visual displays, such as low bowing, body-wing shaking, foraging and preening display sequences, and crouching were never seen. Although all displays were infrequent, vocalizations were much more likely to be a major component of agonistic encounters.

During approximately 70 hours of observation at the French Creek Wildlife Area (Fig. 1), pairs A and B vocalized 45 times (Table I). Two major events stimulating vocalization were incubation exchange and the visual or auditory presence of other cranes near a pair's territory. Thirty-five of the vocalizations could be associated with one or both of these two events. Of these 35 vocalizations, 31 could be partly or wholly associated with the presence of other cranes. Cranes flying over a pair's territory, cranes calling in the distance, or members of two pairs (A and B, or A and C) near the common border of their territories all stimulated vocalizations. If the female was incubating when another crane approached the territory, the male often responded by flying or walking toward the intruder and giving the male half of the unison call. Twice the female simultaneously gave the female half of the unison call from the nest. Nine times the male was incubating when another crane approached pair A's territory. Every time, the female, red crown expanded, walked silently to the nest, and the pair unisoned at the nest. Six times the female replaced the male at the nest and the male walked or flew in the direction of the intruder. Three times the male continued incubating and the female left the nest after several minutes. Only once did the female vocalize by herself. This was at dawn when many other cranes were calling simultaneously. I was unable to associate ten vocalizations with the occurance of any other specific events, but it is quite possible that at least some of these vocalizations were caused by the presence of other cranes that I did not see or hear.

Interactions of pairs near their boundaries were rare during nesting, and often so subtle that it was difficult to tell whether an interaction or display was occuring or whether it was simply chance that brought a bird near its territorial boundary. During nesting, females were never observed displaying near territorial boundaries. The male of pair A was observed displaying near a territorial boundary six times. Five times the interactions occurred between male A and male B, once between male A and one of pair C. The most intense interaction observed occurred when pair A had been incubating less than six days. Initially, female A, who had been foraging, stood with her neck vertical

and red crown expanded, facing the male of pair B about 700 m away. She stood motionless for 3 minutes, red crown expanded, then walked directly to the nest. Both male and female carried on intermittent nest mending activity for about 20 minutes, then male A flew near and landed about 200 m from male B and began foraging. Male B immediately began walking stiffly and rapidly (1.5 steps per second) toward male A, red crown highly expanded. For about 40 minutes both birds intermittently foraged and walked obliquely towards each other, and approximately parallel to their common boundary, red crowns constantly expanded. Each gave the male half of the unison call once during this time. The distance between the two birds was never less than 100 m. After approximately 40 minutes they gradually foraged farther and farther apart until they had returned to more central regions of their territories. All boundary displays were characterized by a male flying or walking, either directly or indirectly, to an area near his territorial boundary. He would alternately walk, stand and forage, red crown expanded, near the boundary for 10 to 40 minutes, then walk or fly to a more central region of his territory. Each time he gave the male half of the unison call once. Sometimes both males give similar displays and sometimes the other male does not appear to respond to the displaying male, although he is always clearly visible to the displaying male. When approach and retreat from the territorial boundary are made indirectly by walking and foraging, the whole display may be very subtle.

Agonistic Encounters in Spring and Fall Flocks

Threat displays were seen very frequently in spring and fall flocks because of higher densities and greater numbers of cranes. Unlike the subtle territorial border displays described previously, more complex, stereotyped visual displays or display sequences are most common in flocks. This is especially true when flock composition is changing, with cranes taking off and landing frequently, and when cranes are drawn together by a concentrated food source such as corn-baiting area. Displays were given under many other circumstances: when landing in or near a flock and when walking, standing, or foraging, either near the center or on the periphery of the flock. Threat encounters could involve two individuals, two families or pairs, or a family and an individual. When cranes in flocks gave displays, it was usually easy to determine what crane was the object of the display by its proximity to the displaying crane and its response to the displaying crane. Threat displays almost always involved either two clearly aggressive cranes (or pairs), both displaying, or one threat displaying crane (or pair) and one or more clearly submissive birds. When both cranes (or pairs) initiate threat displays, one usually assumes a submissive posture in less than a minute. If both continue displaying, an actual fight may occur. Occasionally, both cranes cease displaying within a few seconds, without an apparent clear resolution to the conflict. Often in a flock, certain individuals seem to perform threat displays very frequently while other individuals are almost constantly in a submissive posture.

It seems very probable that these complex visual displays evolved to thwart physical conflict in flock situations. Here the potential for physical conflict and the need for a means to avoid it are great. On nesting territories, the distance between pairs and the visual isolation provided by tall vegetation, make vocal displays such as the unison call most effective.

REFERENCES CITED

Archibald, G.W. 1975. The Evolutionary and Taxonomic Relationships Cranes as Revealed by Their Unison Calls. Ph.D. Thesis. Cornell Univ., Ithaca, N.Y.

Harvey, J.M., B.C. Lieff, C.D. MacInnes, and L.P. Prevett 1968. Observations on Behavior of Sandhill Cranes. Wilson Bull. 80:421-425.

Lewis, J.C. 1974. Ecology of the Sandhill Crane in the Southeastern Central Flyway. Ph.D. Thesis. Oklahoma State Univ. 213 pp.

Littlefield, C.D. and R.A. Ryder 1968. Breeding Biology or the Greater Sandhill Crane on Malheur National Wildlife Refuge, Oregon. Trans. 33rd N. Am. Wildl. and Nat. Res. Conf.: 444-454.

Masatomi, H. and T. Kitagawa 1975. Biology and Sociology of Tancho or the Japanese Crane, Grus japonensis, II. Ethogram. Journal of the Faculty of Science, Hokkaido University, Series VI, Zoology 19: 834-878.

Voss, K.S. 1974. Observations on the Adoption of a Sandhill Crane Chick by a Pair of Manchurian Cranes. Avi. Mag. 80: 14-16.

Voss, K.S. 1976. Behavior of the Greater Sandhill Crane. M.S. Thesis, Univ. of Wisconsin-Madison.

Walkinshaw, L.H. 1965. One Hundred Thirty-three Michigan Sandhill Crane Nests. Jack-Pine Warbler 43: 136-143.

Table 1. Circumstances of Vocalizations in Nesting Crane Pairs

	Male-Female Unison	Male-Female Guard	Male Male 1/2 Unison	Male Guard	Female Guard	Total
Other Cranes	5	1	18		1	25
Nest Exchange	4					4
Other Cranes and Nest Exchange	6					6
Unknown	6		2	2		10

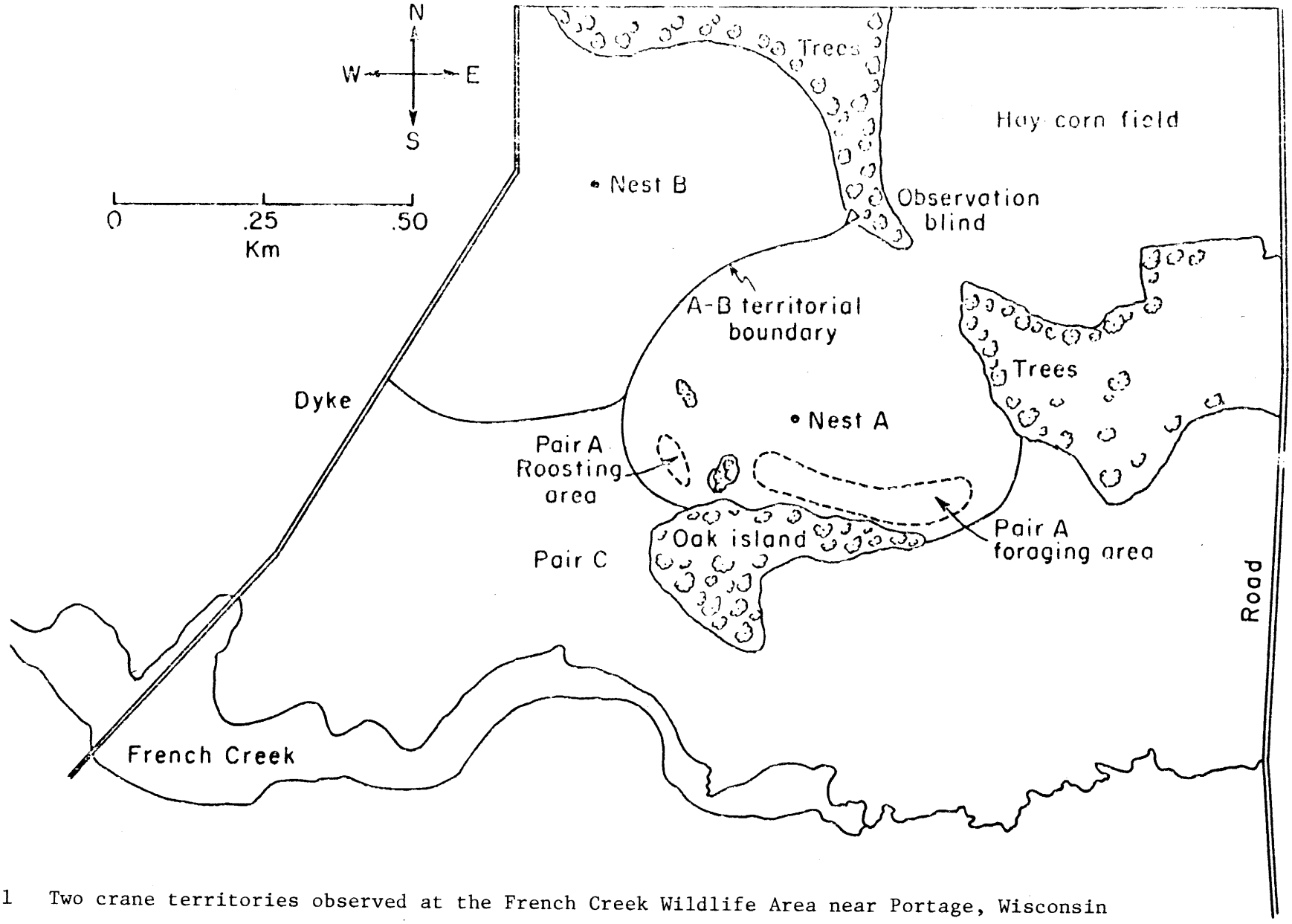


Fig. 1 Two crane territories observed at the French Creek Wildlife Area near Portage, Wisconsin

Fig. 2 Red crown expansion: a) Crown not engorged
b) Crown greatly engorged

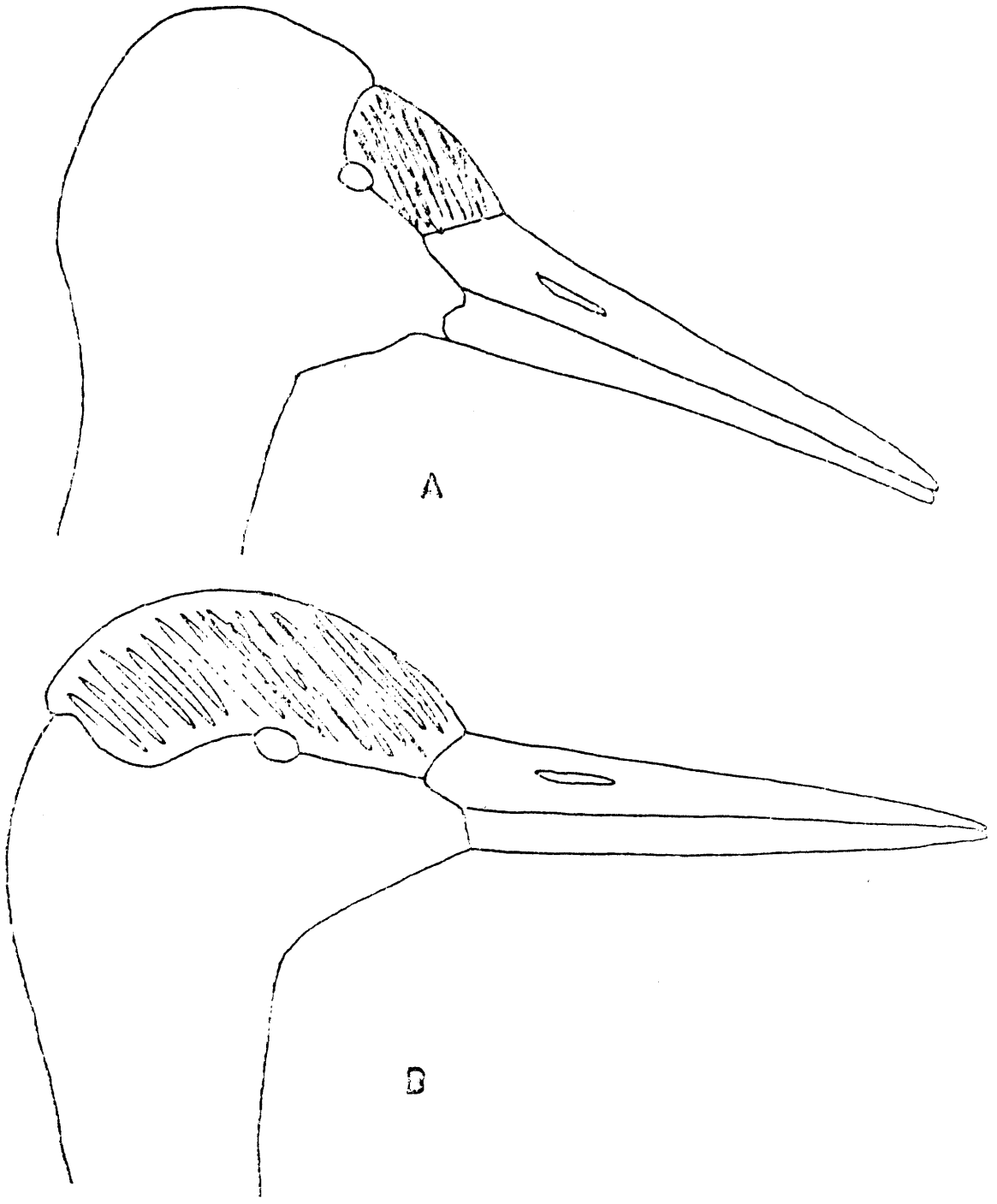
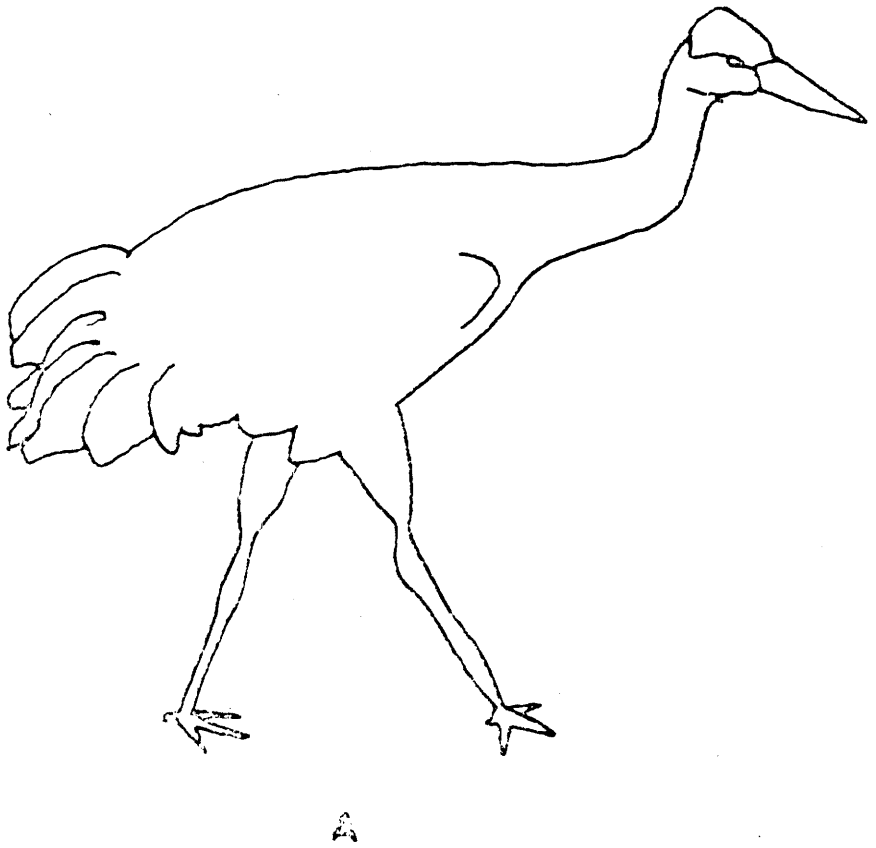
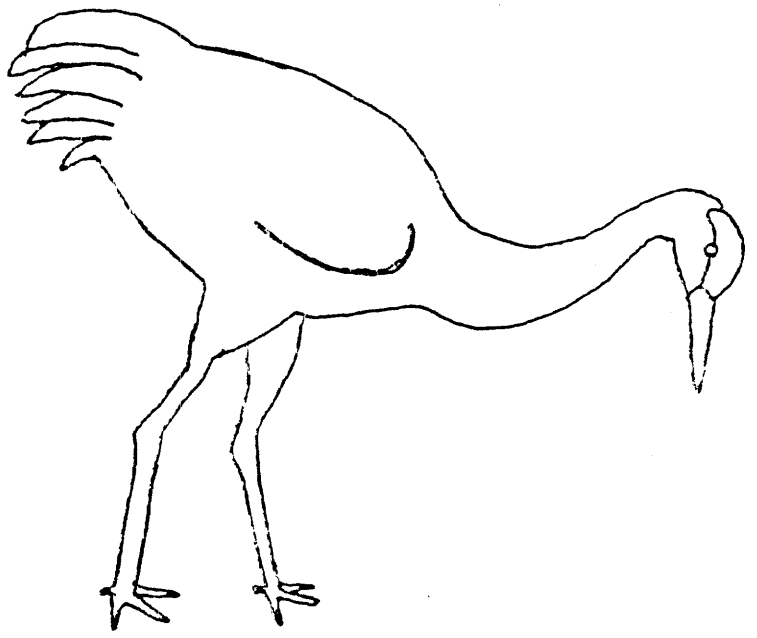


Fig. 3 Adornment display: a) Forward (low intensity) adornment
b) Lowered (high intensity) adornment



A



B

Fig. 4 Low bowing display

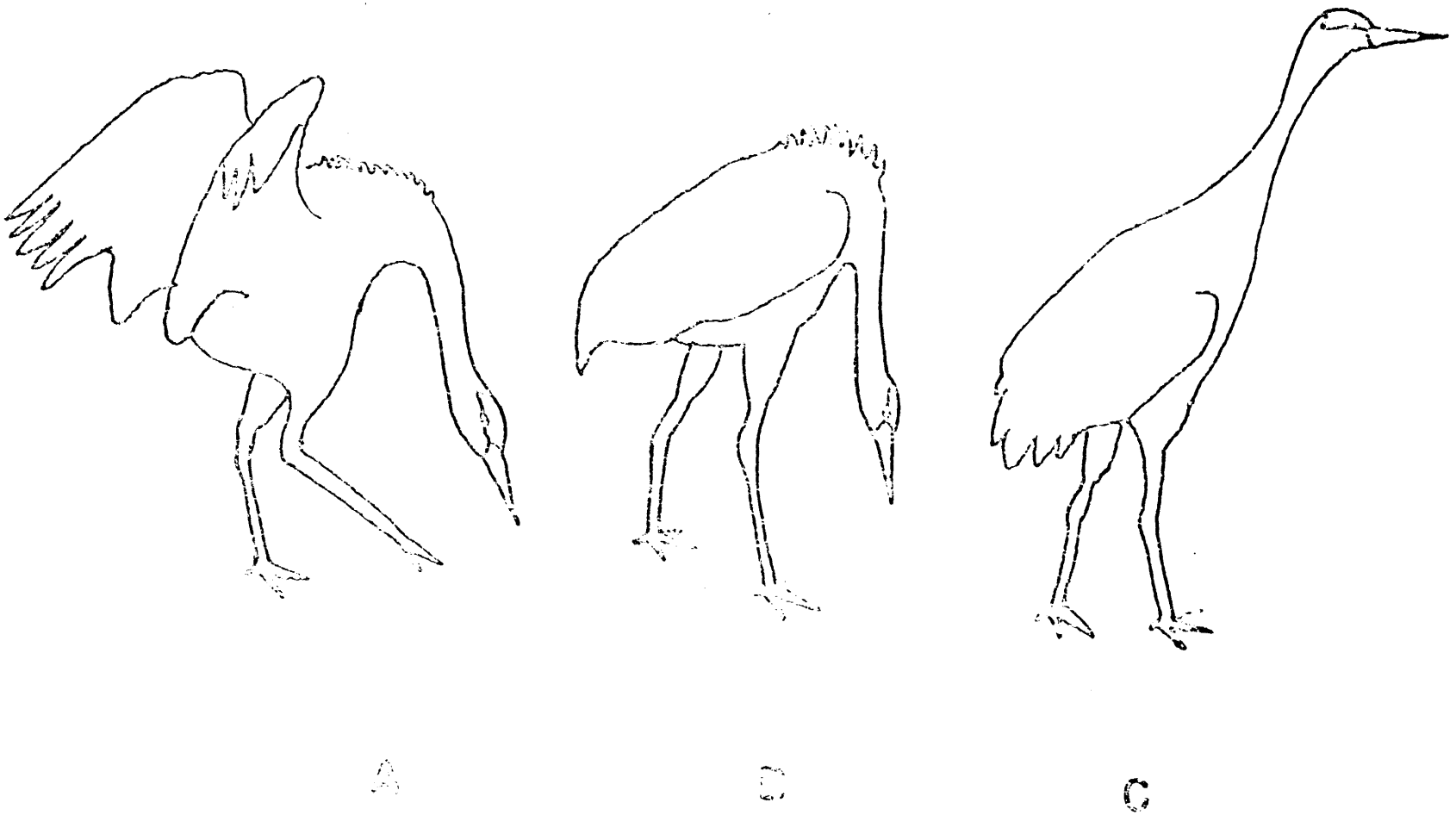
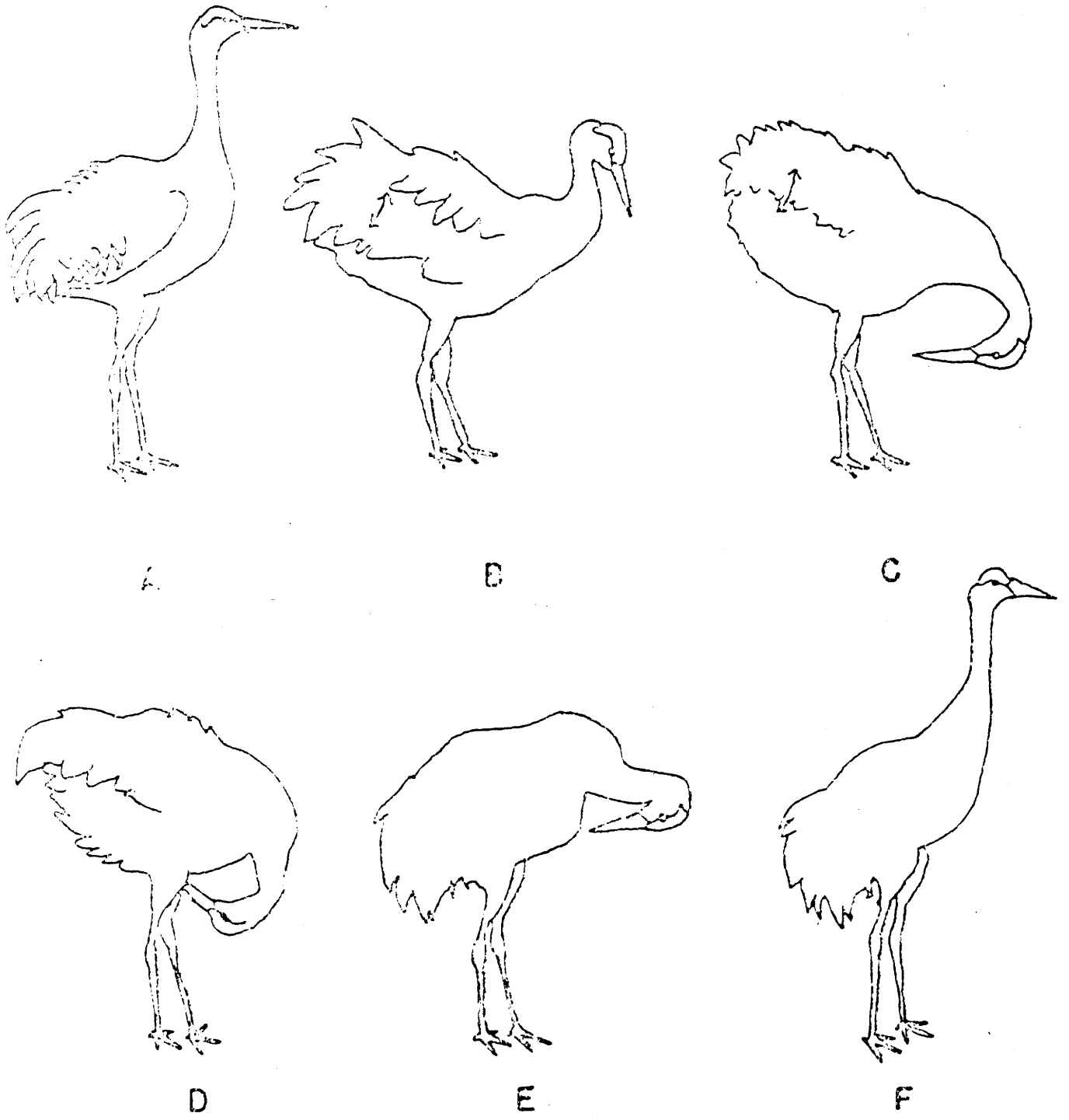


Fig. 5 Body-wing shaking display
a-b) Simple body-wing shaking display
a-f) Body-wing shaking - leg preening display



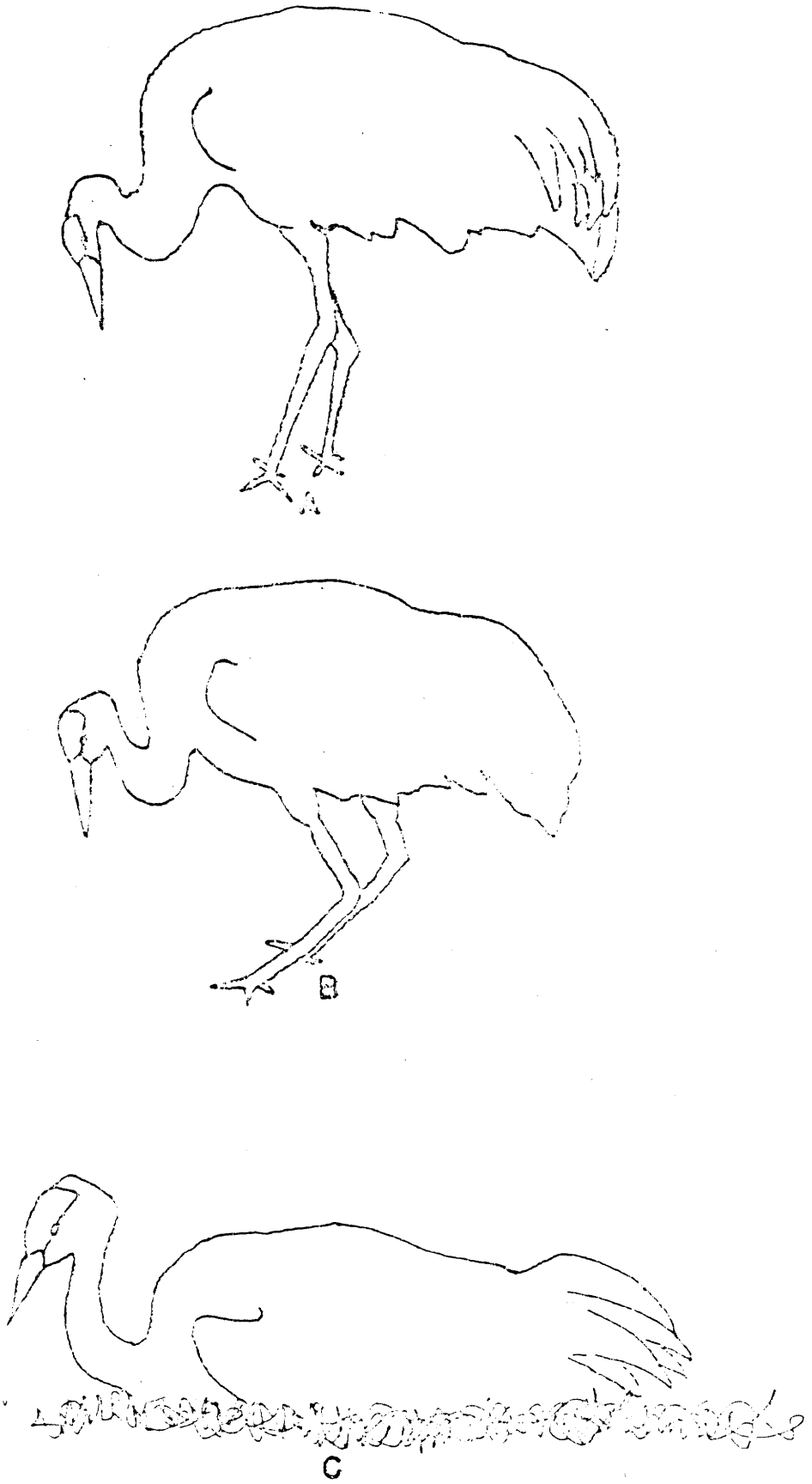


Fig. 6 Crouch display

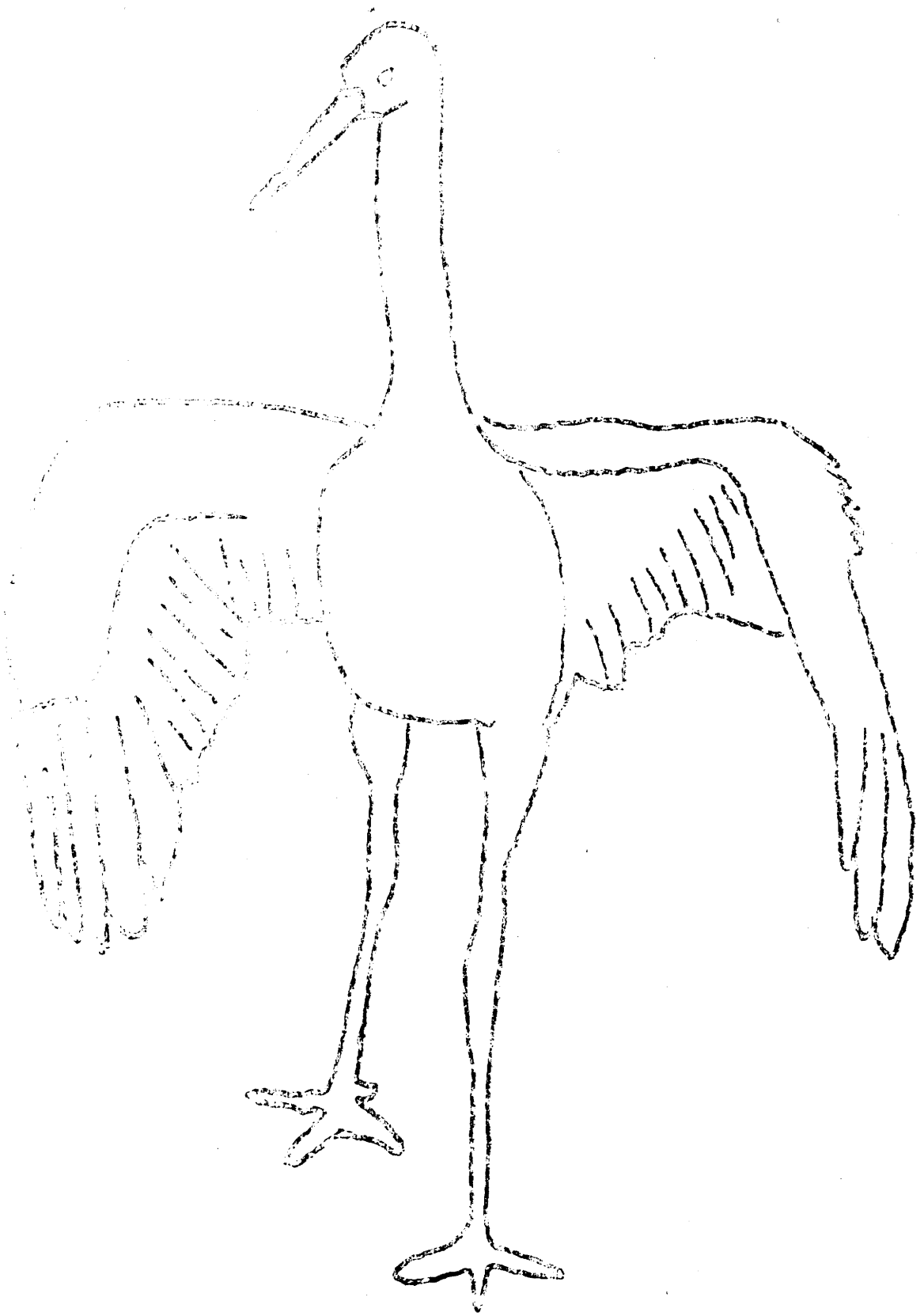


Fig. 7 Spread wing display

Fig. 8 Unison call

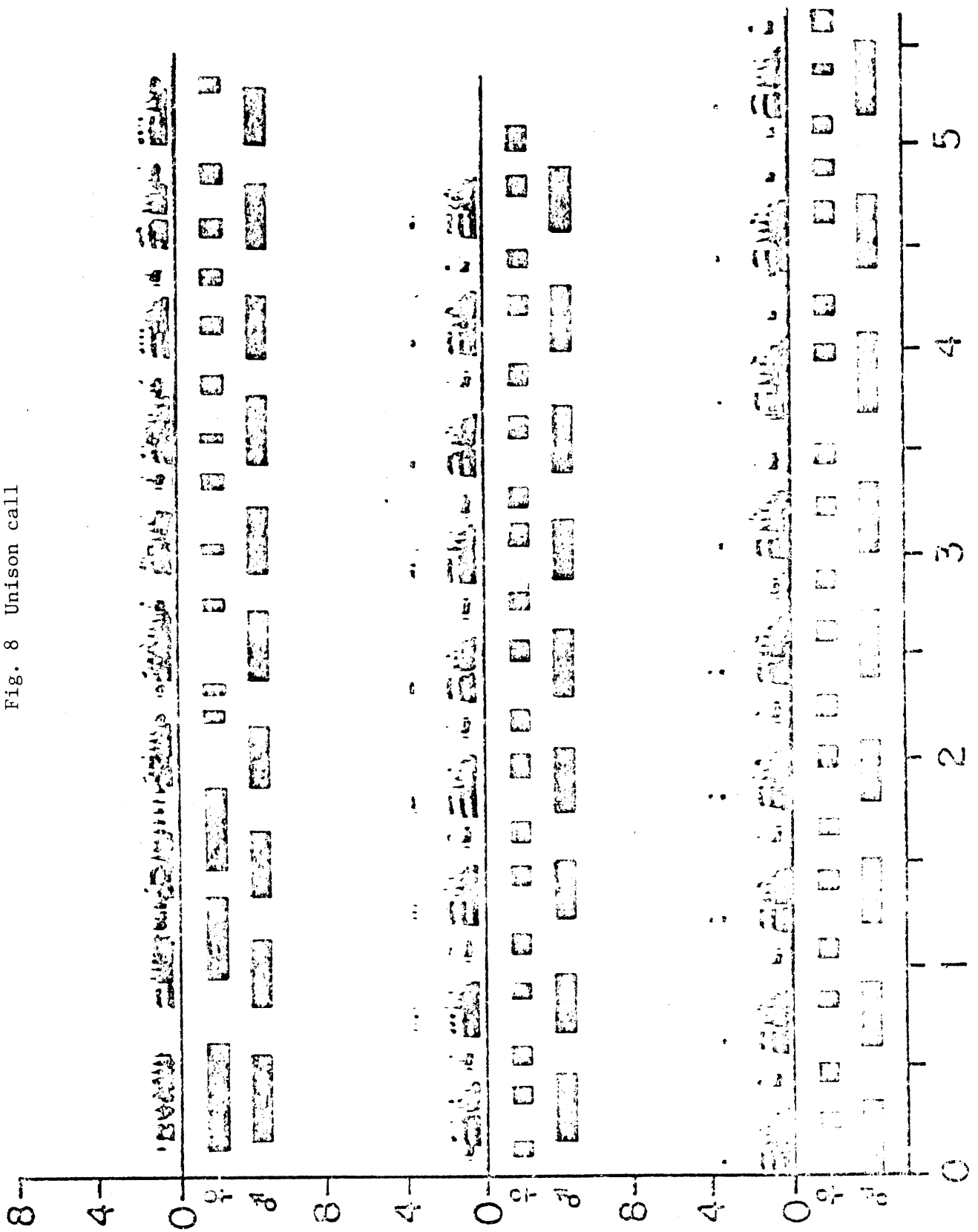


Fig. 9 Guard call a) 40 week old chick
b) Adult

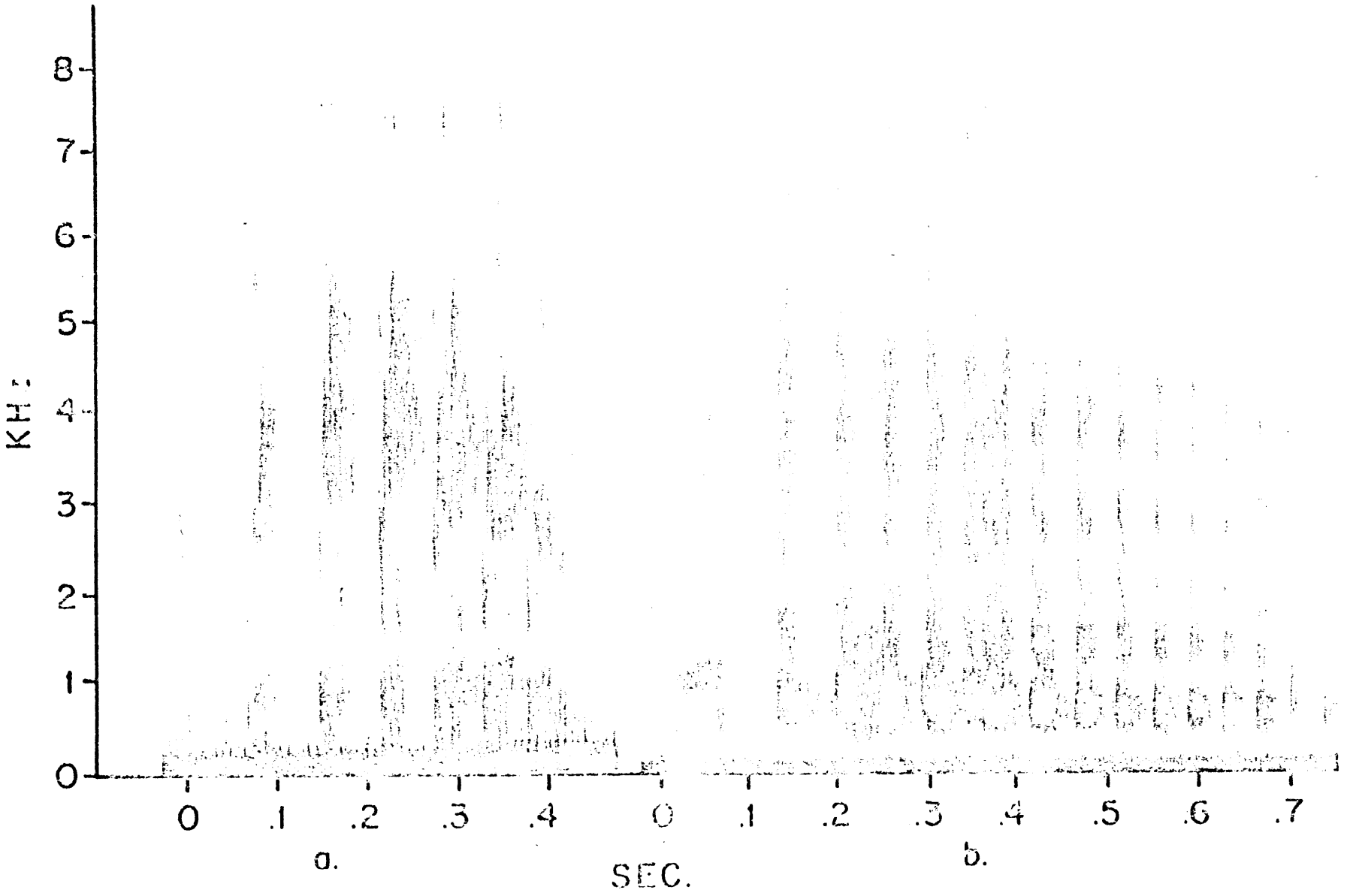


Fig. 10 Attack a) Chasing
b-e) Kicking

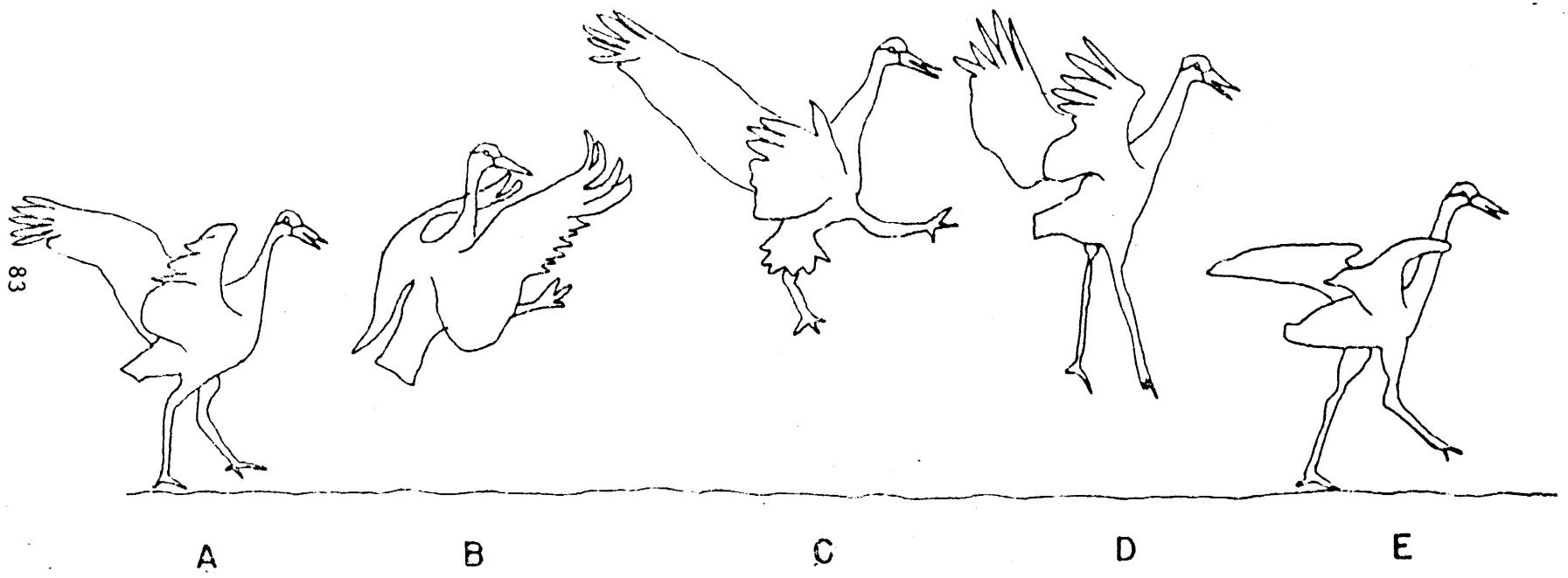
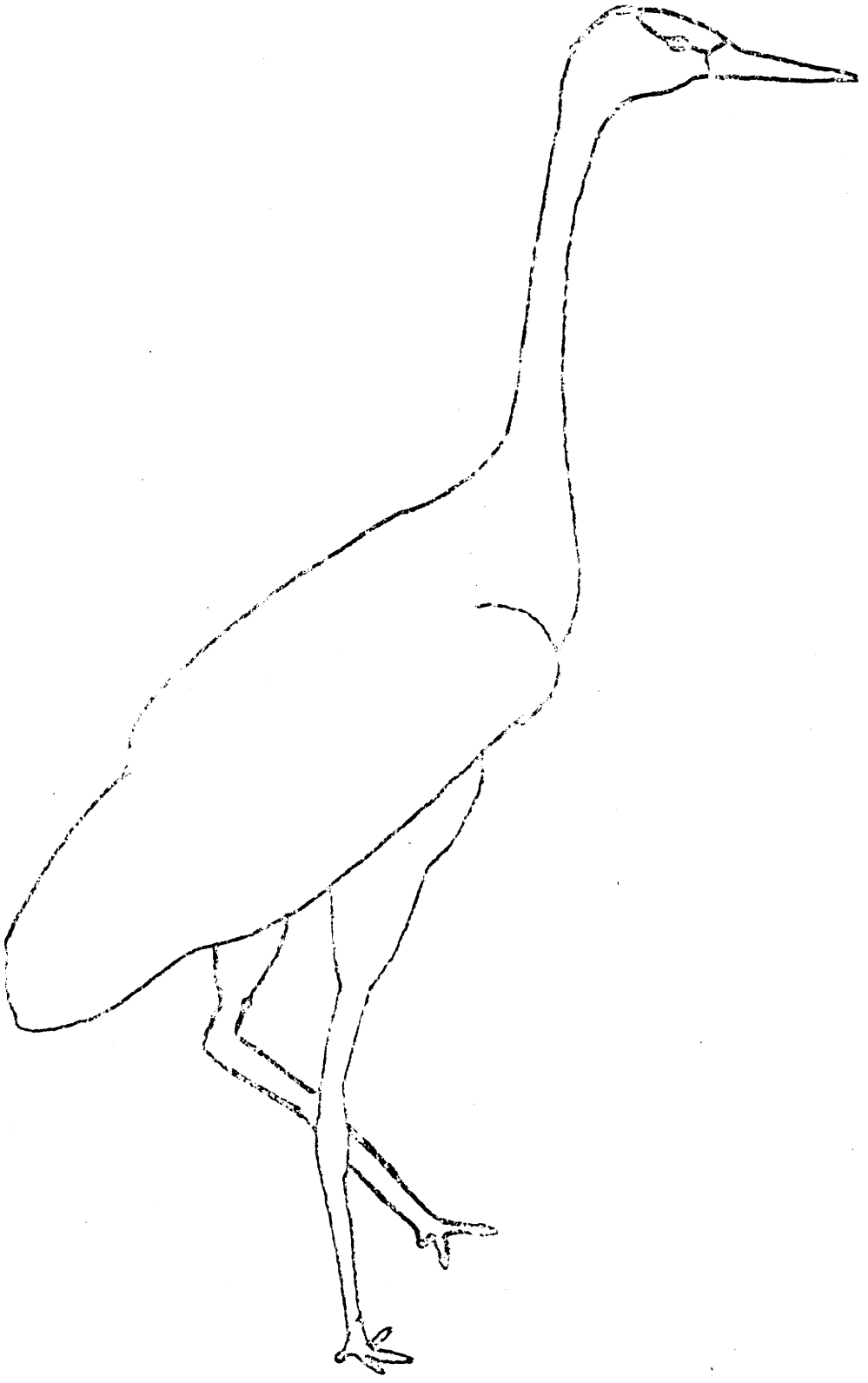
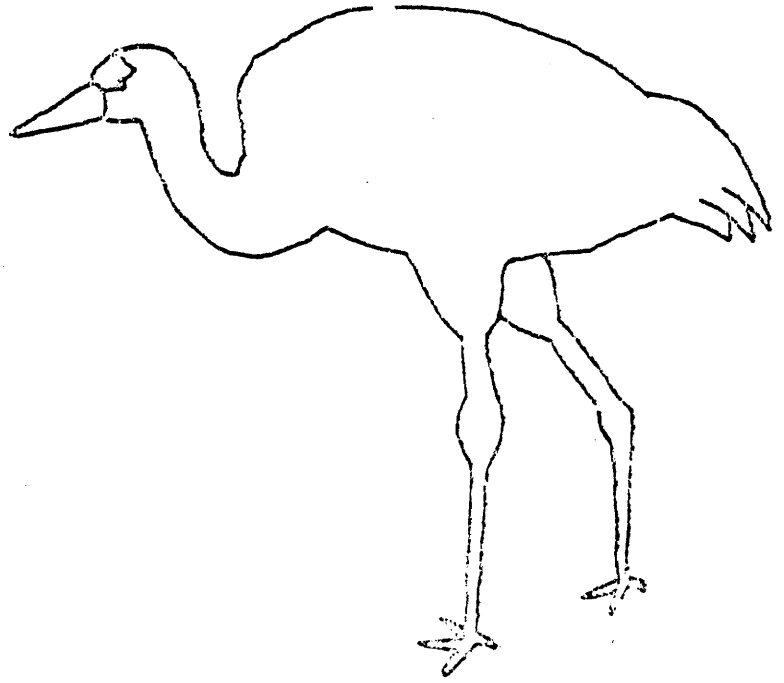
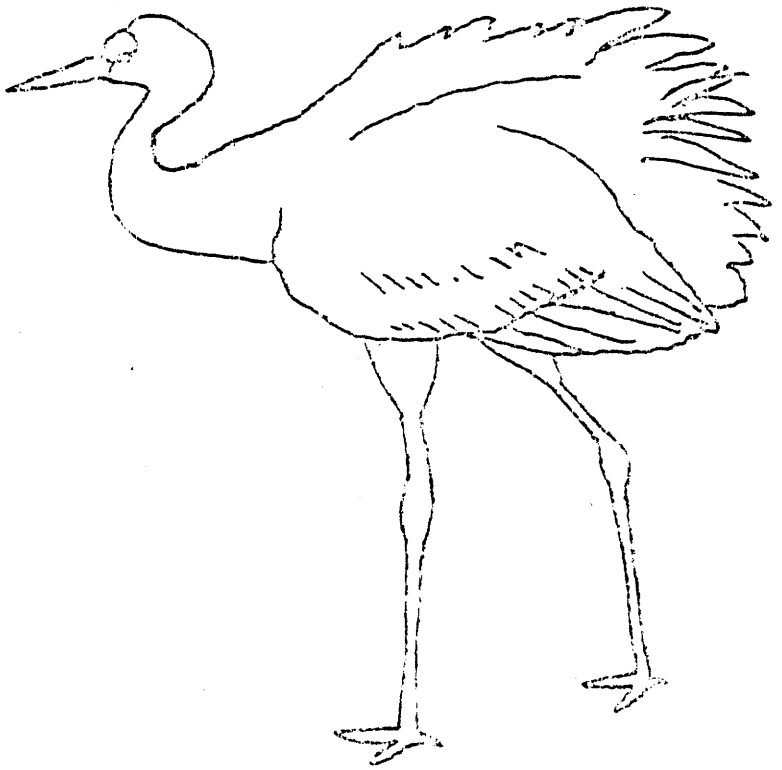


Fig. 11 Alert posture





A



B

Fig. 12 Neck retracted submissive posture a) Adult
b) Immature