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Cranes of the World: Japanese Crane (*Grus japonensis*)

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Japanese Crane

Grus japonensis (Müller) 1776

Other Vernacular Names. Manchurian crane, Red-crowned crane; Tan-ting ho, Hsien-ho (Chinese); Grue de Mandchourie (French); Mandschuren-Kranich (German): Tancho, Tozuro (Japanese); Manshuskiy zhuravl, Ussuriskii zhuravl (Russian); Grulla blanc (Spanish).

Range. Breeds in northeastern Mongolia on the border of Manchuria (Hahlin Basin) and eastwards through northern and central Manchuria to Lake Khanka and along the Ussuri to its mouth, and in the middle Amur Valley west to the Bureya or Gorin River. An essentially resident population also occurs in northeastern Hokkaido, Japan. The continental population is migratory, wintering in Korea and in eastern China (north of the Gulf of Chihli, and occasionally also the lower Yangtze and sometimes on Taiwan), with vagrants reaching Sakhalin (Vaurie, 1965; Yamashina, 1978). There is apparently also a small resident population near Pyongyang, North Korea (King, 1979).

Subspecies. None recognized. Archibald (1975) has suggested that the mainland population should perhaps be distinguished (as *punmunjomii*) from the Japanese population on the basis of vocal differences, although evidence so far does not indicate any morphological differences between these groups, and no formal description of *punmunjomii* has appeared.

Measurements. Wing (chord), males 560-670 mm (average of 8, 618.6 mm); females 557-635 mm (average of 11, 609 mm). Exposed culmen, males 151-167 mm (average of 8, 159 mm); females 135-167 mm (average of 11, 150.9 mm). Tarsus, males 267-301 mm (average of 8, 285.7 mm), females 255-297 mm (average of 11, 271.9 mm). Eggs average 101.2 × 64.9 mm (94.8-108.0 × 61.2-68.8 mm) (Walkinshaw, 1973).

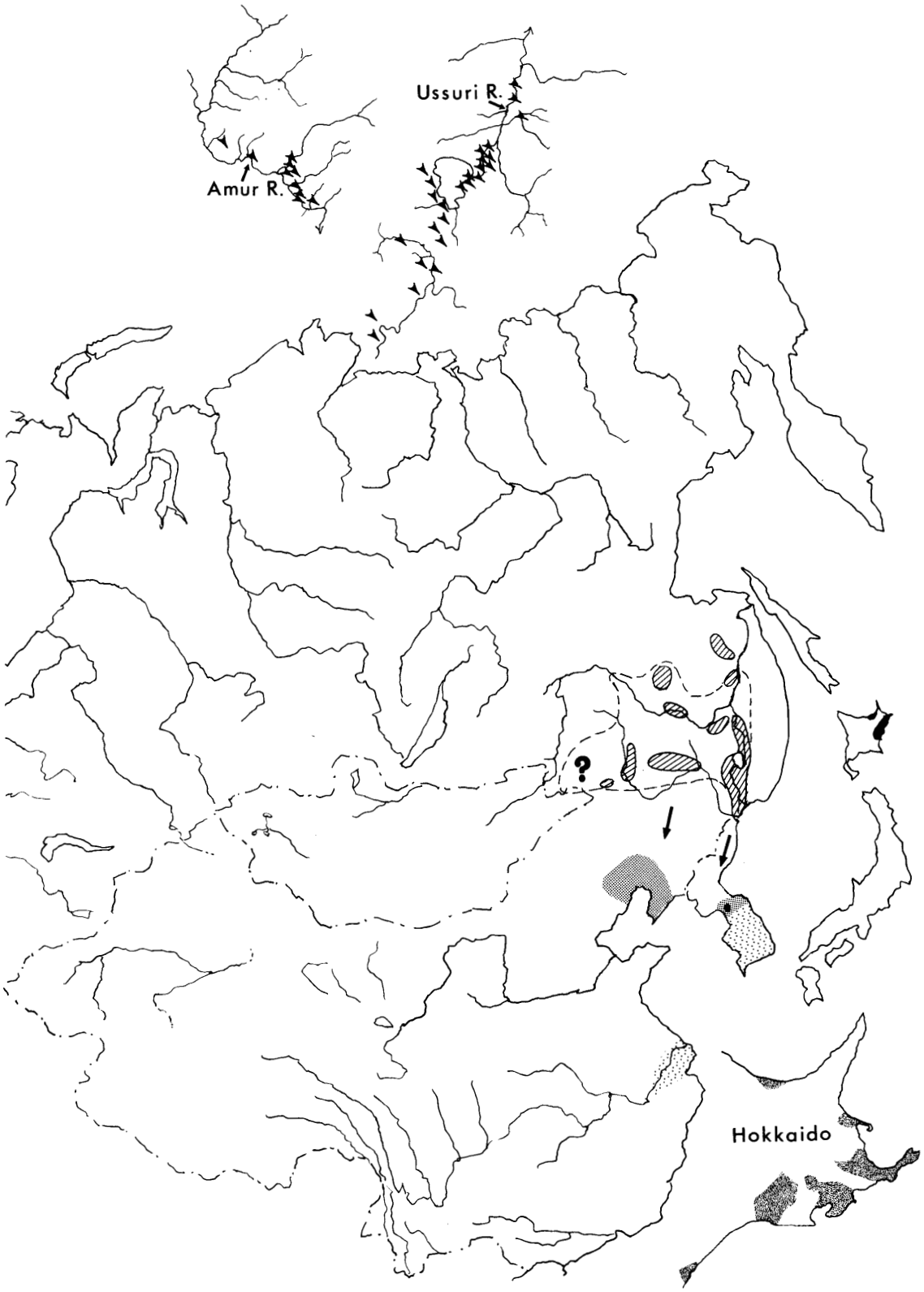
Weights. Dementiev and Gladkov (1968) report questionable weights of 9,000 to 10,500 grams, even to 15,000 grams. Cheng (1964) indicates adult weights of 7,000 to 9,000 grams, with a year-old female weighing 5,250 grams. Heinroth (1922) indicates adult weights of 6,000 to 7,000 grams. The estimated egg weight is 235 grams; the actual weight of 16 eggs averaged 239.4 grams (Ma, 1981).

Description

Adults of both sexes are nearly alike, but the cheeks, throat, and neck are ashy black in males and pearly gray in females. The forehead and crown are without feathers and red, becoming brighter during breeding, and covered with black hairlike bristles down nearly to the eyes. Starting below and behind the eyes, a white band extends from the ear coverts and occiput down the hindneck to meet with the blackish lower neck in a sharp point. The rest of the body and wings are white except for the secondaries, which are black. The innermost secondaries are somewhat pendent and pointed. The bill is olive green to greenish horn, the legs are slaty to grayish black, and the iris is dark brown.

Juveniles are a combination of white, partly tawny, cinnamon brown, and rusty or grayish. The neck collar is grayish to coffee brown, the secondaries are dull black and brown, and the crown and forehead are covered with gray and tawny feathers. The primaries are white, tipped with black, as are the upper primary coverts. The legs and bill are similar to those of adults, but lighter in color.

Immatures in their first winter show an indefinite brownish rather than sharply defined black or grayish neck area, and also have dark-tipped primaries and primary coverts (Masatomi and Kitagawa, 1975). Scattered dark feathers also occur on the upper and lower wing surfaces.



Breeding (hatched) and wintering (dark shading) ranges of the Japanese crane, and residential range of the species in Japan (inked). Known migratory routes are indicated by arrows, and previous or uncertain wintering areas are shown by light stippling. Insets show summer occurrences in the Amur and Ussuri valleys (above), and local residential distribution on Hokkaido, Japan (below).

One-year-old birds lack brown on the upper wing or back, but have a dark brown upper neck band and black tips on the outer primaries. During their second year this neck band gradually attains the adult black color. *Two-year-old* birds are essentially like adults, but may show black tips on some of the outer primary coverts.

Downy chicks are tawny brown to cinnamon brown, becoming darker on the shoulders and rump, and tawnier on the head and neck. The cheeks are light gray and tawny, and a white spot is present at the base of the wing. The bill is flesh-colored, with a more yellowish base, the iris is dark brown, and the legs are initially bluish, becoming flesh-colored a day or two after hatching. The toes and tibio-tarsal joint are bluish, tinged with yellowish flesh color (Walkinshaw, 1973). By two months of age the down is shed and most of the juvenile feathers are grown.

Identification

In the field, the Japanese crane appears white-bodied except for black inner secondaries and a black neck that passes forward under a white nape and eye patch. Except for the much broader white area behind the eye and on the nape, this crane is somewhat similar to the black-necked crane, but the latter has a darker and more ashy-gray body color. The calls of the Japanese crane are loud and resounding, and while calling in unison both sexes often raise the wings and droop the primaries.

In the hand, the combination of a pale grayish white body, a black neck, and a white patch that extends to the nape serves to identify this species. The trachea is coiled inside the keel of the sternum.

DISTRIBUTION AND HABITATS

Historical Range

The historical range of this species is only very poorly known, for although the Japanese crane was described over two centuries ago, its breeding grounds remained undiscovered by scientists for another century. Prezhwalsky was the first naturalist to provide any information on the summer occurrence and biology of this species, and in 1870 found it common in the area of Lake Khanka. Quite probably it once bred in marshes around Lake Khanka, along the Prihanka plain and throughout the valley of the Ussuri River. Around Lake Khanka itself, the birds nested on the swampy plains to the east of the lake and on the marshy areas of the lower Lefu River to the south. Shulpin found a nest on the lower Lefu in 1928, and the birds were also then apparently common along the lower Mo River and the Sugatch River in the same area. Little if any other historical evidence on the original breeding areas exists for the mainland. Dementiev and Gladkov (1968) suggested that the species might have bred beyond the Ussuri River to the lower Amur River, as well as in the valleys of central and western Manchuria, and in the valley of the Sungari River (a Manchurian tributary to the Amur).

There is no evidence that the birds bred in Korea, although wintering was regular in Korea during the late 1800s and early 1900s. Indeed, even after the birds became rare as winter visitors in eastern China, they continued to be common in Korea during winter, where they have probably been trapped for sale in Japan and China for hundreds of years.

The historical distribution in Japan was certainly more widespread than at present. Probably the species was not uncommon in eastern and northern Honshu during winter, and nested not only in eastern Hokkaido but also in southwestern parts of that island. Until the latter part of the nineteenth century, some might have wintered in central Japan. However, after the Meizi Restoration the birds rapidly declined, and were rarely seen on Honshu after the early 1900s. Indeed, some ornithologists believed that they might have been extirpated from Japan about that time, but they were found nesting at Kushiro in 1924, when about 20 birds were believed to be present in the Kushiro Marsh. Thereafter, the population increased very little until the 1950s, when artificial feeding in winter was begun (Masatomi, 1981a).

Current Range

Apparently, the area around Lake Khanka still represents the center of this species' mainland breeding range. However, there are now known to be several nesting areas in the USSR. In addition to the nesting area on the eastern shore of Lake Khanka, the crane also nests along the lower Amur River (the basin of Lake Bolon and the Evron-Chukchagir lowlands), the middle Amur (the Arkharinsk lowlands and the area of the confluence of the Bureya and Amur Rivers), and the Zeya River (along the Ulma and Tom Rivers, which are tributaries to the Zeya). However, all told, there may have been no more than 25 or 30 breeding pairs in the entire USSR in the late 1970s (Flint, 1978a). The breeding range also extends into northern China a considerable distance along the Sungari River, and west into the drainage of the Nun River, a tributary of the Sungari. There the breeding density is greatest in reed swamps in the lower reaches of the Wu Yu-erh and the Du-lu rivers, and in the Qu-xing River basin (Ma, 1981). The total population of this area is not known, but on the Sung-nun plains 233 cranes were observed in 283 hours of field observation, and on the San-jian plains 98 cranes were observed in 115 hours. Undoubtedly

these numbers represent many repeated observations, but they nonetheless suggest that the Chinese population is appreciably larger than that of the USSR.

Lake Bolon, on the western side of the lower Amur River in Khabarvsk Territory, USSR, was discovered to be a nesting area of the species in 1975, when it was estimated that 13 to 15 pairs nested in the Lake Bolon basin. In 1980, 6 territorial pairs were found in this basin (USSR Crane Working Group Information Bulletin No. 2, 1981).

In the upper Amur River basin, along the lower Bureya River, this species has been observed during summer since 1956, and chicks were found in 1965 (Dymin and Pankin, 1975). In 1981, 8 pairs nested between the Bureya and Kingan rivers. In 1977, a survey was made of the upper Zeya River, northwest of the Bureya, and 4 nests were found, as well as 4 additional pairs and 2 lone birds. Nesting apparently also occurred in 1978 and 1979 in the upper Zeya Basin, but no cranes were observed there in 1980 (USSR Crane Working Group, Information Bulletin No. 2, 1981).

The Lake Khanka area of Maritime Territory is still believed to be the major nesting area for Japanese cranes in the USSR. In 1980 nesting was observed along the Ilistay River, on the marshy plain to the northeast of Lake Khanka, and in the Sungach River basin (upper reaches of the Chertov, and Chertov Marsh). At the end of August 116 individuals were counted there, including 18 young birds. During the spring of 1981 there were 70 to 74 birds in these areas. Finally, in the summer of 1981 a new nesting area was discovered in the Bikin River basin to the northeast of Lake Khanka (USSR Crane Working Group Information Bulletin No. 2, 1981).

The present distribution of the species in Japan is limited to southeastern Hokkaido, and consists of the marshes near the Otsu River mouth (Takochi District), the Kushiro Marsh and adjoining lowlands along the Bekanbeushi River, the Kiritappu Marsh (Kushiro District), the marshes of Nemuro Peninsula, Lake Furen, and Nishibetsu and Shibetsu rivers and the lowlands between them (Nemuro District). The major wintering grounds in Japan are generally restricted to several areas of Kushiro District (Masatomi, 1981a)

Since the Korean War the wintering flocks in South Korea have steadily declined, and there are few recent records except for the area of the demilitarized zone. Archibald (1981a) reported that a group of about 15 winters on the mudflats and rice paddies just north of the west coastal city of Incheon, another group of about 40 winters in Panmunjom Valley along the Sachon River, and a third flock of 80 to 100 winters in the Cholewon Basin.

Breeding Habitat Requirements and Densities

In the USSR, the typical breeding habitat of this species consists of wide sedge-cottongrass (*Carex-Eriophorum*) marshes and sedge-smallreed (*Carex-Calamogrostris*) wet meadows. Such habitats are usually located near rivers and lakes, and often are interspersed with larch (*Larix*) and birch (*Betula*) growths. Waterlogged meadows and extensive tussocky marshlands provide the tall grassy cover favored by these birds for nest sites, and the birds build their nests in those areas where the previous year's growth is still standing. In the USSR prime nesting habitats are being degraded because of land reclamation, soil cultivation, cattle grazing, and fires (Flint, 1978).

In Hokkaido, the habitat requirements for breeding have been analyzed by Masatomi and Kitagawa (1974). They reported that breeding territories must provide for the range of all daily activities, including foraging, nesting, and roosting. They must also provide a safe nesting site, usually reeds in watery surroundings, and also a brood-rearing location. Generally, nesting occurs in one of three habitat types: loose forests or groves, low moor covered with dense and tall grass, and relatively open lowlands. Of these, the first is less preferred than the others, the second is more favored. Open high moor, such as *Sphagnum-Empetrum* habitats, is apparently not utilized.

Even in the favored habitats, breeding densities are quite low. Flint (1978a) reported that in the USSR neighboring nests may be up to several kilometers apart. Masatomi and Kitagawa (1974) reported that 13 pairs observed during the breeding season had maximum home ranges of from 1 to 7 square kilometers, averaging about 2.8 square kilometers. The breeding area of Kushiro Marsh apparently consists of about 2,700 hectares, and in the early 1970s supported about 10 breeding pairs each year, suggesting a density of roughly a pair per 270 hectares (2.7 square kilometers). This is probably a maximum density estimate, and it is undoubtedly much higher than most other breeding areas. However, Cheng (1981) reported a breeding density of about 120 cranes in a sanctuary of 169.5 square kilometers, representing a similar maximum density of about 2.8 square kilometers per pair (assuming all the birds present were paired). Viniter (1981) estimated that in the central Amur region of the USSR the territorial sizes ranged from 4.0 to 12.3 square kilometers, and that up to 8 pairs nested in an area of 162 square kilometers, a breeding density of 20 square kilometers per pair.

Nonbreeding Range and Habitats

The wintering habitats of this species in Korea primarily consist of paddy fields and grassy tidal flats or mudflats. The mudflats and tidal channel areas are generally used in early fall, when the birds feed on earthworms, small crabs, other small aquatic invertebrates, and some plant seeds. When the cold weather

arrives the birds usually move to nearby paddy fields, where they feed on rice gleanings (Won, 1981).

In Japan, most of the birds of Hokkaido leave their breeding areas in late autumn, and form flocks at various wintering sites where artificial feeding stations have been developed for them. At such times, flocks of up to 80 birds will sometimes approach farms to obtain food, including grain. However, some pairs or families never leave their breeding habitats, and maintain their territories throughout the year. Such pairs occur now in Takkobu, in Shimochanbetsu in Kushiro District, in Tofutsu in Abashiri District, and possibly also in Nemuro District (Masatomi, 1981a).

FOODS AND FORAGING BEHAVIOR

Foods of Adults

Rather little is known of natural foods of this species. Masatomi and Kitagawa (1974) stated that in Japan the natural plant foods so far known include parsely, some water plants, carrot, pasture plants, the young buds of reed, the inflorescence of *Potamogeton*, acorns and buckwheat. Animal foods reported by various authors include loaches, crucian fish, snakes (*Radix japonica*), sticklebacks, tadpoles, and frogs. Additional animal materials found as foods by these two authors included mud snails, dragonflies, lampreys (*Entosphenus*), carp (*Cyrinus carpio*), goldfish (*Carassius auratus*), frogs (*Rana chensinensis*), mallard duckling, juveniles of reed-warbler (*Acrocephalus*), and small mammals (mole or mouse). Nothing in detail is known of the proportions of these foods taken by the birds.

However, in winter, Japanese cranes are now largely dependent on corn in Hokkaido. Nonetheless, they seem to prefer animal foods when available.

In Korea, the birds also seem to be relatively carnivorous during winter months, although they also feed on rice gleanings during that season. When foraging around the Sachon River and around unfrozen springs, the birds probe for aquatic animals, especially amphipods, snails, and small eels (Archibald, 1981a). Won (1981) stated that earthworms, small crabs, and various plant seeds (*Salsola, Suaeda*) are consumed in tidal mudflat areas before cold weather forces the birds into rice paddies for the rest of the winter.

Foods of the Young

Feeding of the young chick begins soon after hatching, and observations by Masatomi (1970, 1972) indicate that initially the chick is fed little tidbits from the ground, such as *Anisogammarus*. There is a record of a chick being fed a small fish (probably *Pungitius pungitius*) only three days after hatching. Other foods include *Moroco percnurus*, Salmonidae, and Gobidae. Later on, aquatic animals are consumed as staple items. Within 20 days of leaving the nest the chicks feed heavily on dragonflies (Odonata), such as *Libellula*. As the young grow the parents feed them larger fish. The parents have also been observed feeding them frogs (*Rana chensinensis*). By 12 weeks of age, the young are being fed from two to five times per hour, and the foods include fishes such as *Barbatula, Misgurnus, Cyprinus,* and *Carassius*.

Foraging Behavior

Little specific information on foraging patterns is available for the species. Masatomi and Kitagawa (1975) reported that food-searching behavior takes two forms, including walking about slowly while searching for food with the head variably lowered and the bill directed downwards, and probing in mud or the ground surface, often inserting the bill into the mud repeatedly at the same place. Small food items such as corn are held by the tip of the bill and then swallowed by tossing the head upward a little. When the bird catches a small fish or similar agile animal it performs a heronlike thrust. Although larger fish or small mammals are sometimes swallowed directly, the bird more often tears the food into pieces by grasping it in the bill and shaking the head, and then swallowing each piece separately. Foraging is often performed at wet grasslands, on cultivated fields, along shallow rivers, and on lakeshores. Probing into the ground, under the water, and obtaining items from the ground surface are all commonly performed.

Viniter (1981) also described foraging behavior in this species and noted that during the breeding season the foraging areas were located from 600 to 1,500 meters from the nest, and coincided with the deepest portions of the nesting marsh. Foraging birds would walk slowly for several hundred meters and, having caught something, would often rinse the catch in water, before swallowing it. At times a bird would catch flying horseflies or other flies by rapid lunging movements.

MIGRATIONS AND MOVEMENTS

Seasonal Movements

Since the Japanese population is now essentially sedentary, only the mainland population needs to be dealt with in any detail as to migration. Masatomi (1981a) reported that most of the Hokkaido population moves less than 150 kilometers between breeding and wintering areas, and some families never leave their breeding territories all year. Those birds that do migrate leave their summer habitats during October and November, and the movement is generally ended by mid-December. In late February they begin to leave their

wintering areas, and by early April they have established their individual breeding territories. This period generally corresponds to the time of disappearance of snow in Hokkaido. The birds leave their wintering areas in pairs or small flocks of nonbreeders, and typically return in the fall as pairs or family groups.

In Korea, where the birds are only migrants, they arrive in fall, from mid-November until early December, somewhat later than do white-naped cranes, and remain until March (Archibald, 1981a).

In China, fall migration extends from late October to mid-November and the return flight northward occurs in March, judging from historical records. Observations at Bei-dai-he Beach, Hebei (Hopei) Province, in the early 1940s, suggest that the species was the fourth most common migrant crane (after Eurasian, Siberian, and hooded) in that area. Ma (1981) reported that the birds arrive on the Chinese breeding grounds in early or mid-March, with nest-building beginning as early as the end of March. Fall migration begins in early to mid-October.

In the USSR, the cranes begin to return to the southern parts of the Maritime Territory during the first third of March, or about a month before the marshes begin to thaw. At about the end of March or the beginning of April the birds move into the lowlands around Lake Khanka and to their nesting areas along the Ussuri and Amur rivers. About the same time they usually arrive in Lake Bolon area and also in the vicinity of the Zeya and Bureya rivers of the upper Amur. Since eggs have been found by late April, nesting must get underway soon after arrival. Most birds leave these areas in October, with a few late fall records extending into early November.

Daily Movements

Nothing specific has been reported on daily movements in this species.

GENERAL BIOLOGY

Sociality

Flock sizes are bound to be limited in this very rare species, and furthermore the species' relatively carnivorous foraging habits are likely to cause group dispersion except under artificial feeding conditions. Archibald (1981a) reported that in Korea the wintering birds around Panmunjom spend part of the day foraging as family groups, pairs, and single individuals, but roost together in flocks. Pairs and family groups tend to forage in the same region for much of the winter. The nonbreeders, on the other hand, will forage in a single area for several days, and then without apparent reason will move to a different region.

In Hokkaido, where winter feeding is regular, the birds gradually begin to associate during the late fall months. Pairs and families that initially remain rather scattered and occupy separate feeding territories gradually concentrate in areas centering around the feeding stations. Thus, two or three large flocks of 40 to 80 cranes, and several smaller ones, are formed annually in December. The activity range of each flock, including its roosts and feeding areas, has a diameter of a few kilometers. Most of the birds roost communally in shallow unfrozen rivers, but some families remain to themselves in separate roosting areas. In February the paired birds begin to leave the area, leaving their last-year's young and the subadults behind (Masatomi and Kitagawa, 1974).

Daily Activities

As in most other cranes, roosting is performed in relatively safe locations, and normally the birds leave the roost site at dawn, returning again at dusk. During unusually cold weather, the birds may remain on their roosts until early afternoon, flying out to foraging areas for a few hours, and then returning to their roost sites (Archibald, 1981a).

Interspecific Interactions

Studies by Viniter (1981) in the central Amur area of the USSR indicate that the birds are indifferent to most other nearby nesting birds while on their breeding territory, including some raptors. Thus, falcons (*Erythropus amurensis*), buzzards (*Buteo buteo*), and owls (*Asio otus* and *A. flammeus*) would sometimes hunt above an incubating crane, and a harrier (*Circus melanoleucus*) was observed to land in sedge cover as close as 50 meters from the nest. However, when a harrier (*C. aeruginosus*) appeared above a nest when a crane chick was present, the parents uttered unison and warning calls. When crows (*Corvus corone*) came too close, they would be chased for some distance. The strongest responses were found toward spotted eagles (*Aquila clanga*), which in one case nested some 300 meters from a crane nest. Such birds would be watched intently by the breeding birds, and Viniter saw several aggressive encounters. In all cases, one of the cranes remained on the nest while the other pursued the enemy.

One encounter with a wolf was also observed by Viniter. When the male crane observed a wolf about 600 meters away, it flew over and landed within 10 to 15 meters of the animal. Then, standing very erect, it approached to within 6 or 8 meters. For about 30 minutes the crane followed the wolf until they came to the edge of woods, after which the crane flew back to its mate on the nest. Similarly, when a large dog was released near a pair of cranes with chicks, the birds

swiftly ran at the dog from both sides, chasing it for about 200 meters, and attempting to peck at its flanks. Likewise smaller carnivores, such as foxes, badgers, raccoon-dogs (*Nyctereutes*), and similar mammals are regularly chased by the adult birds without hesitation.

Masatomi and Kitagawa (1974) likewise reported that most birds are ignored by breeding cranes, but that carrion crows (*Corvus corone*) and jungle-crows (*Corvus macrorhynchos*) frequently take eggs and chicks. Occasionally the black kite (*Milvus migrans*), buzzards (*Buteo buteo*), and marsh harriers (*Circus aeruginosus*) do the same, but the adult birds can readily drive away these species. The breeding birds pay particular attention to white-tailed sea eagles (*Haliaeetus albicilla*), but attacks by this species have not been observed.

Competition between the white-naped crane and the Japanese crane is perhaps of some local significance, but the former is much more a vegetarian than is the Japanese crane, and thus the levels of foraging competition are probably reduced. Archibald (1981a) found that when an artificial breeding station was established in Korea, a pair of white-naped cranes attacked and supplanted several Japanese cranes that attempted to feed there. On the other hand, territorial pairs of Japanese cranes were dominant over the white-naped, but did not attack them when they were present on their feeding area.

BREEDING BIOLOGY

Age of Maturity and Time of Breeding

Few records on the age of maturity of the Japanese crane are available. A female at the Cologne Zoo bred for the first time when she was approaching 6 years old, and Archibald and Viess (1979) reported that semen was obtained from males in their third year of life. Masatomi and Kitagawa (1974) believed that maturity probably occurs at 3 to 4 years of age.

The time of breeding in this species is quite restricted (see table 14), and is largely centered in April. Masatomi and Kitagawa (1974) reported egg-laying as early as the start of April and extending to the latter part of May in Hokkaido. Ma (1981) likewise stated that in northern China the egg-laying period begins in April and ends in late May. In the Central Amur valley egg-laying occurs in the second half of April (Viniter, 1979).

Pair Formation and Courtship

In their analysis of the social/reproductive behavior of this species, Masatomi and Kitagawa (1975) divided the components into duetting, dancing, copulatory behavior, nest-building, and incubation behavior. Duetting display is normally only performed by pairs, in a variety of situations such as after copulation, in wintering flocks, and when there are territorial intruders. Thus the unison call has manifold functions, including formation and maintenance of the pair bond, as well as territorial advertisement and agonistic signaling. As described by Archibald (1975, 1976) and other authors, the display begins with the birds standing 1 to 3 meters apart. Either sex can initiate the call, but this is usually done by the female. Both sexes raise their humeri and expose their primaries during the calling, and these are usually moved in a rhythmic manner during the calling. The male's wings are usually raised higher than those of the female during display. Both birds call in an antiphonal manner. For each male call, which is typically monosyllabic, the female utters two (mainland population) or three or four (Japanese population) calls. Unison calling often provokes the same display from other nearby pairs, sometimes resulting in a synchronous chorus of calling.

In addition to the unison call, several other social vocal signals occur among paired birds, and Viniter (1981) reported a total of six call types among adults. Many of these are associated with alarm, threat, or communication between members of a pair.

Like the unison call, dancing is a complex behavior having several probable functions, of which pair maintenance is perhaps a minor one. The movements associated with dancing were described by Masatomi and Kitagawa (1975), who recognized eight distinct postures and four types of movements. These movement categories are pumping (of the head and neck), bouncing, pursuing movements (as in chasing and fleeing behavior), and throwing movements. Dancing often occurs in winter flocks at feeding places, and also solitary dancing sometimes occurs, as when a bird has left the nest after being relieved of incubation. Dancing behavior toward other species, including both other cranes and such birds as crows, has also been reported, further suggesting multiple functions of this behavior. Perhaps dancing is best considered simply a general signal of excitement, and this can include intraspecific agonistic and sexual excitement, as well as a variety of other interspecific responses.

Copulatory behavior has been described in detail by Masatomi and Kitagawa (1975). It apparently differs little at all from the pattern described earlier for cranes in general. It can be initiated by either sex, by a bill-raising display that stimulates the mate to follow. The receptive female turns her back to the mate, and sometimes begins to spread her wings. The male then approaches, uttering a series of *kotz* sounds, which gradually become louder and increase in pitch. As he steps upon the female the calls become even higher in pitch, and while mounted the male calls continuously. As treading is completed the male stops calling abruptly, and slides down forward over the female's head. The pair then invariably performs bowing, and sometimes

assumes an arching posture, with the bills raised vertically and the heads turned at right angles to the body.

Territoriality and Early Nesting Behavior

Shortly after their return to the breeding areas, paired cranes establish territories, or reclaim those of the previous year. Masatomi and Kitagawa (1974) estimated that territories in this species range from 1 to 7 square kilometers, an area coequal with their reported home range estimate, since all activities occur within the territorial boundaries. Viniter (1981) similarly estimated that the territories of three pairs ranged from about 4 to 12 square kilometers, and consisted of tussocky cotton-sedge marshes mixed with oak-birch islands, these also containing a sparse undergrowth of shrubs and saplings. Four of the eight territories studied by Viniter were in marshes that ranged from about 1 to 2 square kilometers in area, and a fifth was in a marsh of about 0.1 square kilometer. Distances between neighboring nests ranged from 2.7 to 4.0 kilometers, and the nearest settlements were 8 to 10 kilometers away. Ma's (1981) study of breeding birds in China indicated a territorial size of 45 and 130 hectares for two pairs, and a minimum distance between nests of 800 to 1,000 meters.

Of 13 territorial pairs studied by Masatomi and Kitagawa (1974), nearly all could be characterized as low moor habitats, ranging from reed communities to reed-sedge or reed-grass communities, or sparsely wooded and alder-dotted habitats. Probably the presence of tall grassy vegetation from the previous year is an important territorial component, insofar as well hidden nest sites seem to be critical. In the central Amur it was found that pairs chose nest sites in flooded sedge marshes that had not been burned the previous year and provided cover from 30 to 80 centimeters in height (Viniter, 1981). Of twenty nest sites in China, ten were well hidden, and only two were unconcealed. Of these nests, thirteen were constructed almost entirely (90 percent) of reeds. Viniter stated that the five nests he studied were raised above water level 15-30 centimeters and were oval platforms about 100 centimeters in diameter. Likewise, the Chinese nests observed by Ma had average outer nest diameters of about 135 × 165 centimeters and were from 10 to 39 centimeters high.

Masatomi (1970-1972) believes that the female probably chooses the nesting site, but both sexes help build the nest, with the male primarily cutting the materials and the female placing them on the nest. It requires from two to three days at minimum to construct a nest, depending on weather and other disturbances. There is no good information on the frequency with which old nest sites are reused, but one pair observed by Viniter built their nest 600 meters away from the previous year's site.

As the nest is constructed, an open area around it is formed because of the cutting or pulling of reeds and grass. The diameter of this open space may be about 4 to 5 meters, and several paths often radiate from the area out into the reeds, reflecting the birds' movements. Sometimes nestlike platforms are found near the nests and apparently serve as nocturnal roosting sites. These structures are also used for roosting during the brooding period by the young (Ma, 1981).

Egg-laying and Incubation

Typically, egg-laying occurs during morning hours, often between 6:00 and 10:00. During the four years of observation at Tsuru Park, the first eggs were laid between March 18 and April 4, and about a month after the first copulations were observed. Eggs are laid from 2 to 4 days apart. It is believed that incubation begins with the first egg laid (Viniter, 1981). Of 20 nests studied by Ma (1981), 13 contained 2 eggs, 1 had 3 eggs, and 4 (possibly incomplete) nests had only a single egg. Five nests in the Amur River area had either 2 eggs (4 nests) or a single egg (1 nest). These data, together with those of Walkinshaw (see table 16), suggest that 2-egg clutches are normal in this species.

Most observers have found that incubation required from 29 to 31 days under wild conditions (Viniter, 1981; Ma, 1981), although Masatomi (1970-1972) reported durations in the wild of 31 to 34 days, and 31 to 36 days in Kushiro Park. Incubation is by both sexes, but females tend to spend more time on the nest than do males, especially during the nighttime hours (Viniter, 1981). Masatomi (1970-1972) reported that during the daytime hours, however, the male tends to incubate for a greater proportion of the time than does the female, with a particular tendency to incubate during the middle portion of the day. The eggs are usually turned when the birds exchange incubation duties, and in general the male tends to do more shifting of the eggs than does the female. In captivity, there are usually 2 to 6 shifts in incubation per day, but sometimes as many as 12.

The male takes the primary role in defending the nest against possible danger, and whichever parent is off the nest keeps a sharp lookout for possible intruders. Other Japanese cranes that enter the territory are immediately chased away, and white-naped cranes have also been observed being evicted.

Hatching and Postbreeding Biology

A few days prior to hatching, weak cries can be heard from the chicks inside their eggs, and shortly thereafter pipping begins. Although there is considerable variation, about 30 hours often elapse from the time the egg shell is initially pierced until the chick is completely out. The second egg often pips the second day after the

hatching of the first chick, although at times the second chick may emerge as soon as a day after the first chick. As soon as the chick has emerged from its shell, the parent crushes the shell and throws it from the nest (Ma, 1981).

Viniter (1981) reported that if food was plentiful near the nest, the brood remained on the pair's feeding territory for 1 to 2 weeks, but should they be disturbed the birds would move to the most distant areas of the marsh on the day after hatching. Ma (1981) found that birds moved about 20 meters from the nest on the day of hatching, and up to about 100 meters by the second day. Masatomi (1970-1972) found that the chicks may remain in the nest for 3 to 5 days. He noted that within 2 days of hatching parental feeding was noted only once, but 10 times on the third day, 5 times on the eighth day, and 93 times by the twenty-fifth day. Both parents feed the young, with no obvious tendency for one sex to do this more than the other. By the time the young are 10 weeks old, the chicks are being fed about twice an hour, and by 12 weeks from 2 to 5 times per hour. Generally the female pays more attention to the chicks than does the male, probably because the chicks tend to follow the female. By 3 months after hatching, the young are easily able to keep up with their parents, and fledging occurs at about this time. In China, fledging occurs in August, and by mid-September the young are able to fly for considerable distances. At this time they begin to move out into nearby uplands and cornfields, and within a month they begin their fall migration (Ma, 1981).

RECRUITMENT RATES, POPULATION STATUS, AND CONSERVATION

Age-ratio data for this species (tables 8 and 30) suggest that the annual recruitment rate is probably between 12.8 and 15.2 percent for the Japanese population, which is essentially fully protected. There seems to be no good information on age ratios for the population wintering in Korea. Of these, the majority probably come from the Manchurian portion of China, and at least part of that population is protected by the Jalong Natural Reserve, in the lower portion of the Wu Yu-erh River, southeast of Chichihar, in the Nun River basin. In the middle Amur Valley of the USSR the birds are so far subject to limited human disturbance, and a provincial refuge has been established there that may help to secure future nesting. However, the development of the Amur and Bureya floodplains by drainage activities and increased use by cattle has had a negative effect on crane populations (Dymin and Pankin, 1975). Similarly, the Lake Khanka area has suffered from intensive land development, and the white-naped crane no longer nests in that area at all, while the Japanese crane nests only in quite small numbers. In the Lake Bolon area of the lower Amur, some 13 to 15 pairs of Japanese cranes are known to be nesting, and part of this basin has been recommended as a preserve.

It is apparent that international efforts of the USSR, China, Japan, and Korea will be required to save the Japanese crane from extinction. Although the Hokkaido population is relatively secure because of its sedentary nature, its size is evidently close to a saturation point, as it has remained at about 200 birds since the late 1960s. Very little unoccupied marshland now exists in eastern Hokkaido, so it seems unlikely that the population will be able to increase very significantly from its present level. Indeed, only a section of the Kishiro Marsh and the Kiritappu marshes have been designated as a natural monument and are fully protected. Additionally, several wildlife protection areas and prefectural parks include some summer habitats. Nevertheless, reclamation of marshlands, primarily by drainage, threatens parts of the Kushiro Marsh, and several other summer habitats are in danger of land development programs (Masatomi and Kitagawa, 1974.)

EVOLUTIONARY RELATIONSHIPS

Archibald (1975, 1976) concluded that the closest relationships of the Japanese crane are with the hooded, Eurasian, and whooping cranes, based on unison call characteristics. However, Wood (1979) found that the hooded and Eurasian crane tended to cluster with the white-naped cladistically, so it seems likely that the nearest relative of the Japanese crane is the whooping crane.