



Title	Bionomics and Sociology of Tancho or the Japanese Crane, <i>Grus japonensis</i> , II. : Ethogram (With 132 Figures and 4 Tables)
Author(s)	MASATOMI, Hiroyuki; KITAGAWA, Tamaki
Citation	北海道大學理學部紀要, 19(4), 834-878
Issue Date	1975-06
Doc URL	http://hdl.handle.net/2115/27589
Type	bulletin (article)
File Information	19(4)_P834-878.pdf



[Instructions for use](#)

Bionomics and Sociology of Tancho or the Japanese Crane, *Grus japonensis*, II. Ethogram

By

Hiroyuki Masatomi and Tamaki Kitagawa

Hokkaido College, Senshu University, Bibai and Zoological Institute,
Hokkaido University, Sapporo

(With 132 Figures and 4 Tables)

Following the first report on the distribution, habitat and outline of annual cycle of Tancho or the Japanese crane *Grus japonensis* (Müller) (Masatomi and Kitagawa 1974), the present paper deals with the descriptions of its elementary behaviour patterns observed under natural conditions in eastern Hokkaido. The present study is basic for the clarification of Tancho's daily activities and coactions under diverse social situations, as well as for the analysis of behaviour patterns themselves, namely their origin, modification, causation, sequential association, and intra- and interspecific comparisons.

Various behaviour patterns of the cranes have been described by many authors, notably Blaauw (1897), Heinroth and Heinroth (1926), Walkinshaw (1949, 1973), Allen (1952), Moll (1963a, b, c), Makatsch (1970), etc., mainly in connection with specific life history of particular species and effort to breed them in captivity. But no attempt to prepare the specific ethogram has been carried out for any single species, except the recent observations of various species in captivity by Archibald (unpubl.).

As a *preliminary* tentative to such multiple purposes, only the typical postures, realized under various situations as combinations of some elementary forms and dispositions, are described below with brief interpretations of corresponding movements to facilitate appreciation and description of the Tancho's social life. Several bouts of behaviour appearing in particular social situations as territory defense, relief of incubation, parental care, etc., will be mentioned in detail in the subsequent papers as well as the variation of each behaviour pattern and released situations in the life of the Tancho. Vocalization and further discussions of behaviour patterns will be given in a later paper.

Methods

One of the serious obstacles for closer studies of Tancho is its official protection by the Japanese Government as a special natural monument, which prohibits any interferences in birds including closer contacts for scientific studies. Of course the rigorous protection is in principle justified and necessary but it occasionally changes to bureaucratic redtapes which, we believe, are not always necessary and sometimes even impeding real protection, that is, the protection based upon the scientific knowledge of the animal to be protected. Anyhow, our observations were made within this legal limitation.

Some basic procedures necessary for observations are briefly mentioned. The first approach is to find Tanchos in rugged deep marshlands from the top of the nearby hill. The important prerequisite is the choice of the favourable observation point, where their behaviour is easily checked. Unfortunately it is often difficult to detect them, especially in summer, when they are in or behind clusters of tall grasses, thickets, groves and other obstacles. The only procedure is *waiting* for their appearance in somewhat open and low vegetations or such watery places as shores of rivers or ponds. In several cases, however, transcribed unison calls produced by a tape recorder made the location of hidden pairs possible by their responding calls to the artificial ones. Early in the morning a pair sometimes utters unison calls which cause frequently chain reactions from one pair to another, making the location of several pairs possible, especially in early breeding period. On the contrary, behaviour in winter flocks is easier to observe, sometimes even from only 10 m or less, at the artificial feeding stations, except hindrance of heavy cold, reaching down to -28°C .

Using binocular telescope ($\times 9$) and high magnification telescope ($\times 25$, $\times 40$, $\times 60$), the crane could be identified individually by a number of features: Patterns of cheek feathers, minute wounds or deformities on legs, feather coloration, body size, and some other morphological peculiarities. But these features were useful only for birds in the breeding territory, not always for those in winter flocks, because the assemblage of many birds make the accurate individual identification difficult. Other auxiliary features useful for identification are: 1. Relative age can roughly be estimated by feather coloration on wings and neck and development of red crown (Figs. 1~6). 2. Identification of sexes is made by voice qualities and behaviour, especially unison calls (Figs. 101~105) and copulation behaviour (Figs. 119~123). The unison call is a duet made between two sexes, and in winter flocks often produces a synchronous chorus by many pairs. There are several types of unison call but generally male cries are one-syllabled while female follows it with two to three-syllables. In copulation, female spreads her wings and male mounts on female, though reversal mounting was once observed in the field and sometimes in captivity. Besides field observations and sketches, most postures and movements were photographed by 35 mm format cameras with a 200~600 mm zoom lens, 500 mm and 1,000 mm telephoto lens, etc., and a 8 mm cinecamera with a 9.5~78 mm zoom lens. All figures given below were redrawn from these photos.

Most observations are the continuous tracing of individually identified pairs for several days per month throughout the year, on each day from early morning, usually before sunrise till night. Additional observations were conducted also in various adverse weather conditions. Further, an aerial survey covering lowlands of the Kushiro Marsh, Bekanbeushi riverside, Kiritappu Marsh, and a part of the shore of Lake Furen, etc., was made on 19th May, 1972 in order to find nests or breeding individuals.

Some remarks on behaviour patterns

Various types of behaviour patterns are classified into two groups: *Maintenance behaviour* which does not involve coactions between conspecific individuals or with other objects such as enemies, competitors as well as strange objects and *interindividual behaviour* which deals with the coactions mentioned above.

First elementary forms and dispositions of main body parts participating in the realization of behaviour patterns such as head, neck, trunk, etc., are arbitrarily classified into several phases (Figs. 7~17 and Table 1) which are used in subsequent descriptions though the change between successive phases are continuous. Body

Table 1. Terms and abbreviations used for behaviour descriptions.

Body part (abbreviation)	Phase (elementary form and position)
<i>Body</i> <i>Body position</i> (B_{op})* (B_o) Fig. 7	1. Standing 2. Heel-standing 3. Sitting
<i>Feather</i> <i>Feather</i> (F)* (F) <i>Head</i> (F_h) <i>Neck</i> (F_n) <i>Trunk</i> (F_t) <i>Breast</i> (F_{tb}) <i>Belly</i> (F_{te}) <i>Leg</i> (F_{ll}) Fig. 8	1. Erected or fluffed 2. Normal 3. Sleeked
<i>Bill</i> <i>Bill direction</i> (B_d)* (B) Fig. 9	1. Steeply down ($90^\circ \sim 60^\circ$) 2. Obliquely down ($60^\circ \sim 30^\circ$) 3. Slightly down (30° or less) 4. Horizontal 5. Slightly up (to $\sim 30^\circ$) 6. Obliquely up ($30^\circ \sim 60^\circ$) 7. Steeply up ($60^\circ \sim 90^\circ$) 8. Touching body 9. Backward
<i>Bill state</i> (B_s)* Fig. 10	1. Opened widely 2. Opened slightly 3. Closed
<i>Head</i> <i>Head position</i> (H)* (H) Fig. 11	1. Highest (conspicuously above trunk level) 2. High (slightly above trunk) 3. As high as trunk 4. Low (slightly below trunk) 5. Lowest (conspicuously below trunk level)
<i>Red crown</i> <i>Red crown</i> (C)* (C) Fig. 12	1. Expanded entirely 2. Expanded slightly 3. Contracted

Table 1. Continued.

Body part (abbreviation)	Phase (elementary form and position)
<i>Neck</i> <i>Neck inclination</i> (N_i)* (N) Fig. 13	<ol style="list-style-type: none"> 1. Downsteep ($90^\circ \sim 60^\circ$) 2. Obliquely down ($60^\circ \sim 30^\circ$) 3. Slightly down (30° or less) 4. Horizontal 5. Slightly up (to $\sim 30^\circ$) 6. Obliquely up ($30^\circ \sim 60^\circ$) 7. Vertically up ($60^\circ \sim 90^\circ$) 8. Backward
<i>Neck form</i> (N_f)* Fig. 14	<ol style="list-style-type: none"> 1. Retracted slightly (curved in shallow S shape) 2. Retracted fairly (curved in deep S shape) 3. Waved exaggeratively 4. Stretched 5. Arched
<i>Trunk</i> <i>Trunk inclination</i> (T_i)* (T) Fig. 15	<ol style="list-style-type: none"> 1. Obliquely down ($60^\circ \sim 30^\circ$) 2. Slightly down (30° or less) 3. Horizontal 4. Slightly up (to $\sim 30^\circ$) 5. Obliquely up ($30^\circ \sim 60^\circ$) 6. Upright ($60^\circ \sim 90^\circ$)
<i>Wing</i> <i>Wing</i> (W)* (W) Fig. 16	<ol style="list-style-type: none"> 1. Opened widely to sides 2. " " upwards 3. " partially to sides 4. " " upwards 5. " laterally and backwards 6. Folded obliquely up (detached fairly from trunk) 7. " slightly up (detached slightly from trunk) 8. " faintly up (not detached from trunk) 9. Closed 10. Drooped
<i>Tail</i> <i>Tail direction</i> (T_{ad}) (T_a)	<ol style="list-style-type: none"> 1. Elevated up 2. Same with T_i 3. Slightly below 4. Laterally compressed
<i>Tail form</i> (T_{af})	<ol style="list-style-type: none"> 1. Fanned 2. Closed
<i>Leg</i> <i>Leg</i> (L)* (L) Fig. 17	<ol style="list-style-type: none"> 1. Stretched 2. Normal 3. Bent 4. Drawn
<i>Toes</i> <i>Toes</i> (T_o) (T_o)	<ol style="list-style-type: none"> 1. Opened clearly 2. " partly 3. Closed
<i>Eyes</i> <i>Eyes</i> (E) (E)	<ol style="list-style-type: none"> 1. Opened 2. Closed

*: Figure reference.

Table 2. Appearance of different phases of elementary forms and positions

Postures	Phase	B_{op}	F_h	F_n	F_{tb}	F_{te}	F_{tl}	B_d
R _{e1}	Sleep-like-resting	1	1	1	1	1	1,2	8
R _{e2}	Neck-shortening-resting	1	1	1	1	1	1,2	3
R _{e3}	Sitting	3	1	1	1	?	?	v
S ₁₁	Back-sleeping	1	1	1	1	1,2	1,2	8
S ₁₂	Down-sleeping	1	1	1	1,2	1,2	1,2	1
S ₁₃	Sit-back-sleeping	3	1	1	1	?	?	8
S ₁₄	Sit-down-sleeping	3	1	1	1	?	?	1
P _{r1}	Neck-preening	1,3	1	1	1	1	1,2	8
P _{r2}	Back-preening	1,3	2	2	2	2	1,2	8
P _{r3}	Breast-preening	1	2	2	1	1	1,2	8
P _{r4}	Wing-preening	1	1,2	1,2	1	1	1,2	8
P _{r5}	Leg-plumage-preening	1	1,2	1,2	1	1	1,2	8
P _o	Oiling	1	1,2	1,2	1,2	1	1,2	8
P _{s1}	Head-scratching	1	2	2	2	2	2	1,2
P _{s2}	Neck-scratching	1	2	2	2	2	2	2
P _{h1}	Ordinary-head-rubbing	1	2	2	1	1	2	v
P _{h2}	Crown-rubbing	1,3	1,2	1,2	1,2	1,2	1,2	?
S _{h1}	Head-shaking	1,3	2	2	2	2	2	1,2
S _{h2}	Head/neck-shaking	1	1	1	1	1	1,2	3
S _{h3}	Body-wing-shaking	1	1	1	1	1	1,2	2
S _{h4}	Wing-shaking	1	1,2	1,2	1	1	1,2	2
S _{h5}	Leg-shaking	1	v	v	v	v	v	1~4
S _{h6}	Tail-wagging	1	v	v	v	v	2	1~4
L _s	Leg-stretching	1	2	2	2	2	2	3
W _r	Wing-raising	1	2	2	1,2	1,2	2	2,5
R _r	Rump-raising	1	1,2	1,2	1,2	1,2	1,2	?
W _f	Wing-flapping	1	2	2	2	2	2	3
B _a	Bathing	2	1	1	1	1	1	2~4
W _a	Head/beak-washing	1	2	2	2	2	2	2,3
S _{u1}	Neck-sunning	1	1	1	1,2	1,2	1,2	2,3
S _{u2}	Wing-spread-sunning	2	1	1	1	1	1	2
P _a	Panting	v	2,3	2,3	2,3	2,3	2,3	4
Y _a	Yawning	v	1,2	1,2	1,2	1,2	1,2	3
W ₁	Slow-walking	1	1,2	1,2	1,2	1,2	1,2	3,4
W ₂	Rapid-walking	1	2	2,3	2,3	2,3	2,3	3,4
R _u	Running	1	3	3	3	3	3	4
S _w	Swimming	1	2	2	2	2	2	4
F _w	Watching	1	3	3	3	3	3	4
F _i	Intentional posture	1	3	3	3	3	3	4
F _{d1}	Horizontal-head-dashing	1	3	3	3	3	3	4
F _{d2}	High-head-dashing	1	3	3	3	3	3	3
F _t	Taking-off	1	3	3	3	3	3	4
F _f	Flapping-flight	1	3	3	3	3	3	4
F _s	Soaring	1	3	3	3	3	3	4
F _{g1}	Horizontal-gliding	1	3	3	3	3	3	4
F _{g2}	Downward-gliding	1	3	3	3	3	3	3
F _l	Landing	1	3	3	3	3	3	2,3
S _{e1}	Foraging	1	2	2	2	2	2	1,2
S _{e2}	Sticking	1	2	2	2	2	2	1

in various postures. Abbreviations and phase numbers given in Table I.

B_s	H	C	N_i	N_f	T_i	W	T_{ad}	T_{af}	L	T_o	E
3	3	3	8	2	3,4	9	2	2	2.4	1	1
3	2,3	3	7	2	3,4	9	2	2	2	1	1
3	2,3	3	7	v	3	9	3	2	4	1	1,2
3	3	3	8	2	4	9	2	2	1,4	1	2
3	2	3	7	1,2,5	4	9	3	2	2	1	2
3	3	3	8	2	3	9	3	2	4	1	2
3	2	3	7	1,5	3	9	3	2	4	1	2
2	1	3	6,7	4	5	9	2	2	2	1	1
2	2,3	3	8	1,2	3,4	9,10	2	2	2	1	v,2
2	3	3	2	1	4,5	9	2	2	2	1	1
2	3	3	8	1	4,5	9	2	2	2	1	1,2
2	4	3	1	1	4,5	9	2	2	2	1	1,2
1,2	v	3	v	v	v	v	2	1,2	2	1	1,2
3	5	3	2	1	4	9	2	2	2,3	v	1,2
3	5	3	2	4,5	3	9	2	2	2,3	v	1
3	3	3	8	1,2,4	4,5	9	2	2	2	1	2
3	3	3	8	4	5	9	2	2	2	1	2
3	2~5	3	2~6	1,2	2~4	9	2	2	2	1	2
3	3	3	4	4	3,4	9	2	?	2	1	2
3	3	3	5	1,2	4	7	2	2	2	1	1
3	2	3	5,6	1,4	3,4	3	2	2	2	1	1
3	1~3	3	5~7	1,2	3,4	9	2	2	2,3	2,3	1
3	v	3	v	1,2	2~4	7~9	2	2	2	1	1
3	2,3	3	7	2	2	9.5	2	v	1,2	1,2	1
3	3,4	3	7	1,5	3	2,4	2	2	2	1	1
3	3,4	3	?	?	2	?	?	?	1	1	1
3	1	3	7	4	6	1	2	?	2	1	1
2,3	v	3	v	1,2,4	v	v	v	v	3	v	1,2
3	4	3	?	?	2	9	2	2	2	1	?
3	2	3	7	1,5	4	9	2	2	2	1	1,2
2	3	3	7	2	3	1,10	?	?	3	?	1
1,2	1,2	3	6,7	1,4	v	v	?	v	v	v	1
1	1~3	3	6,7	1,2	3,4	9	2	2	v	v	1
3	2	3	7	2	4	9	2	2	2	1	1
3	1	2,3	7	1	3	9	2	2	2	1	1
3	1	2,3	7	4	3	9,1	2	2	2	1	1
3	1	3	7	1	3	7	?	?	?	?	1
3	1	1,2	7	4	5	9	?	2	2	1	1
3	3	2,3	4	4	3	9,3	3	2	2	1	1
3	3	2,3	4,5	4	3	1	2	1	3,2	1	1
3	2	2,3	6	1	3	1	2	1	2,3	1	1
3	2,3	2,3	5	4	4	1	2	1	1,2	3	1
3	3	3	4	4	3	1	2	1	1	3	1
3	3	3	4	4	3	1	2	1	1	3	1
3	3	3	4	4	3	1	2	1	1	3	1
3	2,3	3	3	4	3	1	?	1	3	3	1
3	1,2	3	4,5	1	4~6	1	1	?	2,3	1	1
3	3	3	5,6	1,2	3	9	?	2	2	1	1
2,3	5	3	1	1	2,3	9	?	2	2	1	?

Table 2.

Posture	Phase	B_{op}	F_h	F_n	F_{tb}	F_{te}	F_{tl}	B_d
E _{t1}	Eating-small-food	1	2	2	2	2	2	1
E _{t2}	Eating-medium-food	1	2	2	2	2	2	1, 2
E _{t3}	Eating-moving-animal	1	2	2	2	2	2	1, 2
E _{t4}	Eating-large-food	1	2	2	2	2	2	1, 2
D	Drinking	1	2	2	2	2	2	5
D _e	Defecation	1	v	v	v	v	v	2~4
G ₁	Neck-retracted-gazing	1	1	1	1	1	2	4
G ₂	Neck-raised-gazing	1	2, 3	2, 3	2, 3	2	2	4
G ₃	Neck-curved-gazing	1	3	3	3	2	2	4
G ₄	Sit-gazing	3	3	3	3	?	?	4
A ₁	Downward-adornment	1	3	3	2	1	1, 2	1
A ₂	Forward-adornment	1	3	3	2	1	1, 2	4
A ₃	Lowered-adornment	1	3	3	2	1	1, 2	1
A _{r1}	Forward-arching	1	3	3	1, 2	1	2	6, 7
A _{r2}	Side-backward-arching	1	3	3	1, 2	1	2	9, 6
B ₁	Low-bowing	1	3	3	2	1	1	1, 2
B ₂	High-bowing	1	3	3	2	1	1	1
B ₃	Wing-shake-bowing	1	3	3	2	1	1	1
B ₄	Wing-raise-bowing	1	3	3	2	1	1	1
I _g	Irrelevant-ground-sticking	1	3	3	2	1	2	1, 2
I _b	Irrelevant-back-preening	1, 3	3	3	2	1	2	8
I _l	Irrelevant-leg-preening	1	3	3	2	1	2	8, 4
I _{c1}	Irrelevant-crouching 1	3	2	2	2	2	2	4
I _{c2}	Irrelevant-crouching 2							
I _w	Irrelevant-wing-opening	1	3	3	2	3	3	4
I _h	Irrelevant-head-shaking	1	3	3	2	1	1	2
A _{t1}	Chasing	1	3	3	3	3	3	4
A _{t2}	Upright-pecking	1	3	3	3	3	3	3
A _{t3}	Forward-pecking	1	3	3	3	1	1	4
A _{t4}	Kicking	1	3	3	3	1	1	3
A _l	Alert	1	3	3	3	3	3	4
E _{s1}	Neck-retracted-submission	1	1, 2	1, 2	1, 2	1, 2	1, 2	2
E _{s2}	Head-down-submission	1	1	1	2	2	2	2
E _a	Avoiding	1	3	3	3	3	3	2, 3
E _w	Wing-raise-fleeing	1	3	3	3	3	3	2, 3
E _p	Wing-spread-fleeing	1	3	3	3	3	3	3
E _r	Running-off	1	3	3	3	3	3	4
E _j	Jumping-up	-	3	3	3	3	3	3
D _{u1}	Closed-wing-duetting	1	3	3	3	1	1	6, 7
D _{u2}	Semiclosed-wing-duetting	1	3	3	3	1	1	6, 7
D _{u3}	Semiraised-wing-duetting	1	3	3	3	1	1	6, 7
D _{u4}	Obliquely-riased-wing-duetting	1	3	3	3	1	1	7
D _{u5}	Drooped-wing-duetting	1	3	3	3	1	1	7
D _{a1}	Stooping	1	3	3	3	2	2	v
D _{a2}	Pre-leaping	1	3	3	3	2	2	3
D _{a3}	Leaping	1	3	3	3	2	2	3
D _{a4}	Floating	1	3	3	3	2	2	1

Continued.

B_s	H	C	N_i	N_f	T_i	W	T_{ad}	T_{af}	L	T_o	E
2	5	3	1	1	2~4	9	?	2	2	1	1
1,2	5	3	2,3	1	2,3	9	?	2	2	1	1
2	5	2,3	2,3	4	2	9	?	2	2	1	1
1~3	5	3	2	1	2,3	9	2	2	2	1	1
3	2	3	7	1	3	9	?	2	2	1	1
3	2,3	2,3	4~6	1	3	9	2	2	2	1	1
3	2,3	2,3	7	2	4	9	?	2	2	1	1
3	2	2,3	7	1	4	9	?	2	2	1	1
3	1	1,2	7	1	5	9	?	2	2	1	1
3	1	1,2	7	1,4	4	9	?	2	4	3	1
3	1	1	7	3	5	8	2	2	2	1	1
3	1	1	2	3	5	8	2	2	2	1	1
3	2	1	7	3	3,4	8	2	2	2	1	1
3	1	1	6,7	3	4	6	1	2	2	1	1
3	1	1	8,6	3	4	6	1	2	2	1	1
3	5	1	1,2	5	4,5	7,9	2	2	2	1	1
3	1	1	6,7	4	5	9	2	2	2	1	1
3	2	1	5	4	4	7	2	2	2	1	1
3	1	1	6,7	5	6	1,6	2	2	2	1	1
2	5	1	1	5	2	8	2	2	2	1	1
3	2	1	5.8	5	3,4	3.8.10	2	2	1	1	1
3	5	1	1	4	4	9	2	2	2	1	1
3	1	?	7	5	3	9	?	2	3	?	1
3	1	1	7	4	5	1	?	?	2	1	1
3	5	1	1	1	2	9	?	2	2	1	1
1	3	1	6	1	3	1	2	1	2,3	1	1
1	1	1	6,7	4	6	3	?	2	2	1	1
3	2	1	7	2	3	8	1	2	2,3	1	1
1	1	1	7	4	6	1	1	1	3	?	1
3	1	1,2	7	4	5	9	?	2	2	1	1
3	3	1-3	7	2	3,4	9	?	2	2	1	1
3	5	-	2	1	3	9	?	2	2	1	1
3	1	1	7	4	4	9	?	2	2	1	1
3	1	2,3	7	1	4	2,4	?	2	2	1	1
3	1	2,3	7	1	5	1,3	?	1	2	1	1
3	3	2,3	7	1	3	1	?	2	3	1	1
3	2	2,3	6	1	3	1	2	2	3	1,2	1
1	1	1	7	4	3	9	2	2	2	1	1
1	1	1	7	4	3	8	2	2	2	1	1
1	1	1	7	4	3	7	1	2	2	1	1
1	1	1	7	5	3	6	1	2	2	1	1
1	1	1	7	5	3	10	1	2	2	1	1
2,3	3,4	1	7	2	2,3	1,3,9	2	1,2	3	1	1
3	2	1	7	1	5	1	1,2	1,2	2	1	1
3	1	1	6,7	4	5,6	1	1	1	2,3	1,2	1
3	2	1	6	1	4,5	1	3	1	2	3	1

Table 2.

Posture	Phase	B_{op}	F_h	F_n	F_{tb}	F_{te}	F_{ti}	B_d
D _{a5}	Rushing	1	3	3	3	2	2	4
D _{a6}	Picking-up	1	3	3	3	2	2	3
D _{a7}	Throwing	1	3	3	3	2	2	5
D _{a8}	Turning	1	3	3	3	2	2	4, 9
C ₁	Bill-raising	1	3	3	3	2	2	5, 6
C ₂	Wing-spreading	1	3	3	3	2	2	3, 4
C ₃	Mounting	1	3	3	3	3	2	1
C ₄	Being-mounted	1	3	3	3	3	2	1, 2
C ₅	Copulating							
N _b	Nest-building	1	2	2	2	2	2	1, 2
I ₁	Shifting	1	2	2	2	2	2	1
I ₂	Settling	3	1	1	1	1	?	v
I ₃₁	Nest-mending-in-standing	1	2	2	2	2	2	1
I ₃₂	Nest-mending-in-sitting	3	2	2	2	2	?	1, 2
F _{e1}	Low-feeding	1	2	2	2	2	2	1
F _{e2}	Forward-feeding	1	2	2	2	2	2	3
F _{e3}	Side-back-feeding	1	2	2	2	2	2	9, 3
B _r	Brooding	3	1	1	1	1	?	v
F _o	Following	1	2	2	2	2	2	3
C _c	Chick-covering	1	3	3	3	1	1	1, 2
B _t	Bill-touching	1	2	2	2	2	2	2, 3
M _o	Mobbing	1	3	3	3	3	2	3, 4
D _i	Diversionsary display	1	3	3	3	3	2	3

Comma: or; Period: plus; V: variable.

parts and their dispositions are abbreviated in Italique in Table 1 and in subsequent descriptions. These elementary forms and dispositions are organized into complex behaviour patterns characteristic of this species.

In the following description of each behaviour pattern, first the phases of elementary forms and dispositions presumed to be typical of behaviour pattern concerned under various situations are briefly mentioned (cf. Table 2), followed by references to the associated movements or the situations under which the concerned pattern is frequently performed. Fundamental dispositions of body are divided into three phases (Fig. 7), standing, heel-standing, and sitting, which are common to many postures.

Concerning interindividual behaviour, which can further be classified into four major divisions, common names are used for several similar behaviour patterns appearing in different situations for the lack of any appreciable difference in the posture. Although these behaviour patterns may differ one another as to the underlying mechanisms or significance, we provisionally lumped together those similar in external form into one and the same behaviour pattern, giving common explanations. The description of behaviour patterns is given often but not always with an abbreviated style.

Continued.

B_s	H	C	N_i	N_f	T_i	W	T_{ad}	T_{af}	L	T_o	E
1, 3	2, 3	1	7	2	3	1	1, 2	1	2, 3	1, 3	1
2	5	1	3	1	3	1	?	2	2, 3	1	1
3	1	1	7	4	6	1	?	2	1, 2	1	1
3	1	1	7	4	6	1, 5	?	2	2	1	1
3	1	1	7	4	4, 5	9	2	2	2	1	1
3	1	1	7	1	5	1	2	2	2	1	1
1, 2	3	1	4	2	3	1	2	1	3	1, 2	1
3	3	1	3~5	1, 2	2, 3	1	2, 3	2	2	1	1
3	3	3	5, 6	1, 2	2	9	2	2	2	1	1
3	5	3	1	1	2	9	2	2	2	1	1
3	2, 3	3	7	v	3	8	2	2	4	?	1
3	5	3	1	1	2	9	?	2	2	1	1
3	3	3	v	2	3	9	?	?	4	?	1
3	4	3	1	1	3	9	2	2	2	1	1
3	3	3	5	1	3	9	2	2	2	1	1
3	3	3	8, 5	1	3	9	2	2	2	1	1
v	2, 3	3	7	1, 2	3	8	2	?	4	?	1
3	2	3	7	2	3	9	2	2	2	1	1
1	2	1	7	1, 2	3	1	2	?	2, 3	?	1
3	2	3	5, 6	1	3, 4	9	2	2	2	1	1
2, 3	1	1, 2	7	4	5	9	2	2	2	1	1
3	2	1	6	1, 2	3	1	2	2	2	1	1

A. Maintenance behaviour

Under the maintenance behaviour the following behaviour patterns are involved: resting, sleeping, comfort movements (preening, shaking, leg-stretching, wing-raising, rump-raising, wing-flapping, head/beak-washing, bathing, sunning, panting, yawning), locomotion, food intake, defecation, and gazing. One characteristic feature common to them is the contraction of the red crown with the colour inconspicuous blackish-red (Fig. 12), though variable according to individual, season and situation.

A.I. Resting (R_e): Composed of sleep-like-resting, neck-shortening-resting, and sitting.

I.1. Sleep-like-resting (R_{e1} , Fig. 18): F erected enough, B completely hidden within F of back, H laid on back, N_i backward, T_i nearly horizontal, B_o seen to be lessened. Similar to back-sleeping (S_{11} , A.II.1.) but E usually opened.

I.2. Neck-shortening-resting (R_{e2} , Fig. 19): F similar to R_{e1} , B_d oriented slightly down or horizontally forwards, H held slightly high, N_f fairly retracted and curved in deep U shape, T_i slightly upward.

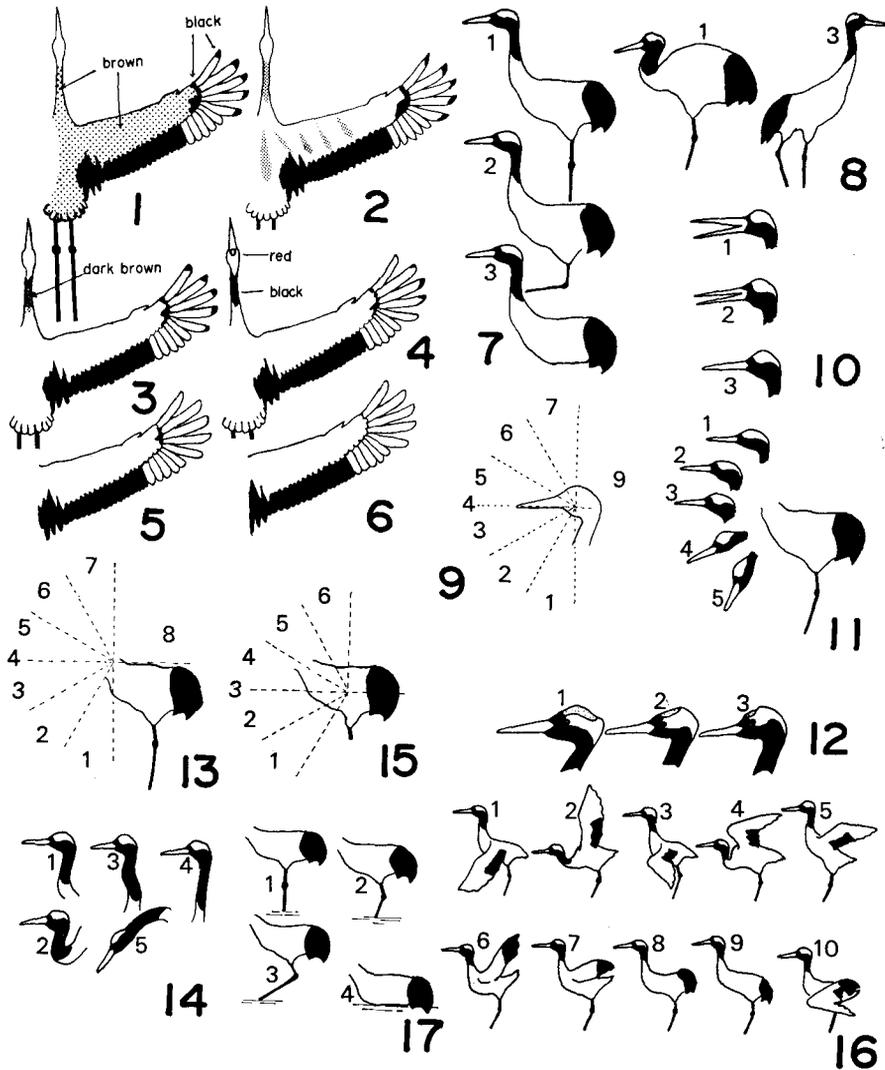


Fig. 1~17. Distinction of relative age (Fig. 1~6) and schematic presentation of elementary forms and dispositions of movable body parts (Fig. 7~17), abbreviations given in Table 1. 1. Juvenile; 2. Younger than one year; 3. One year old; 4. One~two years old; 5. Two years old; 6. Older than two years; 7. *Body position* (B_{op}); 8. *Feather* (F); 9. *Bill direction* (B_d); 10. *Bill state* (B_s); 11. *Head position* (H); 12. *Red crown* (C); 13. *Neck inclination* (N_i); 14. *Neck form* (N_f); 15. *Trunk inclination* (T_i); 16. *Wing* (W); 17. *Leg* (L).

I.3. Sitting (R_{e3} , Fig. 20): Similar to incubating posture (I, B. II. 5.), relatively rare, seen more frequently in young and unhealthy Tanchos than in adult. In winter, 1972, however, once nearly all Tanchos of a flock took this posture simultaneously at a feeding station seemingly after satisfied to feed.

The Tancho rests on land, never on trees, usually in a standing position (*Bipedal standing*, S_b), but it frequently draws up one L in F_{1e} (*Unipedal standing*, S_u), after wagging T_0 and L concerned (cf. leg-shaking, L_s , A. III. 2.5.). Resting (R_e) occurs mostly after feeding. By synchronisation of activity cycle nearly all birds of a flock rest drowsily at the winter feeding station and then they sometimes turn to the same direction (e.g. windwards) with similar resting posture. The duration of resting is variable, especially at artificial feeding stations by human interference. Resting and other comfort or maintenance behaviour are usually performed alternately during a relatively short inactive period.

A.II. Sleeping (S_1): **II.1. Back-sleeping** (S_{11} , Figs. 18 and 21). Similar to sleep-like-resting (R_{e1}), but E closed, both H and B at times fairly hidden in F of wing-base, T_i held slightly or obliquely upwards; **II.2. Down-sleeping** (S_{12} , Fig. 22) Similar to neck-shortening-resting (R_{e2}), but sometimes B drawn to N and its tip nearly touching lower N or upper breast; **II.3. Sit-back-sleeping** (S_{13} , Fig. 23). S_{11} in sitting. **II.4. Sit-down-sleeping** (S_{14} , cf. Fig. 22). S_{12} in sitting.

Sleeping (S_1) is performed with the similar manner and in similar situations as in resting (R_e), it is naturally prolonged at roost and often at incubation (I, B.II.5.)

A.III. Comfort movement: Composed of activities caring body surface, but stretching, sunning, panting and yawning are also included here (cf. McKinney 1965).

III.1. Preening (P): Many different postures are recognized depending upon the part to be preened, but only some typical ones are cited below. In all cases generally, F erected slightly to fairly.

1.1 Preening usually with bill (P_r): **1.1.1. Neck-preening** (P_{r1} , Fig. 24). B_d oriented steeply down and touching F_n , H highest, N_i stretched obliquely to vertically up, T_i slightly or obliquely up; **1.1.2. Back-preening** (P_{r2} , Figs. 25 and 26). B touching F of back, H high or as high as T , N_f retracted slightly, N_i held backwards, T_i slightly to obliquely up; **1.1.3. Breast-preening** (P_{r3} , Fig. 27). B touching F_{1e} , H as high as T , N_i obliquely down, N_f retracted slightly, T_i obliquely up; **1.1.4. Wing-preening** (P_{r4} , Fig. 28). B touching W , H as high as T , N retracted slightly, N_i held back and side, T_i slightly or obliquely up; **1.1.5. Leg-plumage-preening** (P_{r5} , Fig. 29). B touching F_{1b} , H low, N_i downsteep, T_i slightly or obliquely up.

The Tancho frequently preens its plumage with B regardless of season, place or time of day, e.g. even at midnight. But the activity is most frequent at roosts before and after sleep, and feeding stations in daytime. It is usually practiced with bipedal (S_b) or unipedal standing (S_u). Preening at sitting is mostly per-

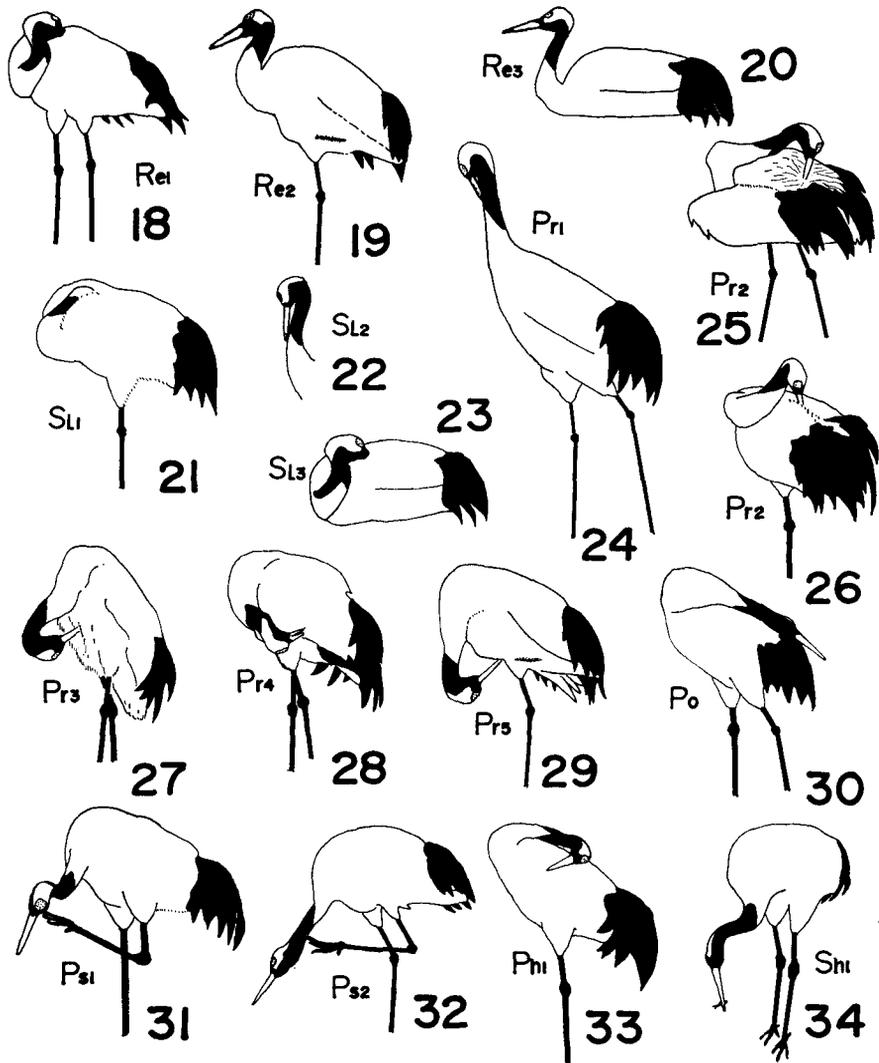


Fig. 18~34. Postures of maintenance behaviour. 18. Sleep-like-resting (R_{e1}) or Back-sleeping (S_{11}); 19. Neck-shortening-resting (R_{e2}); 20. Sitting (R_{e3}); 21. Back-sleeping (S_{11}); 22. Down-sleeping (S_{12}); 23. Sit-back-sleeping (S_{13}); 24. Neck-preening (P_{r1}); 25, 26. Back-preening (P_{r2}); 27. Breast-preening (P_{r3}); 28. Wing-preening (P_{r4}); 29. Leg-plumage-preening (P_{r5}); 30. Oiling (P_0); 31. Head-scratching (P_{s1}); 32. Neck-scratching (P_{s2}); 33. Ordinary-head-rubbing (P_{h1}); 34. Head-shaking (S_{h1}).

formed by incubating birds. Some movements such as careful pecking, nibbling and drawing accompany to preening.

1.2. Oiling (P_0 , Fig. 30): During preening with $B(P_r)$, the Tancho sometimes swears F with secretions from uropigial glands with B and H , which is outwardly difficult to distinguish from P_r and ordinary-head-rubbing (P_{h1} , A.I. 1.4.1.). The Tancho combs F as in P_r and rubs oiled head against back, wings, neck, breast, etc., as in P_{h1} .

1.3. Scratching (P_s): H and upper parts of N to which B cannot reached, are scratched with T_o of one L .

1.3.1. Head-scratching (P_{s1} , Fig. 31): B_d steeply down, H lowest and usually twisted a little, N_j retracted slightly and N_i obliquely down, T_i slightly up, T_o closed partly. **1.3.2. Neck-scratching** (P_{s2} , Fig. 32): Similar to P_{s1} but N_i stretched obliquely down, B_d nearly to the same direction with N , H not twisted.

Scratching is gently made with the middle claw. L is brought directly, not over W , to the part scratched.

1.4. Head-rubbing (P_h): Two distinct types possibly governed by different mechanisms are recognized.

1.4.1. Ordinary-head-rubbing (P_{h1} , Fig. 33): F normal or faintly fluffed, H rubbed against back, B_d side-, down- or backward, N curved or stretched backwards or above back, T_i obliquely up. After turning H backward with B directed down from gazing (G, A.VII.), the Tancho rubs sides and top of H or throat against back or side of B_o . This sometimes performed during or after oiling (P_0 , A.III.1.2.). **1.4.2. Crown-rubbing** (P_{h2}): Similar to P_{h1} , but only C , not face or upper N , is rubbed. Performed independent from preening activities and observed mostly in summer, especially frequently in the evening, possibly to sweep away insects gathering on bare C .

III.2. Shaking (S_h): Six distinct types possibly of different underlying mechanisms and situations are recognized.

2.1. Head-shaking (S_{h1} , Fig. 34): F normal, H high to lowest, B_d obliquely or steeply down, N_j retracted slightly or fairly, N_i obliquely up to down, T_i horizontal, H , mainly B , rapidly shaken laterally, either once or in repetition, usually accompanied with a slight H twisting. This movement is more often associated with eating (E_t , A.V.2.), preening, etc., but appears also at agonistic situations.

2.2. Head/neck-shaking (S_{h2} , cf. Fig. 35): H as high as T , B_d slightly down, N extended horizontally with F fluffed, T_i slightly up, H and N quickly twisted several times around their longitudinal axis.

2.3. Body/wing-shaking (S_{h3} , cf. Fig. 35): F erected fully, B_d obliquely

down, N_f retracted slightly, H as high as T , T_i slightly up. This is eagerly performed always after bathing (B_a , A.III.7.), but sometimes appearing independently. This is mainly performed with B_o shaking circularly, either in bipedal (S_b) or in unipedal standing (S_u), often immediately followed by S_{h2} , resulting in a compound posture shown in Fig. 35.

2.4. Wing-shaking (S_{h4}): Similar to preening (P_r , A.III.1.), but B not touching F , N_i slightly or obliquely up, H high. During oiling (P_o , A.III.1.2.) and preening, the Tancho shakes or rubs both W several times quickly with trembling in nearly horizontal plane. This is regularly combined with preening (P_r , A.III.1.1.)

2.5. Leg-shaking (S_{h5} , Fig. 36): One L bent slightly, T_0 closed partly, accompanied by several basic postures such as resting (R_e , A.I.) and walking (W , A.IV.1.). Besides previous case (cf. A.I.), this movement was performed when the Tancho was caught by grass or something during walking.

2.6. Tail-wagging (S_{h6}): H high to lowest, T_i slightly up to down. T_a is laterally flicked several times, not only among comfort movements, but at social situations.

III.3. Leg-stretching (L_s , Fig. 37): F normal, B_d directed slightly downwards, H slightly high or as high as T , N_f retracted or curved in deep U shape, T_i slightly down, one L and corresponding W , but not always, stretched lateroposteriorly and sometimes touching together. Often preceded by relaxing behaviour such as bouts of preening (P_r , A.III.1.1.), resting (R_e , A.I.), or gurdng in quiet for chicks.

III.4. Wing-raising (W_r , Fig. 38): F normal or fluffed slightly, H as high as T or high, N_f retracted fairly, T_i about horizontal. There are two postures: Raising with widely opened or partially opened W . Also performed at situations similar to those releasing leg-stretching (L_s).

III.5. Rump-raising (R_r): F normal or fluffed slightly, H slightly low or as high as T , T_i slightly down, rump raised slightly, L stretched. Also performed at situations similar to those releasing leg-stretching (L_s), and often combined with wing-raising (W_r).

III.6. Wing-flapping (W_t , Fig. 39): B_d slightly down or horizontal, H highest, T_i steep or upright, N_f stretched, W entirely stretched and beaten several times strongly. Observed during or after resting (R_e , A.I.), preening (P_r , A.III.1.1.), foraging (S_{e1} , A.V.1.1.), eating (E_t , A.V.2.), etc. Sometimes followed by other comfort movements.

III.7. Bathing (B_a): F fluffed fully, first fore body lowered, H , N , and shoulder dipped into water, both W flicked together. Nextly fore body raised slightly with partially opened W beating or shuffling, as well as F ruffled fully. Bathing is made with heel standing disposition in river, lakeshore, or shallow water and always fol-

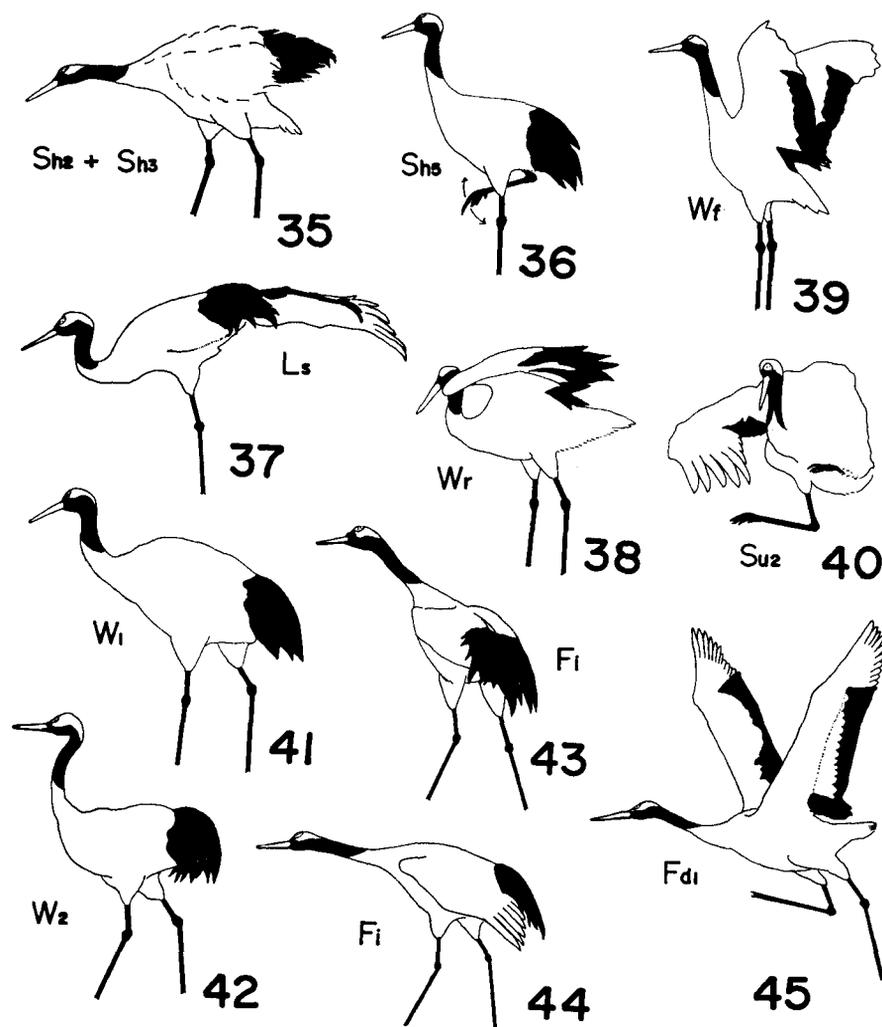


Fig. 35~45. Postures of maintenance behaviour. 35. Compound posture of Head/neck-shaking (S_{h2}) and Body/wing-shaking (S_{h3}); 36. Leg-shaking (S_{h5}); 37. Leg-stretching (L_s); 38. Wing-raising (W_r); 39. Wing-flapping (W_f); 40. Wing-spread-sunning (S_{u2}); 41. Slow-walking (W_1); 42. Rapid-walking (W_2); 43, 44. Intentional postures (F_i); 45. Horizontal-head-dashing (F_{d1}).

lowed by eager preening (P_r , A.III.1.1.), oiling (P_o , A.III.1.2.), wing-shaking (S_{h4} , A.III.2.4.), etc. Observed throughout the year but not frequently.

III.8. *Head/beak-washing* (W_a): F normal, H lowered, B_d slightly or obliquely

down, T_i slightly down, H shaken several times or slightly immersed in water. Performed when B , face and H becoming muddy by food-searching (Se, A.V.1.) in water bottom.

III.9. Sunning (S_u): Relatively rare with two distinct postures.

9.1. Neck-sunning (S_{u1}): Similar to Neck-raised-gazing (G_2 , A.VII.2.), especially with fluffed F_n . H a little leaned away from the sun. **9.2. Wing-spread-sunning (S_{u2} , Fig. 40):** Squatting on tarsi (heel-standing). F conspicuously fluffed, H as high as T , N_f retracted strongly, one W stretched laterally and primaries drooped.

The former postures is observed on sunny days but latter is rarer. An unhealthy seemingly Tancho performed S_{u2} twice at a feeding station in winter. It is still uncertain whether only these two are definite sunning postures.

III.10. Panting (P_a): Abnormal respiration in hot condition, opening its B slightly. Performed with either standing or sitting position during incubation, or other statical situations in summer, and also at situations of fear.

III.11. Yawning (Y_a): Opening widely followed closing of B are infrequently performed by relaxing or incubating individuals.

A.IV. Locomotion: Consisting of walking, running, swimming and flying.

IV.1. Walking (W): **1.1. Slow-walking (W_1 , Fig. 41).** Similar to neck-shortening-resting (R_{e2} , A.I.2.), but B_d about horizontally forward or slightly down; **1.2. Rapid-walking (W_2 , Fig. 42):** F normal or slightly sleeked B_d horizontal H highest, N_f retracted slightly, N_i oriented vertically up, T_i nearly horizontal.

Both L proceed alternately. T_o are closed when L is raised and opened just before treading. The Tancho tends to stride with hurried steps in rapid-walking (W_2), raising secondaries a little. Rump swags laterally and H swags back and forth. There are many transitional postures between W_1 and W_2 .

IV.2. Running (R_u): F somewhat sleeked, B_d horizontally forward, N_i extended vertically up, H high as in rapid-walking (W_2), T_i nearly horizontal, both W opened or sometimes closed. Running posture with or without wing flapping can be variable according to situations, e.g. N stretched forwards to catch food, or held parallel with the ground at starting of flight (A. IV.4.3.).

IV.3. Swimming (S_w): F as in rapid-walking (W_2), B_d roughly horizontally forward, H highest, N_f slightly retracted or curved in shallow S shape, folded W or secondaries slightly raised up and kept apart from T . General appearance similar to courting of Mute swan, *Cygnus olor* Gmelin. Very rare behaviour.

IV.4. Flying (F): Consisting of the succession of watching, intentional posture, dashing, taking-off, flapping-flight, soaring, gliding, and landing.

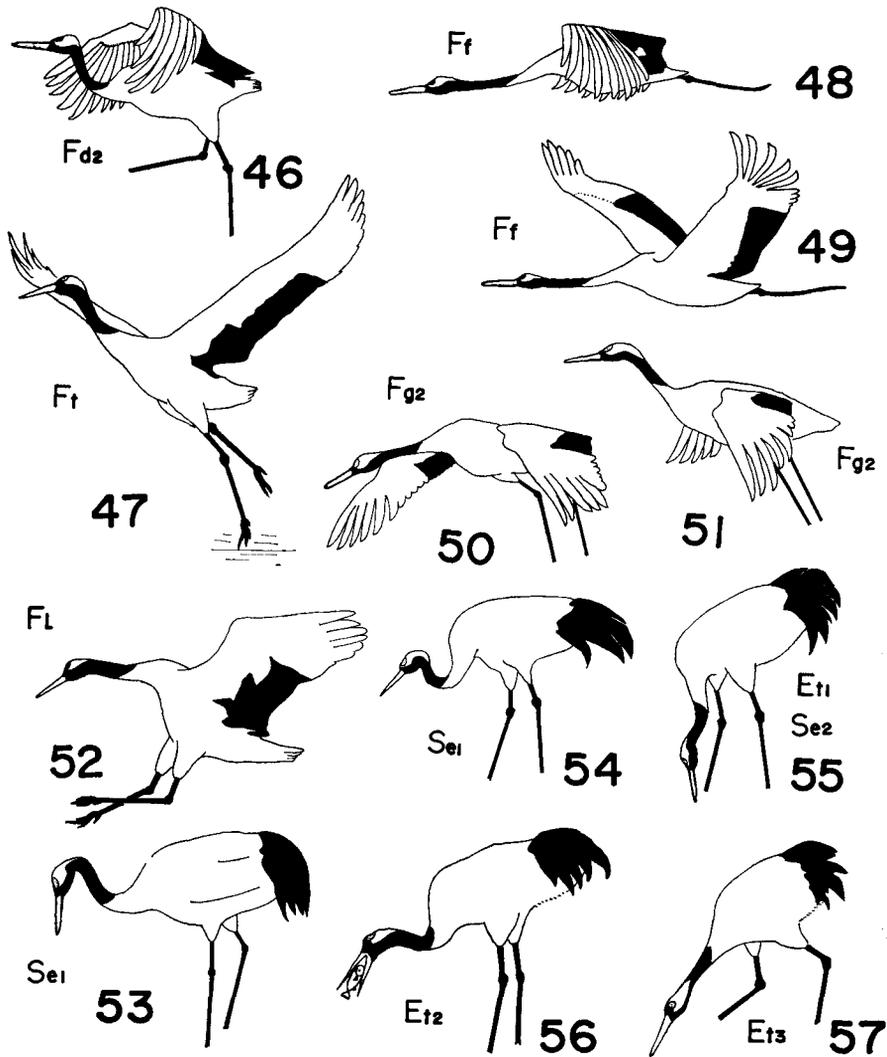


Fig. 46~57. Postures of maintenance behaviour. 46. High-head-dashing (F_{d2}); 47. Taking-off (F_t); 48, 49. Flapping-flight (F_f); 50. Downward-gliding (F_{g2}); 51. F_{g2} in high speed; 52. Landing (F_l); 53, 54. Foraging (S_{e1}); 55. Sticking (S_{e2}) or Eating-small-food (E_{t1}); 56. Swallowing-medium-food (E_{t2}); 57. Eating-moving-animal (E_{t3}).

4.1. *Watching* (F_w , Fig. 92): Identical with alert (A_1 , B.I.6.) or neck-curved-gazing (G_3 , A.VII.3). Described later.

4.2. *Intentional posture* (F_i , Figs. 43 and 44): F sleeked tightly, B_a horizontally

forward, H as high as T , N_i held forwards and entirely stretched, T_i horizontal, B_d , N_i and T_i gradually inclined forwards from F_w to F_i , finally forming a horizontal straight line at shift to dashing (F_d).

4.3. Dashing (F_d): **4.3.1. Horizontal-head-dashing (F_{d1} , Fig. 45).** F sleeked, B_d horizontal, H as high as T , N_i slightly up, N_f stretched, T_i horizontal; **4.3.2. High-head-dashing (F_{d2} , Fig. 46).** F sleeked, B_d slightly down, H high, N_i obliquely up and lower part horizontal, T_i horizontal.

Dashing is done by powerful flapping and running. Some birds in a flock, mainly those initiating the flight, take typical intentional posture (F_i) and dash with horizontal-head-dashing (F_{d1}), while the remainers mostly begin to shift posture from watching (F_w) to high-head-dashing (F_{d2}) without intentional posture (F_i) and follow the initiators in running.

4.4. Taking-off (F_t , Fig. 47): H highest, B_d roughly horizontal, T_i and stretched N_f obliquely up, W fully opened and raised just at beating down, T_a fanned, one L throwing backwards and another L stepping stoutly. At final stage of dashing (F_d) fore body lifted up, followed by taking off with downbeat of W and stamp of one or sometimes both L .

4.5. Flapping-flight (F_f , Figs. 48 and 49): F sleeked, B_d horizontally forward, H as high as T , N_i extended horizontally forwards, T_i horizontal, both L stretched horizontally backwards. At low temperature, one or both L sometimes entirely bent forwards and tucked in $F_{t'}$. W beaten up and down slowly, about one dozen strokes per five seconds.

4.6. Soaring (F_s): Similar to F_f , but without flapping. Fully extended W kept nearly horizontally or cambered. At distant shifting such as between winter and breeding areas in spring and fall, the Tancho raises high in spiral soaring, but usually not for a prolonged period. Soaring is always preceded by power flight at initial spiral raising.

4.7. Gliding (F_g): Two types possibly of different underlying mechanisms and situations are recognized.

4.7.1. Horizontal-gliding (F_{g1}): Similar to soaring (F_s), though frequently made for a while during usual flapping-flight (F_f). **4.7.2. Downward-gliding (F_{g2} , Fig. 50):** F sleeked, B_d slightly down, H as high as T , W spread widely, kept nearly horizontally or slightly bow-shapedly, both L directed downwards. At a high-speed down flight for landing, N stretched obliquely up, H high, W bowed deeply (Fig. 51). The Tancho stops to flutter wings up and down and goes down gradually.

4.8. Landing (F_l , Fig. 52): F sleeked, B_d slightly down, H high, N_f retracted slightly, N_i slightly up, T_i obliquely up, W opened widely and held slightly

backwards, *L* conspicuously projected forwards and slightly bent. *W* flapped obliquely back and forth at landing. Soon after landing, arching (A_r , B.I.2.) appears at times. Postures of gliding (F_g) and landing (F_l) mentioned above are variable according to the wind velocity or speed of plunging into a dive. In a typical case of short flight, the sequence is $F_w-F_i-F_d-F_t-F_f-F_{g2}-F_l-A_r$ but some patterns such as intentional posture (F_i), dashing (F_{d1}) and arching (A_r) are often omitted.

Among locomotive behaviour patterns mentioned above walking (*W*) is most preferred. The Tancho often walks slowly (W_1) when moving for short distance, sometimes longer even up to several hundred metres or less for food searching (S_e , A.V.1.) and other purposes. Walking is rapid (W_2) at long distance traveling, moving through reed thickets, carrying food to chicks, perceiving a suspicious object at distance, mobbing other animals, etc. When enemies, either actual or suspicious, approach nest or chicks in breeding territory, the parents run (R_u) or walk rapidly (W_2) around them with or without uttering calls and opening wings. The parent carrying food sometimes runs (R_u) back to its chicks, but rarely does so at departure for foraging. A Tancho dancing lonely frequently runs about (B.II.1.). When a pair accompanied with chicks crosses over deep river, at least one of the parents swims (S_w) with the chicks, usually following the chicks. Flying (*F*) is rather rare when incubating eggs or brooding unfledged juveniles. The Tancho in these periods flies (*F*) mainly at attacking and chasing intruders (B.I.5.), crossing river, coming back to or going apart from nest at relief of incubation, carrying food to chicks, etc.

A.V. Food intake: Composed of food-searching, eating, and drinking.

V.1. Food-searching (S_e): Two distinct postures are recognized according to searching sites.

1.1. Foraging (S_{e1} , Figs. 53 and 54): *F* normal, B_d obliquely or steeply down, *H* as high as *T*, N_f retracted slightly or forming deep S shape, T_i horizontal or slightly down. Walking about slowly (W_1 , A.IV.1.1.) for food at feeding place.

1.2. Sticking (S_{e2} , Fig. 55): *F* normal, B_d vertically down, *H* lowest, N_f retracted slightly, N_i steeply down, T_i slightly or obliquely down. When the Tancho searches food in water bottom or on grounds, it sticks into muds many times at the same spot.

V.2. Eating (E_i): Four distinct postures are recognized according to kinds of food.

2.1. Eating-small-food (E_{i1} , cf. Fig. 55): Similar to sticking (S_{e2} , A.V.1.2.). Small food such as corn and small insects are held by the tip of *B*, then swallowed by tossing *H* a little. **2.2. Eating-medium-food (E_{i2}):** Similar to E_{i1} , but *H* tossed much more upwards. After swallowing food (Fig. 56), the Tancho gener-

ally holds B_o upright. **2.3. Eating-moving-animal** (E_{t3} , Fig. 57): Similar to E_{t1} , but N_f stretched. When the Tancho catches a small fish or similar nimble animal, it performs this posture as made by herons. **2.4. Eating-large-food** (E_{t4}): The large food such as a full grown carp or small mammal is sometimes swallowed intactly, but usually first Tancho teared into pieces by grasping or sticking by B and several violent shaking of H , then each piece is taken by E_{t1} , or E_{t2} .

Food intake behaviour is composed of these patterns mentioned above. Insects on leaves of relatively tall grasses as high as the Tancho's T are picked with foraging posture (S_{e1}). The Tancho searches foods by walking slowly (S_{e1}) or sticking in grounds (S_{e2}) several times at the same spot. During food intake, the Tancho frequently performs gazing (G , A.VII.), mainly neck-curved-gazing (G_3) for several seconds or more. The Tancho spends much time for food-searching (S_e) or eating (E_i). Food searching is frequently made at wet grasslands, cultivated fields, shallow rivers, lake shores, etc., not only by exploration on the surface but also picking the ground or the bottom of the water. The Tancho repeats ground sticking so many times. But actual food intake judging by swallowing movement of N , seems infrequent in comparison with the time spent for foraging (S_{e1}) and repetitions of picking (S_{e2}). Foods actually or presumably eaten by the Tancho were listed in Masatomi and Kitagawa 1974.

V.3. Drinking (D , Fig. 58): F normal, B_d slightly up, H high, N_f curved in shallow S shape, N_i vertically up, T_i nearly horizontal. The Tancho first puts bill into the water, and after a while raises H high, allowing running down of the water within throat as in hens and most other bird species. The Tancho occasionally eats a bit of snow as in eating-small-food (E_{t1} , A.V.2.1.) or drinking (D) by raising head.

A.VI. Defecation (D_e , Figs. 19, 41, 59~66, etc.): No definite posture for D_e . Caudal parts slightly raised for a moment. No attention is payed for droppings, except occasional staring and pecking at F_{it} .

A.VII. Gazing (G): Four distinct types are recognized according to intensity.

VII.1. Neck-retracted-gazing (G_1 , Fig. 60): F fluffed, B_d nearly horizontally, H high, N_f fairly retracted, N_i vertically up, T_i slightly up. G_1 is connected with resting (R_e , A.I.), preening (P_r , A.III.1.1.) and other statical postures. With this posture the Tancho gazes far without particular intension. In winter flock many individuals often take this posture synchronously.

VII.2. Neck-raised-gazing (G_2 , Fig. 63): F normal or slightly sleeked, B_d horizontal, H high, N_f retracted slightly, N_i vertically up, T_i obliquely up. Seemingly more intentional than the pattern mentioned above (G_1). Observed for instance when gazing other individuals flying at distance.

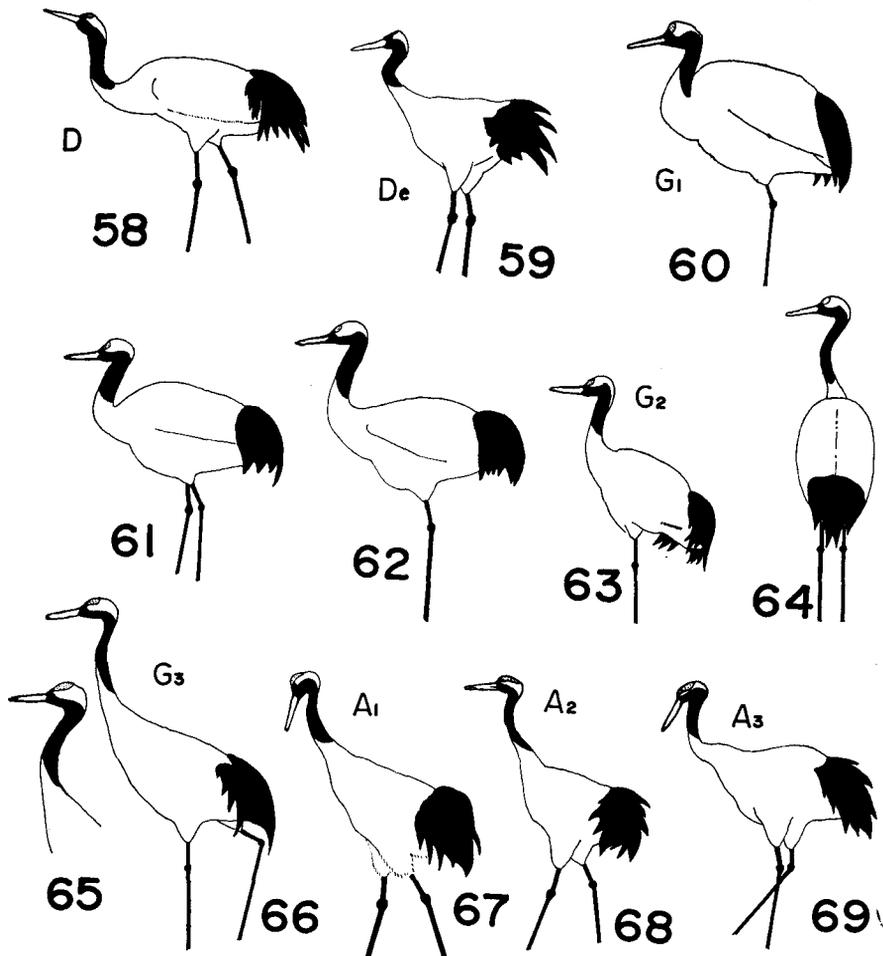


Fig. 58~69. Postures of maintenance behaviour (Fig. 58~66) and interindividual behaviour (Fig. 67~69). 58. Drinking (D); 59. Defecation (D_e); 60. Neck-retracted-gazing (G₁); 61, 62. Transitional postures from G₁ to G₂; 63. Neck-raised-gazing (G₂); 64, 65. Transitional postures from G₂ to G₃; 66. Neck-curved-gazing (G₃); 67. Downward-adornment (A₁); 68. Forward-adornment (A₂); 69. Lowered-adornment (A₃).

VII.3. *Neck-curved-gazing* (G₃, Fig. 66): *F* sleeked much more than G₂, *B_d* about horizontal and directed to the object, *H* highest, *N_i* vertically up, *N_f* curved slightly, *C* expanded partly or completely, *T_i* obliquely up. Strongest gazing generally performed at caring eggs or other social activities.

VII.4. *Sit-gazing* (G₄, Fig. 20): Similar to sitting (R_{c3}, A.I.3.) or alert (A₁, B.I.6.) made at sitting.

These three types are linked with transitional ones (Figs. 61, 62, 64, and 65), forming a spectrum of G_1 - G_2 - G_3 with increased intensities. According to the objects concerned, situations, and state of individual, the Tancho seems to take one of these various postures. It is probable that some of them are better classified in interindividual or social behaviour described below.

B. Interindividual or social behaviour

Body postures and associated movements elicited by the presence of other conspecific individuals are described in this part. The interindividual behaviour is highly complex and involves various transitional types. Only the commonest and typical forms are dealt with here, which are roughly divided into two categories, agonistic and reproductive: The latter is further divided into proper reproductive and parental care. The demarcation between two main categories is subtle and many elementary patterns classified in one category can appear linked with those of the other category or neutral situation. Although not regarded as genuine social behaviour the postures and movements elicited by predators are conveniently included here as the fourth category.

B.I. Agonistic behaviour: A characteristic feature in these postures is the conspicuous enlargement and bright colouration of C though the size and durability differ from case to case. Agonistic behaviour is divided into adornment, arching, bowing, irrelevant behaviour, attacking, alerting, and escaping.

1.1. Adornment (A): Three typical postures are recognized, the first two are possibly caused by the same underlying mechanism, but the third one by different mechanism and appearing at different situations.

1.1. Downward-adornment (A_1 , Fig. 67): F of fore body fairly sleeked, white part of H and face becoming conspicuous by being drawn out with expansion of C , F of caudal parts fluffed, especially of crus and belly, secondaries lifted a little but not kept clearly distant from T , H always highest, B_d vertically down, N_i steeply up, N_f waved exaggerated at middle, T_i obliquely up. As a whole, B_o seen as if larger than actual.

1.2. Forward-adornment (A_2 , Fig. 68): Similar to A_1 , but B_d forwarded nearly horizontally. A_1 and A_2 are often performed reciprocally and repeated synchronously with walking rhythm: A_2 with stepping forwards of one L and A_1 with transferring the centroid on L . B_d is sometimes stable in the form transitional between A_1 and A_2 and its vertical movement is generally accompanied by a slight lateral distortion.

1.3. Lowered-adornment (A_3 , Fig. 69): Similar to A_2 , but H high, B_d steeply down in general, N_f not so extended as in A_1 and A_2 , but upper part raised steeply, T_i horizontal or slightly up.

Adornment display: When more than two individuals get close one another, adornment patterns are easily released by one or many of them against the other or others, even to the mate or the family members, e.g. male to female in pre- or post-copulation (B.II.3.) in spring, territory owner toward intruders in all seasons, among the members of winter flock at communal feeding station, etc. These postures are usually connected with slow and relatively long strides (*adornment walking*, A_w). Walking exaggeratedly or majestically and swinging at times B_a vertically, a Tancho approaches the opponent rather obliquely toward the latter, not directing to its face, or follows it, which mostly avoids the former in various ways. But sometimes both stand with mutual display in wintering assembly.

With enlarged prominent C both reciprocally follow the opponent slowly each other drawing a small circle, rather averting B from the opponent. After a while, one of them usually ceases adornment and sneaks away with certain postures; walking in submission (E_s , B.I.7.1.), alert (A_1 , B.I.6.), running-off (E_r , B.I.7.5.), jumping-up (E_j , B.I.7.6.), fleeing in flight (B.I.7.), etc. On the other hand, this display is occasionally followed by other types of threat or actual attacking.

1.2. Arching (A_r): Two typical postures appear possibly by different underlying mechanisms and at different situations.

2.1. Forward-arching (A_{r1} , Figs. 70 and 71): F sleeked as in adornment (A), B_a obliquely or steeply up, H highest, N_i obliquely or vertically up and characteristically arched, T_i slightly up, one or both W completely lifted up but not stretched outwards, T_{ad} elevated up, T_{af} closed. B_o and T_a forming an angle ca. 120° .

2.2. Side-backward-arching (A_{r2} , Fig. 72): Similar to A_{r1} , but N_i twisted and H thrown side- and backwards, B_a obliquely up and pointed side- or backwards.

According to the intensity of this display, many variant forms are recognized: N more stretched in shallow curve, H and N noticeably jerking backwards, T_i forward, B_a more horizontally or vertically up, both W lifted low or high, etc.

Arching display: This is an outstanding display, preceded or followed by other movements. The common sequence is as follows: a) W raised upright taking bowing (B, B.I.3.4.) with N hooked and B directed to ground, b) B_o gradually thrown down with B and T directed upwards and opened W gradually folded up but yet lifted, c) arching (A_r), and d) B projected fore- or downwards again, and B_o usually kept upright, resulting, though not always, in momentary adornment (A , B.I.1.). Arching display is usually performed in stand still or without shifting. In some cases, e.g. in post-copulatory behaviour (B.II.3.) of female, she stamps quickly at the beginning of the display. It often appears at the final stage of attacking and threatening: After attacking, chasing (B.I.5.) or adornment walking (A_w , B.I.1.), the Tancho performs high bowing (B_2 , B.I.3.2.), sometimes with quick stamping, both followed by arching display. This display occurs also soon after landing, when a Tancho, mostly the male of a pair or family, approaches other pairs or families.

I.3. Bowing (B): Four typical postures possibly of different underlying mechanisms and appearing at different situations are recognized.

3.1. Low-bowing (B₁, Figs. 73, 74, and 75): *F* sleeked as in adornment (A, B.I.1.), *B_d* obliquely or steeply down, *H* lowest, *N_d* obliquely or steeply down and very slightly arched, *T_i* slightly or obliquely up or nearly horizontal, *W* folded but often slightly raised.

3.2. High-bowing (B₂, Figs. 76 and 77): *F* as in B₁, *H* highest but so deeply bent down that tip of *B_d* directed to breast or vertically down, *N_i* stiffly stretched up in oblique or steeped direction, *T_i* obliquely up. Subsequently *H* and *N* swung down.

3.3. Wing-shake-bowing (B₃, Fig. 78): *F* of fore body sleeked but of caudal parts usually more fluffed than in adornment (A, B.I.1.), *W* folded but slightly raised, and frequently shaken quickly several times, *T_i* slightly up. Whole posture resembling B₂, but occasionally *T* lowered more and rarely *N*, too.

3.4. Wing-raise-bowing (B₄, Figs. 79 and 80): *F* nearly sleeked, *H* high, *B_d* nearly vertical or steeply down, *N_i* extended up stiffly in oblique or vertical direction, sometimes forming a loose arch, *T_i* almost upright, *W* variously extended, opened widely or only raised in folding, drawn backwards, *T_{ad}* horizontal. Quick repetitions of stamping frequently observed.

Bowing display: Bowing is one of the prominent transitional elements in compound threats and attacks. Stationary adornment (A, B.I.1.) sometimes switches over the high-bowing (B₂), which again shifts the irrelevant-leg-preening (I₁, B.I.4.3.) by shallow swinging down of stiffen *N*. Low-bowing (B₁) is a threatening approach. The posture with folded *W* and horizontal *T* usually occurs at attack or threat display of low intensities due to the avoidance by the opponent. It is also seen at the final stage of chasing (A_{t1}, B.I.5.1.). The conspicuous forms are recognized just before the end of bowing, i.e. with *W* widely spread, *T_i* kept upright, a tall stance, stiffen *N* stretched down, forming a right angle with *T* for a while, *B* opened, uttering harsh call "ha—" (Fig. 74). After the low-bowing (B₁), the Tancho stamps and sets up *B_o*. This upright, nearly or completely vertical posture with raised or half spread *W*, hooked *N*, and *B* turned downwards is a wing-raise-bowing (B₄) usually followed by arching threats. Wing-shake-bowing (B₃) often ensues from a stationary adornment display. After wing-raise- or wing-shake-bowing, the Tancho sometimes performs postures similar to leg-, belly-, or back-preening (A.III.1.1.), but actual preening is rare.

I.4. Irrelevant postures (I): Six kinds of irrelevant postures possibly differing in underlying mechanisms and situations are recognized. Various allochthonous postures and movements described aroused at agonistic or conflict situations, may be displacement activities. They are grouped together here as irrelevant activities (Kruijt 1964) to leave open the question of their causation.

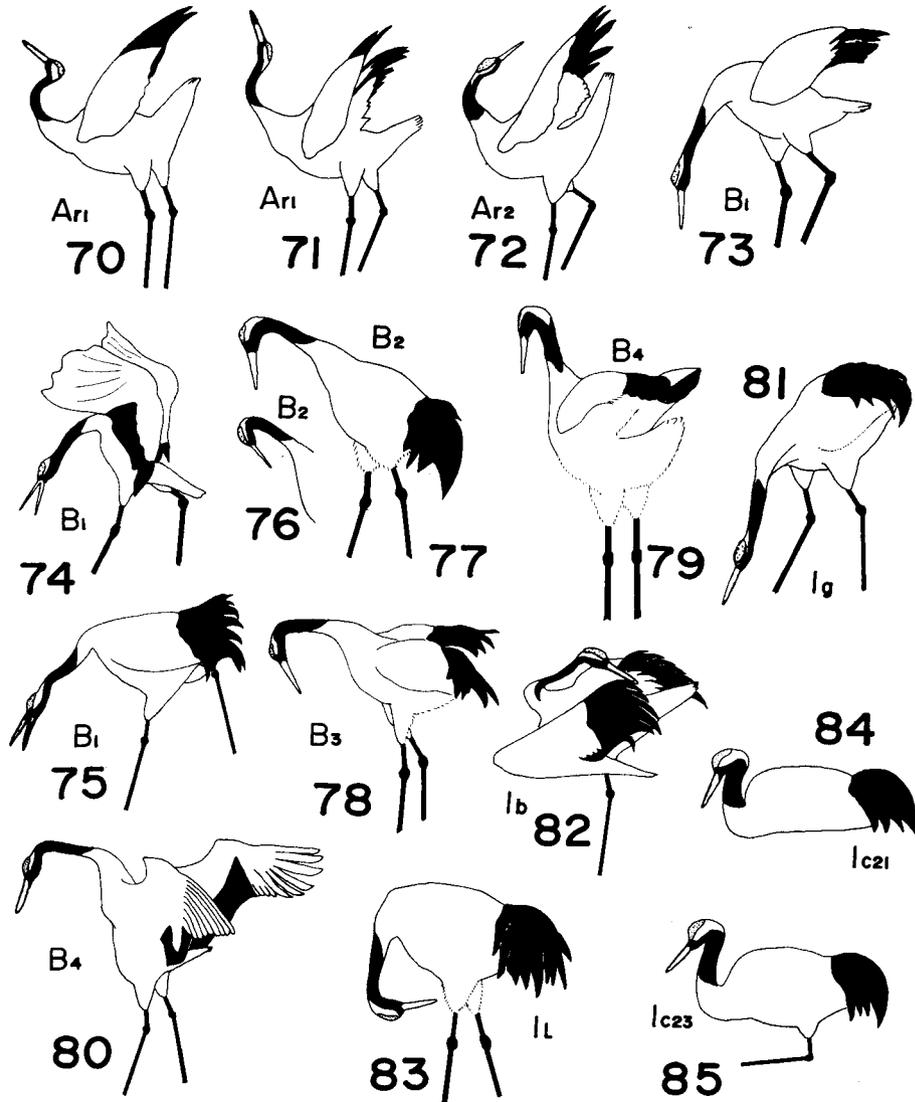


Fig. 70~85. Postures on interindividual behaviour. 70, 71. Forward-arching (A_{r1}); 72. Side-backward-arching (A_{r2}); 73, 74, 75. Low-bowing (B₁); 76, 77. High-bowing (B₂); 78. Wing-shake-bowing (B₃); 79, 80. Wing-raise-bowing (B₄); 81. Irrelevant-ground-sticking (I_g); 82. Irrelevant-back-preening (I_b); 83. Irrelevant-leg-preening (I_l); 84. Irrelevant-crouching (I_{c21}); 85. Irrelevant-crouching (I_{c23}).

These postures resemble the autochthonous ones but distinguished by its position in behavioural context, and some characteristics such as expanded C , stiffen N and other distorted or incomplete elementary forms.

4.1. Irrelevant-ground-sticking (I_g , Fig. 81): Comparable to sticking (S_{e2} , A.V.1.2.), but F more sleeked, N_i steeply down and slightly arched, not forming S shape, secondaries lightly lifted, resulting in enlargement of B_o . With this posture the Tancho vigorously sticks B in the ground several times or plucks off grasses.

4.2. Irrelevant-back-preening (I_r , Fig. 82): Comparable to back-preening (P_{r2} , A.III.1.1.2.). F sleeked, N_f waved exaggeratedly, T_i nearly horizontal, B merely touching F of back or W keeping various angles, one W nearer H or N partially opened and slightly drooped downwards, secondaries lifted slightly, T_i slightly up or horizontal. At low agonistic intensities actual back-preening occasionally observed at final stage. As to drooping of W and bending of N or H , several forms observed beside that shown in Fig. 82.

Irrelevant-back-preening was noted as threat posture in the crane by Lorenz (1941). In Tancho it occurs very frequently in the winter assembly at feeding station. It is often aroused after or during adornment (A, B.I.1.), and sometimes after wing-flapping (W_f , A.III.6.), arching display (A_r , B.I.2.), high-bowing (B_2 , B.I.3.2.), wing-shake-bowing (B_3 , B.I.3.3.), irrelevant-leg-preening (I_1 , B.I.4.3.), etc.

4.3. Irrelevant-leg-preening (I_1 , Fig. 83): Comparable to leg-plumage-preening (P_{r5} , A.III.1.1.5.), but distinguished by expanded C and stiffly straight N usually deviated from the median plane. F rather sleeked, H low, B_a directed backwards nearly horizontally or slightly downwards, N and B forming an angle of ca. 90° , T_i obliquely up.

First stage of irrelevant-leg-preening is similar to high-bowing (B_2 , B.I.3.2.), but B is not so hooked towards breast. Then H is swung down with stiffly stretched N and held stably for a while. Thereafter, the Tancho usually raises H again with N in shallow S shaped, or the display occasionally shifts to the actual preening of leg plumages (P_{r2} , A.III.1.1.5.) or other parts without H raising.

4.4. Irrelevant-crouching (I_c): Two distinct types are recognized possibly differing in underlying mechanisms and corresponding situations.

4.4.1. I_{c1} : Comparable to sit-gazing (G_4 , A.VI.4.). It is rarely performed by a juvenile at family dissolution in spring, who stays at feeding place in spite of frequent attacking by parents for some weeks. It sits suddenly on the snow, gazing the parents, who started to take off together to the field. This behaviour observed twice and might be derived from the conflict between following and escaping or remaining. **4.4.2. I_{c2} :** Four postures being variable in intensity are recognized: First (I_{c21} , Fig. 84) is comparable to incubating posture (I B.II.5.). Second (I_{c22}) is as first except half opened W . Third (I_{c23} , Fig. 85) is heel-standing,

and fourth (I_{c24}) as third with opened W . In all postures C expanded completely.

Although rarer than other irrelevant postures, these are exhibited by both sexes, e.g. female to male on, near, or far from nest under construction, territory owners to intruder, or reverse, and though rarer male to female, etc.

4.5. Irrelevant-wing-opening (I_w , Fig. 86): Comparable to wing-spreading (C_2 , B.II.3.2.) of copulatory behaviour. It is difficult to distinguish this from C_2 . Only several instances were observed in agonistic situations, always female to male.

4.6. Irrelevant-head-shaking (I_h , Fig. 87): Comparable to head-shaking (S_{h1} , A.III.2.1.), but H lowest, or comparable to leg-plumage-preening (P_{15} , A.III.1.1.5.). Irrelevant-head-shaking (I_h) following irrelevant-leg-preening (I_l) or irrelevant-ground-sticking (I_g) is sometimes observed in captivity but scarcely a field. There is no definite boundary from autochthonous posture or movements, but neither obvious objects kept by B or attaching on L , nor fluffed F_h to be preened are detectable.

I.5. Attacking (A_t): Four distinct types are recognized. These appear at different situations and are possibly different in lying mechanisms.

5.1. Chasing (A_{t1} , Fig. 88): Similar to dashing (F_d , A.IV.4.3.) except expanded C and opened B . H and B as high as T or a little above, N_f somewhat retracted and directed to opponent, W spread fully and always flapped, L bent.

5.2. Upright-pecking (A_{t2} , Fig. 89): F sleeked, H highest, B opened and oriented to upper parts of opponent, N stretched obliquely or steeply up, T_i steeply up, W sometimes half opened. **5.3. Forward-pecking** (A_{t3} , Fig. 90): F sleeked, H not so high, B_d nearly horizontal, N bent up rectangularly at middle, T_i about horizontal, W and T_a slightly lifted above. Many transitional postures recognized. **5.4. Kicking** (A_{t4} , Fig. 91): H high, B_f opened, B_d directed to opponent, usually downwards, N stretched straight steeply up, T_i nearly vertical, T_a slightly up and widely fanned, L bent.

Actual attacking occurs commonly at wintering area as well as between territory owners and intruders, but rarely gives rise to serious physical damage on the bird attacked. Diverse threatening or attacking patterns are occasionally followed by chasing (A_{t1}). Distance in a bout of chasing varies from several to score metres. During chasing both L are intermittently lifted up because of rapid running with long strides and deep W beating. Sometimes chasing without W beating occurs with a posture comparable to low-bowing (Fig. 75). After running, the chaser frequently makes a prominent low-bowing (B_1 , B.I.3.1.) and other threatening postures such as arching (A_r , B.I.2.), high-bowing (B_2 , B.I.3.2.), wing-shake-bowing (B_3 , B.I.3.3.), irrelevant-back-preening (I_b , B.I.4.2.), etc. Adornment (A, B.I.1.) and other threatening displays sometimes result in actual pecking by quick approach to the opponent. Although the target may difficult to be localized, tip of B mostly touches caudal parts, not H or N of the chased bird.

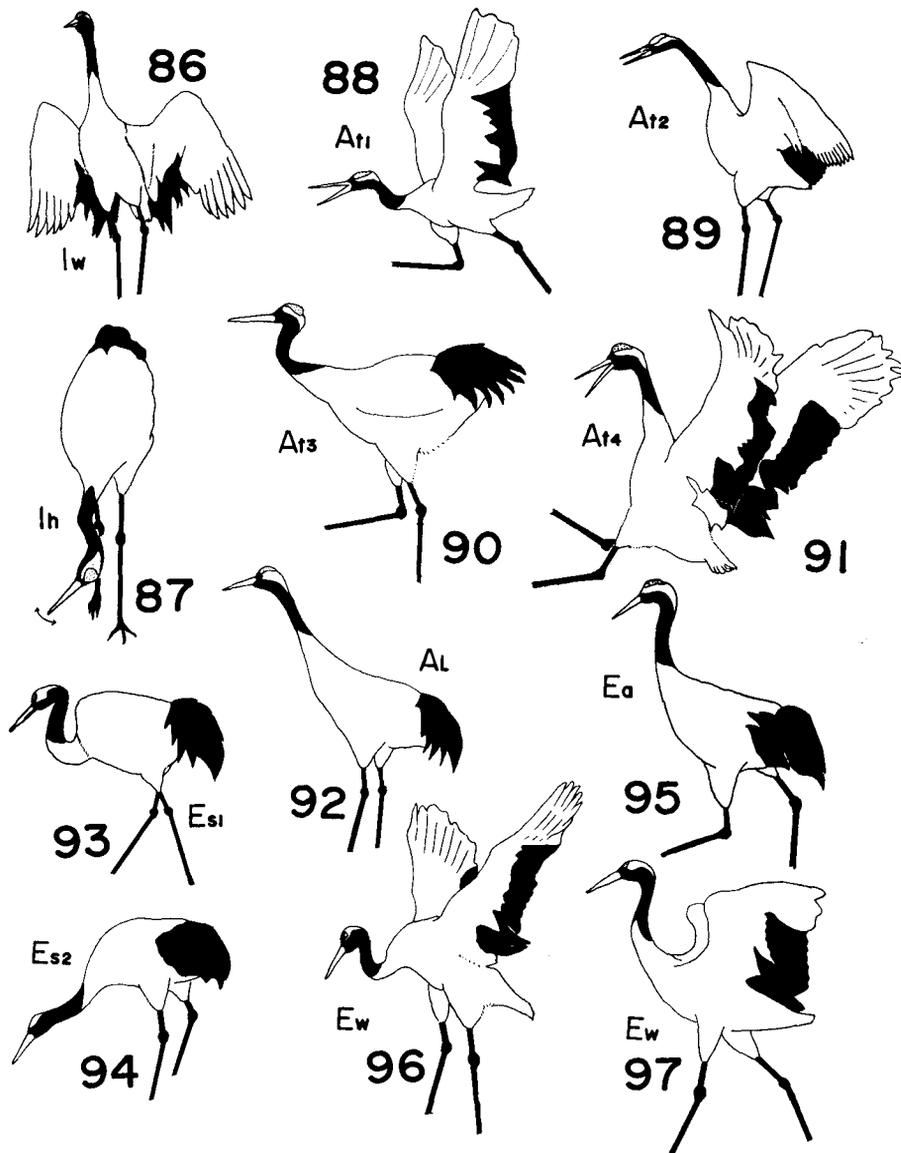


Fig. 86~97. Postures of interindividual behaviour. 86. Irrelevant-wing-opening (I_w); 87. Irrelevant-head-shaking (I_h); 88. Chasing (A_{t1}); 89. Upright-pecking (A_{t2}); 90. Forward-pecking (A_{t3}); 91. Kicking (A_{t4}); 92. Alert (A_1); 93. Neck-retracted-submission (E_{s1}); 94. Head-down-submission (E_{s2}); 95. Avoiding (E_a); 96, 97. Wing-raise-fleeing (E_w).

However, when two or more birds face each other, upright pecking (A_{12}) is sometimes followed by counter-pecking. Then kicking (A_{14}), chasing (A_{11}), stamping, and other threatening patterns appear at times.

A Tancho threatening its opponent staying nearby jumps up in the air and proceeds a little forwards with fully spread W . It once bends L sufficiently. Nextly it strikes strongly the opponent with one L or both. Typical kicking is observed amongst the flock members at wintering area, but it is rather uncommon at genuine agonistic situations. It may be aroused when two birds in hostility seem to be equal in social or physical state, and both individuals facing each other not uncommonly kick simultaneously their opponent in the air.

I.6. Alert (A_1 , Fig. 92): Similar to gazing (G, A.VII) at high intensity, but N stretched up, curved and sometimes inclined slightly forwards. *Alert call* (Kwaro ---) accompanied at times.

As in intentional posture (F_i , A.IV.4.2.), alert (A_1) corresponds to high intensity gazing but the former without and the latter with the obvious source of suspicion. The Tancho usually stands still, but it occasionally walks with short jerky movements of H and N . As the Tancho often stays or walks around with this posture, keeping a certain distance from the stimulator including hetero specific individuals such as a man approaching the nest, this posture should be aroused from the presence of two opposing tendencies; remaining and avoiding.

I.7. Escape (E): Six distinct postures possibly of different underlying mechanisms are recognized which appear at different situations.

7.1. Submission (E_s): **7.1.1. Neck-retracted-submission (E_{s1} , Fig. 93).** C first slightly expanded but soon becoming contracted, and tending gloomy red, F normal, or erected slightly, H as high as T , B_a obliquely down, N retracted fairly and making deep U shape, T_i slightly up or horizontal; **7.1.2. Head-down-submission (E_{s2} , Fig. 94).** F_h and F_n ruffled, other F normal, H lowest, B_a obliquely down, N extended obliquely down with shallow curve, T_i horizontal at walking or slow running.

7.2. Avoiding (E_a , Fig. 95): Similar to upright alert (A_1 , B.I.6.). Besides the typical posture, some postures in avoiding walking such as neck-curved-gazing (G_3 , A.VII.3.) and various other types appearing at lower tension are included here.

7.3. Wing-raise-fleeing (E_w , Figs. 96 and 97): F sleeked, H high, B_a slightly or obliquely down, N erected up and somewhat curved, T_i slightly up, one or both W half or widely spread and usually raised up. With this posture the Tancho runs apart from the attacker.

7.4. Wing-spread-fleeing (E_p , Fig. 98): F sleeked, H highest, B_a a little down, N_i steeply up, N_f making shallow S shape, T_i obliquely up, W spread widely or incompletely, T_a half spread.

7.5. Running-off (E_r , Fig. 99): Similar to high-head-dashing (F_{d2} , A.IV.4.3.2.) or chasing (A_{t1} , B.I.5.1.), but H not so high above level of back, B_a horizontal, N_f bent up and retracted a little, T_i nearly horizontal, W flapped sufficiently. Full speed running with long strides.

7.6. Jumping-up (E_j , Fig. 100): H , B , and N typically held forwards with shallow curve, T_i also horizontal in the air in contrast with the leaping as in dancing (B.II.2.3.) and kicking (B.I.5.4.), L bent at the top.

The approached, threatened, or attacked Tancho mostly avoids or escapes from the opponent. The lowest intentional escape is expressed by avoiding (E_a) and submission (E_s). A Tancho suspecting another approaching with or without weak threat posture usually slowly walks away from the latter. Intense threatening or approaching usually causes typical avoiding (E_a) and wing-raise-fleeing (E_w) at which the subordinate lowers B_o a little and quickly runs away for a short distance. The chased Tancho vigorously flees from the chaser by running-off (E_r) with long strides. Its slightly retracted and erected N is noticeable compared with N of the chaser thrown forwards with shallow curve. Running-off (E_r) is sometimes followed by actual taking off (F_t , A.IV.4.4.).

At the final stage of wing-raised-fleeing (E_w) or running-off (E_r), and at the absence of further approaching by the attacker, running away occasionally shows a wing-spread-fleeing (E_p) with slow running or walking. Wing spread is here regarded as vestigial fluttering with gradually folding up. At sudden and unexpected threat or attack, the Tancho promptly jumps up (E_j) a few metres in the air, flapping deeply. After a while it mostly lands again, but if attacked suddenly by human beings or other enemies, it directly flies away after jumping without dashing (F_d , A.IV.4.3.). Head-down-submission (E_{s2}) is uncommon, but a juvenile frequently chased by parents in spring often escapes with this posture, followed or preceded by neck-retracted-submission (E_{s1}).

B.II. Reproductive behaviour: Composed of courtship, copulation and egg caring; divided into duetting, dancing, copulation, nest building and incubation.

II.1. Duetting (D_u): F sleeked, but F_{te} and those of cruses fluffed, C bright and expanded, T_a always closed. Relative position of N , T and T_a as well as amplitude of wing raising variable as described below. **1.1. Closed-wing-duetting** (D_{u1} , Fig. 101 ♀): H highest, B_a obliquely or steeply up, N extended vertically up, T_i obliquely up, both W held against sides. **1.2. Semiclosed-wing-duetting** (D_{u2} , Figs. 101 ♂, 102 ♀ and 105 ♀): Similar to D_{u1} except T_i nearly horizontal, W a little raised but not apparently expanded above back. **1.3. Semiraised-wing-duetting** (D_{u3} , Fig. 102 ♂): Similar to D_{u2} , but W more raised, back seen distinctly from behind, T_a slightly up. **1.4. Obliquely-raised-wing-duetting** (D_{u4} , Figs. 103 and 104): Similar to arching (A_r , B.I.2.). H highest, B_a directed nearly or completely vertically, N_i vertical and slightly pulled backwards, making an

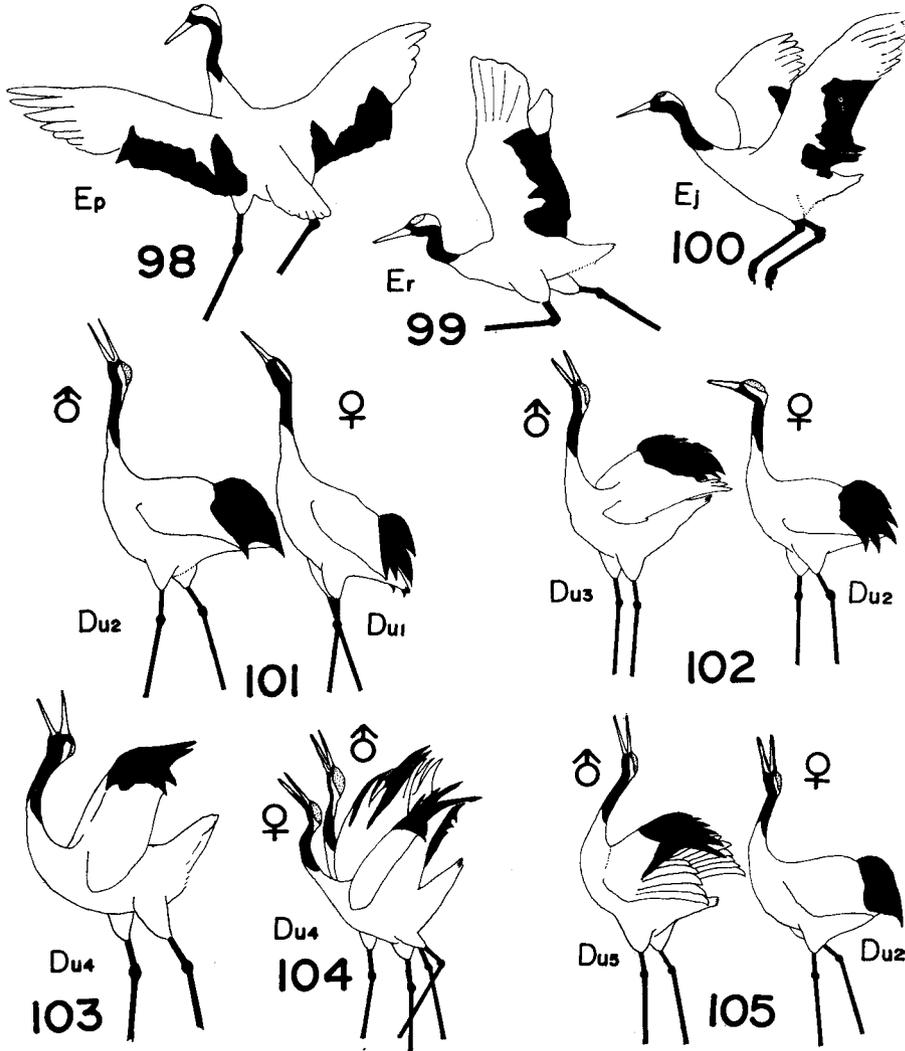


Fig. 98~105. Postures of interindividual behaviour. 98. Wing-spread-fleeing (E_p); 99. Running-off (E_r); 100. Jumping-up (E_j); 101♂. Semiclosed-wing-duetting (D_{u2}); 101♀. Closed-wing-duetting (D_{u1}); 102♂. Semiraised-wing-duetting (D_{u3}); 102♀. D_{u2} ; 103, 104. Obliquely-raised-wing-duetting (D_{u4}); 105♂. Drooped-wing-duetting (D_{u5}); 105♀. D_{u2} .

arch, W folded and raised as much as possible, T_a raised upwards, T_i horizontal. 1.5. *Drooped-wing-duetting* (D_{u5} , Fig. 105♂): Similar to D_{u4} , except primaries held stiffly at T sides, but below as in *Grus antigone antigone* (Linnaeus), *Grus vipio*

Pallas, *Grus grus grus*, etc. (cf. Walkinshaw 1973).

Duetting display (Unison call): In all so far studied crane species, duetting is normally made by a couple, but the display by a single bird was rarely observed in Tancho, occasionally accompanied by duet calls by another pair, or other pairs. While duetting or uttering "unison call" (Walkinshaw 1949), male generally cries one note which is followed by female's two to three shorter notes. This unit, $M_1 + F_{2-3}$, is repeated in succession. Therefore, the unison call is not strictly synchronous "duet" but rather alternate "antiphonal song" by Armstrong (1963), that is, "Female adds her utterance so promptly that the utterance sounds like a single stereotyped song".

Different postures mentioned above seem to depend not only on the intensity of display but also on the individual or pair specificity, though the accurate individual identification is yet difficult. When both W are raised as in D_{u4} and D_{u5} , these are usually a little tossed rhythmically with each call. Besides some representative cases shown in Figs. 101, 102, 104, and 105 transitional or compound postures such as $D_{u1} + D_{u1}$, $D_{u4} + D_{u5}$, etc. are sometimes observed. W of male are generally but not always raised higher than in female at the display. Postures $D_{u1} + D_{u2}$ (Fig. 101), $D_{u1} + D_{u3}$, and $D_{u2} + D_{u3}$ (Fig. 102) are common and $D_{u4} + D_{u5}$ rare at antiphony so that the postures in Figs. 101 and 102 are commonly observed. Unison call uttered in a breeding territory sometimes provokes the same response by neighbouring pairs, resulting in the propagation among many pairs through the habitat. In winter flocks, too, the unison call often results in a synchronous chorus produced by some, usually two pairs.

Duetting postures are performed at various situations, e.g. just after copulation, at relief of incubation, against the intruder in territory, in flocks at wintering roost and feeding station, etc. Therefore it seems to have multifold functions such as territorial advertisement or defense, formation and maintenance of pair bond, synchronisation of reproductive rhythm, and agonistic signal or threat out of territory.

II.2. *Dancing* (D_a): Dancing is a very complex behaviour in which many postures and movements described above are incorporated, either modified or not. The characteristics are: F sleeked sometimes except caudal parts, C in most cases fully reddened. Eight typical postures possibly of different underlying mechanisms are recognized which appear at different situations: **2.1. *Stooping*** (D_{a1} , Figs. 106, 107, and 108). H bowing as high as T , or occasionally below, B_s sometimes opened, B_d mostly pointed towards mate, with various inclinations, slightly down to obliquely up, N_f retracted in deep U shape, T_i lowered a little and horizontal or slightly down with both L bent, W held tightly contact with T or one or both W half to widely stretched; **2.2. *Pre-leaping*** (D_{a2} , Figs. 109, and 110). H high, B_d down a little, N stretched up vertically, T_i obliquely up, W spread or pulled backwards. As D_{a1} and D_{a2} are usually combined, various transitional postures are recognized; **2.3. *Leaping*** (D_{a3} , Figs. 111 and 112): H highest, B_d slightly

down, N stretched up, obliquely or steeply in almost equal slant with T_i , both L still dangled or bent in the air, W flapped, T_a fanned fully and slightly lifted up; **2.4. Floating** (D_{a4} , Fig. 113). Similar to D_{a3} , but N_f curved in S shape, B_d less steep and T_a sometimes drooped; **2.5. Rushing** (D_{a5} , Fig. 114). Similar to running-off (E_r , B.I.7.5.), but B_s opened or closed, in general N_f more retracted; **2.6. Picking-up** (D_{a6} , Figs. 115 and 116). H swung down with opened B , actually picking up some object or only staving, B_d steeply down, N extended straight, T_i various from slightly up to steeply down, W spread, but sometimes held against T ; **2.7. Throwing** (D_{a7} , Fig. 117). Similar to D_{a3} , but B upwards keeping object to be thrown out by stretching up of N at leaping; **2.8. Turning** (D_{a8} , Fig. 118). Similar to D_{a2} , but H turned aside or backwards, B_d nearly horizontal, W usually raised backwards or spread sideways, B_o gradually or hurriedly rotated to the same direction of turned B .

Movements common to various types of dancing are as follow. *Pumping movement*: A Tancho in upright posture as in gazing (G, A.VIII.) stoops (D_{a1}) with retracted N , sometimes spreading W . On rising, it stretches its N upwards as in gazing (G) or pre-leaping (D_{a2}), immediately followed by a second stoop posture. Upright and stoop postures are reciprocally repeated several times. *Bouncing movement*: After stooping (D_{a1}), the Tancho leaps up (D_{a3}) in the air from several centimetres to a few metres high. During a momentary floating (D_{a4}) it always flaps with L bent or dangled. *Pursuing movement*: Just like in chasing-fleeing at attacking (B.I.5.1.), one runs after another or away from it with rushing posture (D_{a5}). The "tagger" occasionally alternates and often the third bird mingles in this movement. Bowing displays (B, B.I.3.) are rare in the final stage of this chasing in contrast to their rather constant appearance in agonistic chasing (A_{t1} , B.I.5.1.). Moreover, solitary running with pre-leaping (D_{a2}) or other postures are frequently observed. *Throwing-movement*: Stretching N_f , a Tancho nimbly picks up (D_{a6}) a piece of object as if to catch animal food (A.V.). Then, it throws the object up (D_{a7}) with leaping (D_{a3}). Watching the falling piece the Tancho sometimes tries to catch or kick it again by B or L , though mostly missing. It is conspicuous that many postures and movements of threatening or attacking display in relatively low intensities appear in the series of dancing, such as adornment walking (A_w , B.I.1.), bowing, especially wing-shake-bowing (B_3 , B.I.3.3.), chasing (A_{t1} , B.I.5.1.), pecking (B.I.5.2. and 5.3.), kicking (A_{t4} , B.I.5.4.), etc.

Boisterous dancings of all members gathering at the artificial feeding place is spectacular as shown by Iwamatsu (1966), resulting in synchronous leaping up of most birds against the winter wind whistling strongly. On the other hand, solitary dancing is common not only in winter area but also during breeding season, e.g. practiced by a mate departed from the nest after relief of incubation. Interspecific dance with a young sandhill crane *Grus canadensis* probably *canadensis* (Linnaeus), straggled to Hokkaido was once recorded (Masatomi 1973). Some Tanchos occasionally chose such crows *Corvus corone orientalis* Eversmann and

Table 3. Behaviour patterns involved in dancing.

Behaviour pattern	Maintenance	Interindividual	Characteristic in dancing
Movement in dancing			
Pumping	Neck-raised-gazing Neck-curved-gazing	Alert	Pre-leaping Stooping
Bouncing	Crouching	Jumping-up Floating	Stooping Leaping Turning
Locomoting	Rapid-walking High-head-dashing		
Throwing	Eating-moving-animal	Jumping-up Chasing Running-off Wing-raise-fleeing Wing-spread-fleeing	Leaping Throwing
Pursuing		Avoiding Peeking Kicking Bowing Arching Adornment	
Agonistic acts ¹⁾			

¹⁾ Observed during a bout of dancing, though not easy to discriminate from real agonistic behaviour.

C. macrorhynchos japonensis Bonaparte, and eastern red-necked grebe *Podiceps grisegena holbollii* Reinhardt as playmates of "solitary dance". Walkinshaw (1949) wrote on the crane's dancing "...they apparently perform regardless of the number of birds present and regardless of age, sex, season, place, or time of day. But the dancing seems to be given most often during the spring...". The description can be applied to the Tancho with little modification. Behaviour patterns involved in these dancing are summarized in Table 3.

II.3. Copulation (C): In all postures and phases the participants keep *C* enlarged.

3.1. Bill-raising (C_1 , Figs. 119, and 120 ♂): *F* sleeked, *H* highest, *B_a* stiffly a little upwards, *N* fully extended and steeply up, *T_i* obliquely up, *W* usually held against *T*, *B_o* slightly enlarged. **3.2. Wing-spreading** (C_2 , Fig. 120 ♀): *F* sleeked, *H* highest, *B_a* nearly horizontal, *N_f* somewhat curved in shallow S shape, *T_i* a little more leaned forwards than in C_1 , both *W* opened slowly and widely sideways. **3.3. Mounting** (C_3 , Fig. 122 ♂): *H* as high as *T*, *B* opened and directed downwards, nearly in vertical, *N_f* retracted, making deep S shape, *T_i* balanced nearly horizontally with softly flapping *W*, *L* bent enough. **3.4. Being-mounted** (C_4 , Fig. 122 ♀): *H* as high as back, *B_a* obliquely or steeply down, *N_f* curved deeper, *T_i* nearly horizontal, *W* spread fully to the sides, *L* partly bent. **3.5. Copulating**

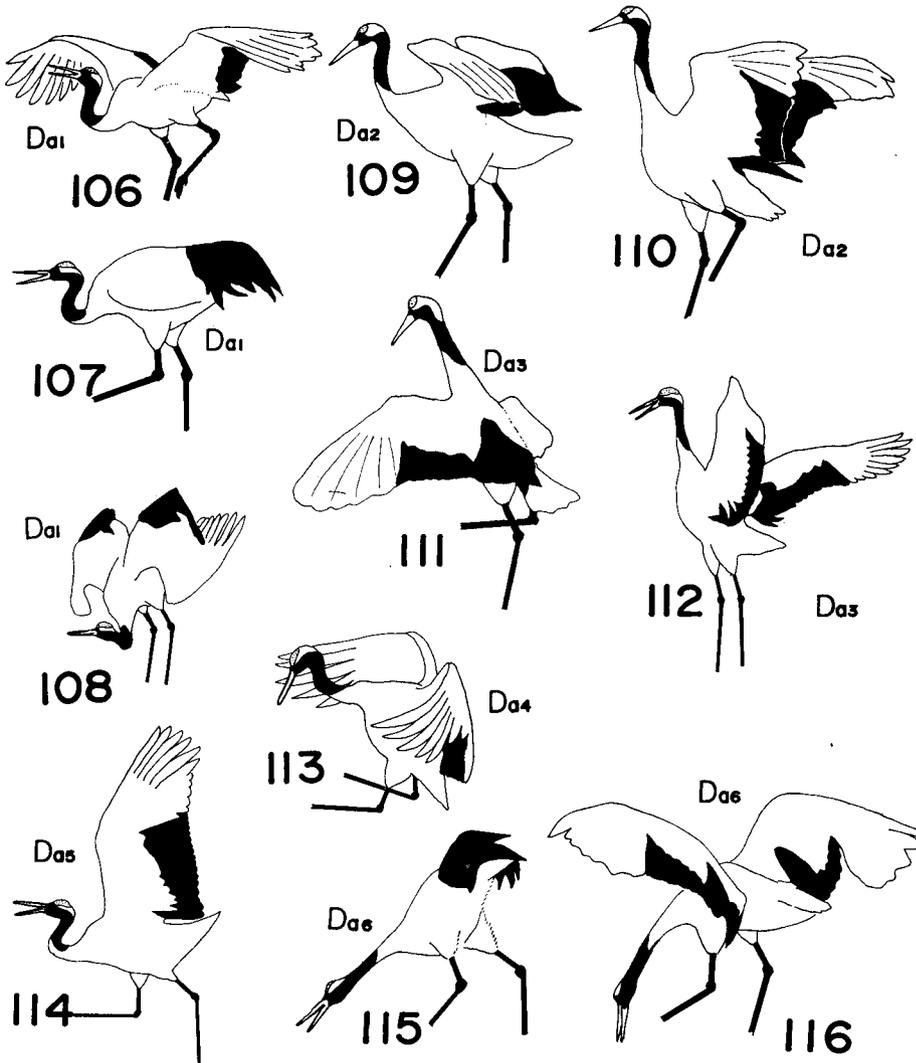
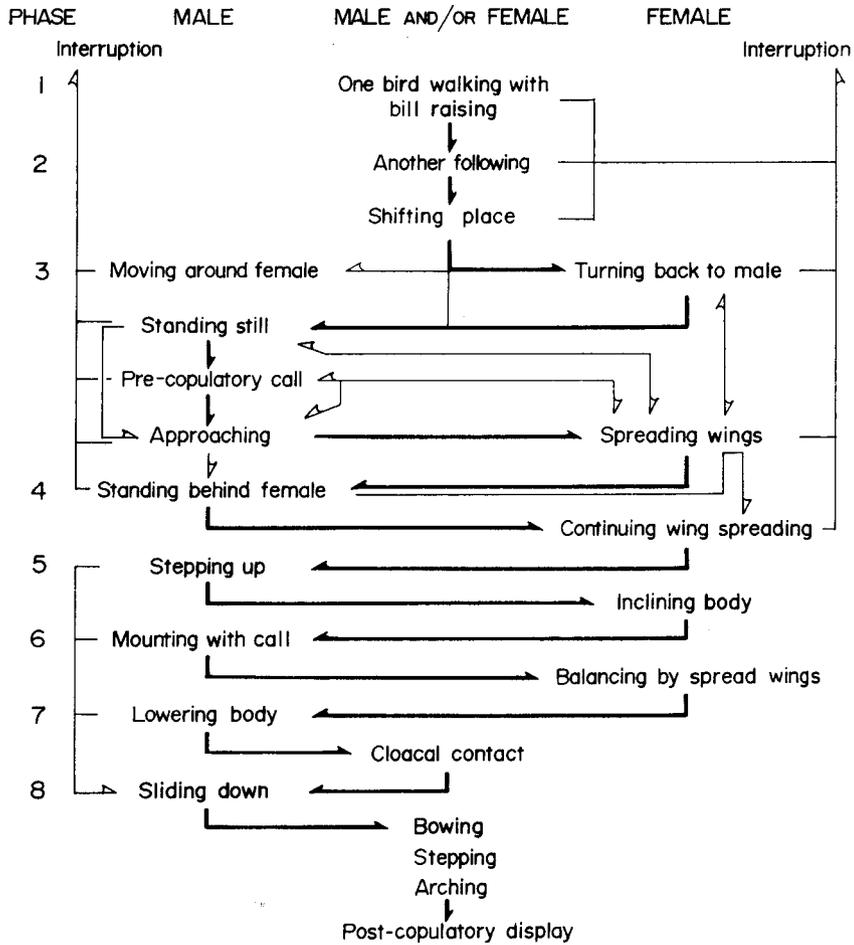


Fig. 106~116. Postures of interindividual behaviour. 106, 107, 108. Stooping (D_{a1}); 109, 110. Pre-leaping (D_{a2}); 111, 112. Leaping (D_{a3}); 113. Floating (D_{a4}); 114. Rushing (D_{a5}); 115, 116. Picking-up (D_{a6}).

(C_5 , Fig. 122): Male leaning backwards and laterally (usually left) a little, flapping W continuously. Male lowering rump, pressing his cloaca to female's by evading her T_{ad} normally to right side. B of female occasionally lowered to be lightly

Table 4. Behaviour sequence in copulation process.
 Thick line: typical case; thin line: rare case.



touched on the ground at the final stage of copulation.

Although the sequence of copulatory behaviour varies from case to case, only the typical sequence is described below, expediently being divided into eight phases (cf. Masatomi 1970), as schematized in Table 4.

Phase 1: One mate takes a posture of bill-raising (C_1). After stiffly holding this posture for a while, it begins to walk slowly to certain open place. Bird utters low call, sounding "Koto, koto...". If in an assembly at artificial feeding station or communal roost it usually intends to walk away from the flock members.

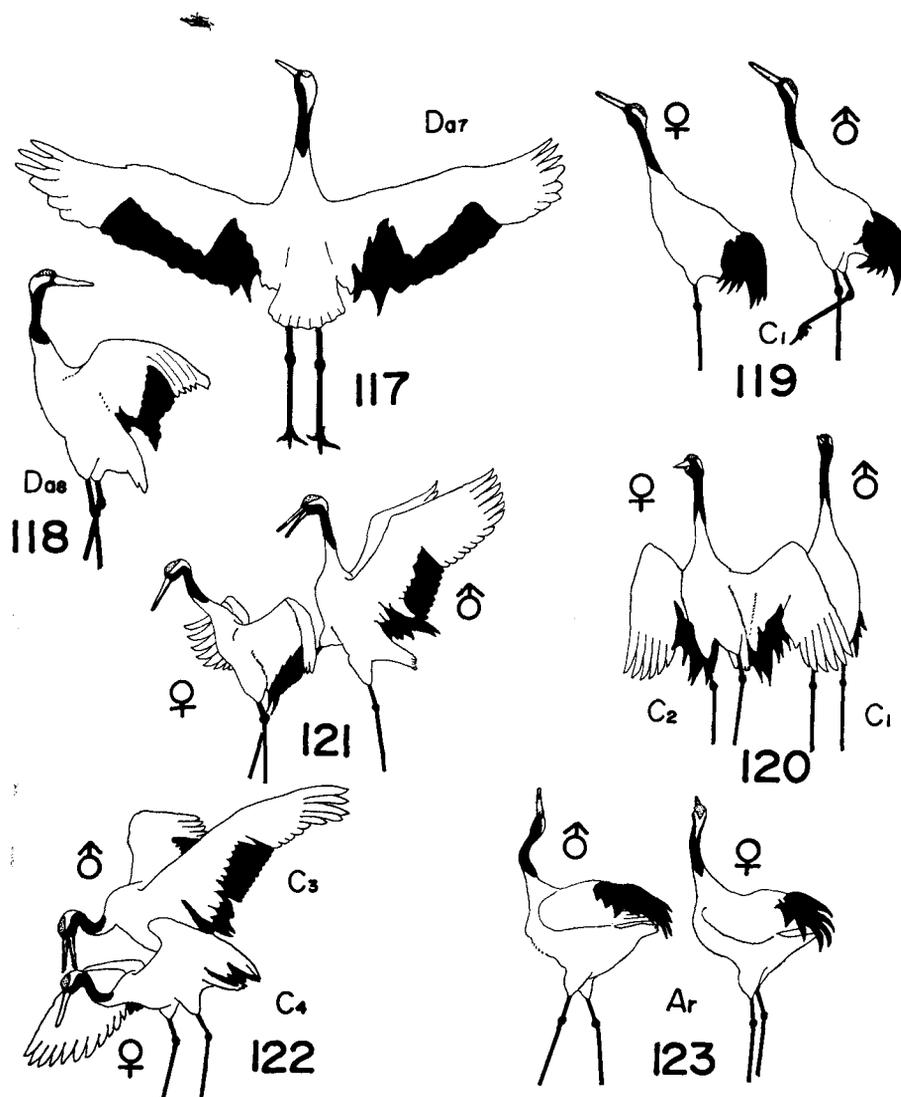


Fig. 117~123. Postures of interindividual behaviour. 117. Throwing (D_{a7}); 118. Turning (D_{a8}); 119, 120♂. Bill-raising (C_1); 120♀. Wing-spreading (C_2); 121. Stepping; 122♂. Mounting (C_3); 122♀. Being-mounted (C_4); 123. Post copulatory display, arching (A_r).

Phase 2: Another mate starts to follow the performer, also taking C_1 or occasionally adornment (A, B.I.1.).

Phase 3: After arrival at an appropriate place, the female turns her back upon the mate, and occasionally begins to spread $W(C_2)$. She stands quietly, but as the male moves around her, she always tries to turn leisurely her back on the male. Then the male successively produces characteristic calls sounding "Kotz! Kotz!...". As the male approaches the female with calls, she generally spreads wings (Masatomi 1972b). The calls gradually become louder and slightly increase the pitch.

Phase 4: The male approaches slowly its mate until about one metre behind, keeping C_1 and calls.

Phase 5: Raising his L on her back, the male steps up on the mate (Fig. 121). *Stepping up* is finished at once by one step. The male still keeps to produce calls which becoming further high-pitched.

Phase 6: Then the male squats carefully on the back of the female, hooking his T_o over her W and keeping balance with his W spread widely and fluttered weakly (mounting, C_3). The male utters calls continuously. The female sometimes spreads and folds her W to keep balance (being mounted, C_4).

Phase 7: Cloacal contact (copulating, C_5) continuing four to eight seconds. The male abruptly breaks off his calls.

Phase 8: Soon after copulating, the male slides down always over her head. Soon the pair performs invariably bowing (B, B.I.3.) and arching (A_r , B.I.2., Fig. 123), frequently accompanied by quick stamping. Sometimes these movements followed by dancing (D_a , B.II.2.), irrelevant-back- and irrelevant-leg-preening (I_b and I_l , B.I.4.2. and 4.3.), and other agonistic displays, occasionally accompanied by unison calls (D_u , B.II.1.).

II.4. Nest-building (N_b , Fig. 124): Similar to foraging (S_{e1} , A.V.1.1.). Closer description of behaviour sequence is left for a subsequent paper. Principal movement consists of cutting or plucking withered reed stems or grasses and throwing them away behind or sides by turning H and N . The Tancho sometimes carries the materials previously cut off towards the nest, holding them between mandibles. Both sexes share in the job.

II.5. Incubation (I): Only characteristic postures or movements are mentioned. C is generally contracted.

5.1. Shifting (I_1 , Fig. 125): F normal, H lowest, B_d vertically down or often slightly backwards and touching eggs, N steeply down and in shallow S shape, T_i slightly down, L normal. Eggs usually moved with B , occasionally with T_o . **5.2.**

Settling (I_2): Similar to sitting (R_{e3} , B.I.3.). F fluffed, W faintly raised, wagging several times. **5.3. Nest-mending** (I_3 , Fig. 128): Identical with nest-building (N_b , B.II.4.) except the presence of eggs. I_3 in standing similar to I , but H sometimes swung horizontally. At I_3 in sitting, H as high as T directed forwards or sideways. B_a obliquely or vertically down, N_f usually retracted, but stretched to pick up materials remote from B_o and to put it sideways. After picking or pulling a piece of nest material, the Tancho lays thrusting or only folding it onto the nest in front or sides of B_o .

Leaving description of the relief of incubation for a subsequent paper, only the typical sequence of movements on the nest is outlined here (cf. Masatomi 1971). Postures and movements concerned with the incubation are, a) *gazing in standing and sitting position* (Fig. 127), b) *shifting*, c) *sitting*, d) *heel-standing*, e) *settling*, f) *nest-mending* (I_3) *at standing and sitting position*, h) *sleeping or resting with H-back and H-down postures* (A.I.), i) *gazing on nest at sitting* (Fig. 126) and j) *standing up*. A Tancho takes gazing (G. A.VII.) in standing up on nest after relief of incubation and sometimes during its attentive period. Then it preens plumage, especially of breast and belly (P_r , A.III.1.1.). The shifting is preceded and followed by gazing at standing, either holding or skipping preening at undersides of B_o between these two movements. Sometimes nest-mending (I_3) is inserted. Then the Tancho lowers itself carefully on the eggs. Sitting bird generally performs nest-mending (I_3) and comfort behaviour such as preening (P_r , A.III.1.1.), head-shaking (S_{h1} , A.III.2.1.), panting (P_a , A.III.10.), and yawning (Y_a , A.III.11.), in addition to sleeping (S_1 , A.II.) and resting (R_e , A.I.).

Doorn (1966) described behaviour of a female hearing the peeping out of the not yet broken egg in captivity. The crane held B vertically and both W somewhat open, supporting herself more than usual by the shoulder at each peeping.

B.III. Parental care: Closer descriptions of parental care are left for a subsequent paper. Here only postures and movements in each behaviour pattern are described briefly.

III.1. Feeding (F): Three typical postures are recognized.

1.1. Low-feeding (F_{e1} , Fig. 129): F normal, C contracted and un conspicuous, H low, B_a steeply down or pointed to the chick, N slightly retracted and steeply down, T_i nearly horizontal. **1.2. Forward-feeding** (F_{e2}): Similar to F_{e1} , but H nearly as high as T , N_i not much inclined down. **1.3. Side-back-feeding** (F_{e3}): Similar to F_{e2} , but fore body turned horizontally to sides or side-back with slightly extended N .

Besides typical instances mentioned above, there are many transitional postures. The chick is fed by both parents since the hatching, though very infrequently on the first day (cf. Masatomi 1971). Parents carry food to their chicks holding it at the tips of B . Mostly staying still with a low-feeding (F_{e1}), they offer or put it in front of the chick. Then the chick picks it directly from B of the

parents or picks up it laid on the ground or nest. The juvenile becomes to turn after the parents leading young to the food (=indirect feeding, Pettingill 1956), though they usually come back to give the chick food in early stages. They sometimes carry fishes in a hurry to the juvenile even a few months after hatching. At feeding, parents utter low calls "Grrrrr...". Tearing, manipulating, and dipping the food in the water before or during feeding are also common.

III.2. Brooding (B_r): Similar to sitting (R_{e3} , A.I.3.), but F fluffed, one or both W a little detached from T when the chicks crawling under B_o .

If a pair has a chick, one parent, usually the female, crouches on the nest or relatively open dry place of the wetlands irrespective of the existence of the chick at the spot. The chick crawls into F usually from behind. *Sitting-site-building*, similar to nest-building (N_b , B.II.4.), is occasionally performed (Masatomi 1972a).

III.3. Following (F_o , Fig. 130): F similar to submission (E_s , B.I.7.1.), H slightly high, B_d slightly down, T_i nearly horizontal, C contracted. In general the female follows the partner, the male, and the chicks do its parents. It is difficult to distinguish this from submission based upon the external appearance alone.

III.4. Chick-covering (C_c): B directed upwards to the enemy and opened widely to attack or to threaten. C expanded and conspicuous, W spread fully to sides, H high, N_f retracted slightly.

If an enemy such as crows *Corvus corone orientalis* and *C. macrorhynchos japonensis*, black kite *Milvus migrans lineatus* (Gray), or Japanese buzzard *Buteo buteo japonicus* (Temminck and Schlegel), flies around over the early stages chick to fall upon, the parents sometimes perform this posture. Standing or stooping by the side of chick, they spread W over it, e.g. the female over the chick and the male over the chick and female. When the parents are apart from the chick, they hurry back to the chick to protect it with this display. C_c in sitting (in brooding, B_r , B.III.2.) was once performed by a female toward an anatid species flying above about ten metres.

III.5. Bill-touching (B_t , Fig. 131): F normal, H slightly high, B_d directed to the tip of the juvenile, N usually retracted and curved in shallow S shape.

Even the full grown juvenile sometimes tries to pick gently tip of the parents' B . The opposite case is rare, and mutual touching scarce with in a single sequence. This is occasionally performed until family dissolution in the next spring. The function and origin of this behaviour is not yet clear, but probably linked with direct feeding, especially food begging by juveniles.

B.IV. Defensive behaviour to enemies: Only two characteristic behaviour patterns are briefly cited in this section.

IV.1. Mobbing (M_o): Identical with alert (A_1 , B.I.6.). If an animal such as feral cat, dog, red fox *Vulpes vulpes schrencki* Kishida, or deer *Cervus nippon*

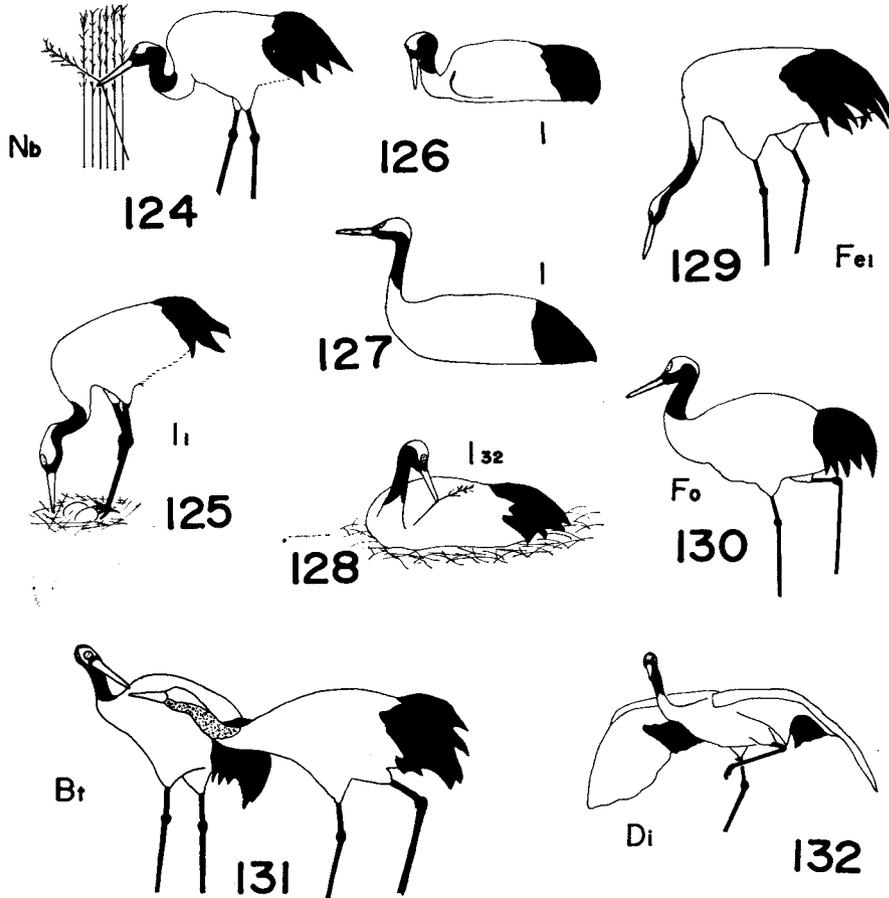


Fig. 124~132. Postures of interindividual behaviour. 124. Nest-building (N_b); 125. Shifting (I_1); 126, 127. Incubating postures; 128. Nest-mending-in-sitting (I_{32}); 129. Low-feeding (F_{e1}); 130. Following (F_o); 131. Bill-touching (B_t); 132. Diversionary display (D_i).

yessoensis (Heude), so far observed as a target approaches the family in the breeding territory, they come up to the animal with the posture uttering *alert call* (B.I.6.). They follow it with rather hurried steps and usually stand or move around it with alert posture, keeping a certain distance. These behaviour patterns are also released in winter flocks at feeding or roosting places against strange animals passing through there: Any member takes part in the tumult in concert.

IV.2. *Diversionary display* (D_i , Fig. 132): *F* sleeked, *H* slightly down, *N*

obliquely up with shallow or deep curve, T_i nearly horizontal, both W spread sideways but sometimes primaries tolerably drooped.

When a man, a dog, or some strange animals approach the nest or the early stage chick, diversionary display (D_i) by the parents is occasionally elicited. Leaving from the nest or the chick, the parents take an alert posture (A_1 , B.I.6.) at first. It begins to step aside with or without spread wings or even proceeds to the enemy with a slightly quick pace. This display, however, is not yet definitely ritualized in the Tancho so that the term diversionary was adopted instead of *distraction* and its occurrence may depend on the situation and condition of the individual concerned. One bird may fly away without any diversionary display or calls and the other may run around the enemy with *alarm calls* "Kwarr---, Kwarr---, ---" or may take alert posture with more upright position and W not spread, etc. (cf. Masatomi 1972b).

We wish to express our sincere gratitude to Dr. Sh. F. Sakagami for his kind and pertinent guidance in the course of the present study and to Prof. M. Yamada for his generous help throughout the work, further to Dr. Y. Akahira, Hokkaido University of Education, Dr. G. Archibald, International Crane Foundation, Dr. and Mrs. Satsuki, Prof. M. Tanaka, Hokkaido University of Education, Dr. S. Tsunematsu, Mr. T. Yoshii, Yamashina Institute for Ornithology, and Dr. L. H. Walkinshaw, who helped in various ways in the course of the study. We also express our cordial thanks to all staffs of the Kushiro Municipal Museum, and of Sapporo, Kushiro, and Nemuro Educational Committee of Hokkaido, for the help offered in order to facilitate the work. Finally we are obliged to mention invaluable suggestions and helps offered given by many friends, for the present work, in particular, by Messrs. S. Abe, T. Hayashida, H. Ito, T. Iwamatsu, A. Kinoshita, M. Hashimoto, K. Nishimura, R. Takahashi, M. Toyohara, the late S. Yamazaki, A. Yoshida, and Y. Watanabe.

Summary

Basic behaviour patterns of the Tancho, *Grus japonensis* (Müller), under natural conditions in eastern Hokkaido were studied. The behaviour patterns confirmed were classified as follows:

A. Maintenance behaviour which does not involve coactions between conspecific individuals or with other animals: I. Resting (R_e), subdivided into 1. Sleep-like-resting (R_{e1}), 2. Neck-shortening-resting (R_{e2}), and 3. Sitting (R_{e3}); II. Sleeping (S_L), subdivided into 1. Back-sleeping (S_{L1}), 2. Down-sleeping (S_{L2}), 3. Sit-back-sleeping (S_{L3}), and 4. Sit-down-sleeping (S_{L4}); III. Comfort movement, subdivided into 1. Preening (P) with various postures, 2. Shaking (S_h) with various six postures, 3. Leg-stretching (L_s), 4. Wing-raising (W_r), 5. Rump-raising (R_r), 6. Wing-flapping (W_f), 7. Bathing (B_a), 8. Head/beak-washing (W_a), 9. Sunning (S_u) with two patterns, 10. Panting (P_a), and 11. Yawning (Y_a); IV. Locomotion, subdivided into 1. Walking (W) with two postures, 2. Running (R), 3. Swimming (S_w), 4. Flying (F) with various successive postures; V. Food intake, subdivided into 1. Food-searching (S_e) with two postures, 2. Eating (E_t) with four

postures, and Drinking (D); VI. Defecation (D_o); VII. Gazing (G) with four postures.

B. Interindividual behaviour involving agonistic, proper reproductive, parental-care, and defensive patterns: I. Agonistic behaviour, subdivided into 1. Adornment (A) with three postures, 2. Arching (A_r) with two postures, 3. Bowing (B) with four postures, 4. Irrelevant behaviour (I) with various six postures, 5. Attacking (A_t) with four postures, 6. Alert (A_r), and 7. Escape (E) with various six postures; II. Reproductive behaviour, subdivided into 1. Duetting (D_u) with five postures, 2. Dancing (D_a) with various eight postures, 3. Copulation (C) with five successive postures, 4. Nest-building (N_b), and 5. Incubation (I) with three postures; III. Parental care, subdivided into 1. Feeding (F_e) with three postures, 2. Brooding (B_r), 3. Following (F_o), 4. Chick-covering (C_c), and 5. Bill-touching (B_t); IV. Defensive behaviour, subdivided into 1. Mobbing (M_o), 2. Diversionary-display (D_i).

Typical postures of these behaviour patterns were at first described with various phases of elementary forms and dispositions, followed by references to the associated movements or the situations at which these concerning patterns are released.

References

- Allen, R. P. 1952. The whooping crane. Nat. Aud. Soc. Research Rep. 3 xxvii+246 pp., New York.
- Armstrong, E. A. 1963. A study of bird song. xv+335pp., London.
- Blaauw, F. E. 1897. A monograph of the cranes. viii+64 pp., Leiden and London.
- Doorn, C. van. 1966. Die Zucht von Manshurenkranichen (*Grus japonensis*) in Rotterdamer Zoo. Freunde des Kölner Zoo 9: 39-45.
- Heinroth, O. and M. Heinroth 1926. Die Vögel Mitteleuropas. Bd. 2. x+285 pp., Berlin.
- Iwamatsu, T. 1966. The Japanese crane. 86 pls.+18 pp., Tokyo. (In Japanese).
- Kruijt, J. P. 1946. Ontogeny of social behaviour in Burmese red jungle fowl (*Gallus gallus spadiceus*) Bonnatere. Behaviour Suppl. 12: 1-201.
- Lorenz, K. 1941. Vergleichende Bewegungsstudien an Anatinen. J. Ornith. 89 (Suppl.): 194-293.
- McKinney, F. 1965. The comfort movements of Anatidae. Behaviour 25: 120-220.
- Makatsch, W. 1970. Der Kranich. 132 pp., Wittenberg.
- Masatomi, H. 1970. Ecological studies on the Japanese Crane *Grus japonensis* I. J. Bibai Agric. Engin. Coll. 1: 37-45. (In Japanese).
- 1971. Idem II. *Ibid.* 2: 93-111. (In Japanese).
- 1972a. Idem III. *Ibid.* 3: 153-161. (In Japanese).
- 1972b. Elegant danseuse in proud loneliness. Kagaku Asahi 32(1): 78-86. (In Japanese).
- 1973. Communal wintering of a sandhill crane with Japanese cranes in Hokkaido, Japan. Wilson Bull. 84(3): 250-260.
- and T. Kitagawa. 1974. Bionomics and sociology of Tancho or the Japanese crane, *Grus japonensis*, I. Distribution, habitat and outline of annual cycle. J. Fac. Sci. Hokkaido Univ. Ser. VI. Zool. 19 (3): 777-802.
- Moll, K.H. 1963. Kranichbeobachtungen aus dem Müritzgebiet. Beitr. z. Vogelk. 8: 221-253, 368-388, 412-439.

- Pettingill, O. S. Jr. 1956. A laboratory and field manual of ornithology. viii+379 pp., Minneapolis.
- Walkinshaw, L. H. 1949. The sandhill cranes. x+202 pp. Cranbrook Inst. Sci. Bull. 29. Michigan.
- 1973. Cranes of the world. 370 pp., New York.
-