COMFORT MOVEMENTS OF THE KEA, *Nestor notabilis* (Psittaciformes: Nestoridae)

By K. J. POTTS

ABSTRACT

Comfort movements of the parrot *Nestor notabilis* in captivity are described and their occurrences in sequence statistically analysed. Some movements were found to be significantly associated.

INTRODUCTION

Systematic study of the non-reproductive ethology of the Kea (a species endemic to New Zealand) has not previously been undertaken; such information as exists is fragmentary, consisting of loosely descriptive or anecdotal references within the framework of more general studies.

Apart from their significance in comparative studies, descriptions of non-reproductive behaviour provide a basis for the study of reproductive behaviour since, in birds, elements of the latter have frequently been shown to derive from the former (e.g. van Iersel & Bol 1958) . Furthermore, non-reproductive behaviour may be organised and, as such, challenges an explanation (Delius 1969). An analysis of uninterrupted sequences (or " bouts " as defined later in this paper) of various kinds of comfort movements of Keas shows that some movements are significantly associated.

The applicability of studies made of captive birds to behaviour in the wild is widely accepted for, although differences in behaviour frequency and intensity do occur, the range of basic movements associated with body maintenance, reproductive and agonistic display tends to be highly stereotyped.

METHODS

Observations were made on caged birds at Wellington Zoological Gardens from mid-March to early July 1969 and in March 1976. The number of birds confined at any one time varied from 6 to 28. No nestlings were available for study.

The 1969 cage measured approximately 10 x 16 x 5 metres; in 1976 6 birds were confined in a larger cage. Details of behaviour were recorded by direct observation from outside the cages, except in 1969 when an internal hide was sometimes used.

COMFORT MOVEMENTS

I have closely followed McKinney (1965) in classifying under

the general heading of comfort movements the activities of shaking, stretching, cleaning, bathing and autopreening*.

These movements serve to remove sources of irritation and extraneous material, care for the body surface and plumage and counteract the effects of muscular inactivity.

Shaking movements:

(i) Head-shake
The head is shaken in a side to side motion several times, usually within the space of 1-3 seconds; its intensity may vary. The bill may be partially open. Head-shaking often occurs after sneezing, drinking and feeding to remove mucus, water, dirt or food particles from the bill surface.

(ii) Body-shake
This consists of a fluffing of the entire plumage, followed by a sharp side to side twisting shake of the body. It is probably performed in response to disarranged feathers or to the presence of water or foreign matter on the plumage.

(iii) Tail-wag
The tail, which may be fanned slightly, is shaken from side to side a number of times, usually within the space of 3-5 seconds. It often occurs after body-shaking for the apparent purpose of arranging misplaced tail feathers.

Stretching movements:

(i) Wing-and-leg-stretch
One wing and the leg on the same side are extended downwards and backwards from the body while the tail is fanned to the same side. The wing and leg are not always returned to rest simultaneously; the leg is sometimes returned to the substrate while the wing remains stretched for a few seconds longer.
Wing-and-leg stretching is often performed after long periods of inactivity and usually lasts about 5 seconds. It tends to follow rest and probably serves to stimulate the flow of blood in the

* McKinney considers what he terms ' social preening ' to be a comfort movement. I do not for the following reasons: (1) Harrison (1965) has pointed out that ' social preening ' is an ambiguous term, synonymous in the literatue with such diverse terms as ' mutual preening,' ' hetero-preening ' and ' feather nibbling ' and as such is not definitive enough. To avoid ambiguity I will follow Cullen (1953) in using ' autopreening ' for the occasions when a bird preens its own plumage — as opposed to ' allopreening ' when it preens the plumage of another bird. (2) Evidence by Harrison suggests that allopreening (McKinney's ' social preening ') does not, in fact, serve the function of caring for the plumage but rather is related to agonistic behaviour. If this is so, and my own observations of the Kea lead me to agree with Harrison, then allo-preening should not be designated a comfort movement. The agonistic behaviour of the Kea is described elsewhere (Potts in prep.).

limbs, thus preparing the bird for action. Andrew (1956) noted that general stretching occurred most frequently in *Emberiza spp.* when birds had been cramped, as in brooding.

(ii) Both-wings-stretch
Both wings, slightly bent at the carpal joints, are raised over the back so the bows and tips come close together, are held for a few seconds, then folded to rest. Its function is probably the same as for both-legs-stretching, except perhaps when it precedes or accompanies defaecation, in which case it may serve to increase muscle tension necessary for faecal ejection.

(iii) Jaw-stretch
The mandibles are held wide open for a few seconds then shut, giving the impression of yawn. It may be performed in response to extended muscle inactivity, internal irritation, or to tense throat and head muscles for vigorous scratching.

Cleaning movements:

(i) Head-scratch
This movement is achieved by first bringing one leg behind, then over, a lowered wing so that the nail of the longest claw can be used to scratch the throat and the crown, back or side of the head i.e. by the 'indirect' method in the terminology of Simmons (1957). The head is suitably inclined and the foot is moved rapidly back and forth over the area being scratched. The bird sometimes shifts its body weight towards the lowered wing side to help maintain balance.
On a few occasions I have observed birds scratching directly i.e. under the wing, but this was performed in a clumsy, less intensive manner.

Simmons (1957) suggested that head-scratching may function as a supplementary means of autopreening and may serve to remove a source of irritation, possibly ectoparasites.

(ii) Bill-wipe
The bill is rubbed against a solid surface, first on one side and then the other. It nearly always follows feeding, and sometimes drinking, to remove food, water and other material from the bill surface.

(iii) Foot-and-leg-nibble
A bird may stand on one leg and bring the other up to the bill so that the foot or leg can be nibbled; it may instead lower the bill to the foot or leg. Commonly, however, it compromises by raising the leg and lowering the bill so that they meet each other halfway.

The function of nibbling is probably to remove foreign matter or dead skin.

Water bathing:

(i) Head-dipping
This is normally the first action in a bathing session. The bird stands in, or at the edge of, the water trough and dips its bill and part of its head. On withdrawal the head is flicked sharply sideways. This serves to direct water adhering to the cheeks and bill onto the back.

(ii) Wing-thrashing
Wing-thrashing is often performed in bathing. Both wings are employed more or less simultaneously to beat the water. This is often very forceful and rapid and the bird tends to spring up as it does so. Body-shaking also serves to splash water onto the unsubmerged parts of the body. Crouching in the water occurs frequently.

Birds did not normally remain in the water for the entire bathing session. They usually bathed for a minute or so, got out of the trough to head-shake, body-shake and tail-wag then re-entered to bathe again. This was often repeated two or three times. The session was usually terminated by another brief spell of shaking and tail-wagging at the side of the trough after which the bird clumsily flew up to a branch to autopreen. A bathing session lasted from about 1-5 minutes.

Water bathing appeared to occur most frequently on sunny days from mid-morning to early afternoon i.e. at the time of maximum light penetration into the cage.

Autopreening:

Autopreening may occur as an isolated event, as when a bird preens its breast feathers during a break in feeding, or it may occur for extended periods, usually following feeding or bathing. It is sometimes preceded by a slight ruffling of the plumage to facilitate the grasping and preening of individual feathers. The longer feathers of the wings and tail are pulled upward by the bill and are then drawn through it while being simultaneously nibbled.

Autopreening serves to remove loose skin and other extraneous material from the plumage. It probably also hastens the drying process after wetting by separating adhering feathers and so exposing a greater surface area for evaporation.

SEQUENTIAL ORGANISATION OF COMFORT MOVEMENTS

Records were kept of sequences of comfort movements performed in " bouts " (see below) by individual birds. These records were combined to obtain sufficient data for statistical treatment; the data were arranged in a matrix to indicate how often particular patterns were either followed or preceded by others and these were analysed to determine significant sequence correlations (by the method of Davies 1963 adapted by Andrew 1956).

A " bout " is defined as a sequence of two or more comfort movements in which the time lapse between any two consecutive components did not exceed one minute nor were interrupted by any other kind of behaviour. Bathing activity was arbitrarily unrecorded. Defaecation, though not a comfort movement in terms of the definition used, was recorded since it commonly occurred during comfort bouts.

I have followed Andrew (1956) in regarding an autopreening component as ended when a bird paused after preening a specific area of its plumage e.g. behind its wing, or its breast. Jaw-stretching often started just after head-scratching began in which case it was recorded as following head-scratching. Likewise defaecation was deemed to follow a both-wings-stretch when it occurred between the onset and full extension of a both-wings-stretch.

The legend underlying Table I describes how significant sequence correlations were obtained.

DISCUSSION

Comfort movements of the Kea tend to occur more in " bouts " during resting periods than as isolated events. Andrew (1956), noting the same tendency in passerines *(Emberiza spp.)** suggested this probably arises, in part, from the absence of any other strong motivation; he found that toilet behaviour was easily suppressed by other tendencies. My own observations support Andrew's explanation. For example, it is rare for bouts of comfort activity to interrupt intense feeding and birds, when attacked, will invariably cease comfort behaviour to flee or retaliate.

Andrew also suggested that stimuli for most toilet behaviour are likely to occur fairly continuously, although at times weakly, and such stimuli will intensify if the movements are not performed for some time. He added: " Sleep is probably another activity that tends to appear when other motivations are low, and this would explain why toilet behaviour often occurs in the same period of time as a resting attitude."

Little can be said about proximate causes of behavioural linkages in birds because of the technical difficulties involved in having to record simultaneously, not only behaviour, but also the external and internal stimuli likely to affect it (for a discussion on this topic see Delius 1969). However, some general explanations of causation have been suggested for certain behavioural associations in birds and these are briefly discussed as they apply to significant associations exhibited by Keas as shown in Table I.

Autopreen + autopreen: Positive correlations between autopreening performances in bouts have also been recorded for Skylarks *(Alauda arvensis)* by Delius (1969) and for *Emberiza spp.* by Andrew

* He was referring specifically to ' toilet behaviour ' but this includes comfort behaviour as defined earlier in this paper.

TABLE I

ORGANISATION OF COMFORT MOVEMENTS IN BOUTS WITH INTEREVENT INTERVALS OF ONE MINUTE OR LESS. BASED ON OBSERVATIONS OF SEVERAL MALES AND FEMALES.

FIRST ACTION \ SECOND ACTION	Head-shake	Body-shake	Head-scratch	Auto-preen	Both-wing-stretch	Wing-leg-stretch	Bill-wipe	Tail-wag	Jaw-stretch	Foot-leg-nibble	Defaec-ation
Head-shake	2 0.6	6* 0.7	1 0.6	3 5.2	- 1.6	- 3.7	2 0.9	1 0.7	- 0.5	- 0.2	- 0.8
Body-shake	4 1.4	1 1.8	1 1.6	10 13.7	1 4.2	2 9.8	2 2.3	15* 1.9	3 1.3	- 0.5	- 2.2
Head-scratch	6* 1.3	3 1.7	5 1.5	7 12.9	2 3.9	1 9.2	2 2.2	- 1.8	8* 1.3	1 0.5	2 2.1
Auto-preen	2 8.2	7 10.7	1 9.2	112* 79.5	5(-) 24.2	13(-) 56.7	16 13.6	1 11.1	- 7.8	- 2.9	-(-) 12.5
Both-wing-stretch	- 3.4	1 4.4	2 3.8	4(-) 32.9	3 10.0	58* 23.5	- 5.6	2 4.6	- 3.2	- 1.9	18* 5.2
Wing-leg-stretch	- 4.2	1 5.4	3 4.7	10(-) 40.6	39* 12.3	34 29.0	1 6.9	- 5.7	1 4.0	1 1.5	2 6.4
Bill-wipe	1 0.3	- 0.4	- 0.3	1 2.8	- 0.9	- 2.0	3* 0.5	- 0.4	- 0.3	1 0.1	2 0.5
Tail-wag	- 0.8	2 1.0	3 0.9	12 7.4	- 2.6	2 5.3	- 1.3	- 1.0	2 0.7	- 0.3	- 1.2
Jaw-stretch	1 0.3	- 0.3	1 0.3	- 2.4	- 0.7	2 1.7	- 0.4	1 0.3	2* 0.2	- 0.1	- 0.4
Foot-leg-nibble	1 0.3	- 0.4	- 0.3	2 2.8	- 0.8	1 1.9	1 0.5	- 0.4	- 0.3	2* 0.1	1 0.4
Defaec-ation	- 0.6	1 0.8	2 0.7	3 5.7	- 1.7	4 4.1	1 1.0	3 0.8	- 0.6	1 0.2	1 0.9

In each cell the upper of the two figures represents the number of times the actions shown down the side of the table were followed by those shown along the top. For example, tail-wagging followed body-shaking 15 times. The lower figure in each cell is the expected value i.e. the number of times the actions at the top of the table would be expected to follow the actions shown down the side if the sequences were due to chance. A difference between the observed and expected values was considered significant if it was more than three times the square root of the expected value. If the observed value was greater than the expected correlation was positive i.e. the sequence occurred more often than would be expected if it was by chance. If the expected value was greater than the observed the correlation was negative and the reverse was true. Positive correlations are indicated by an asterisk and negative correlations by a minus sign in brackets (after the method of Davies, 1963 adapted from Andrew, 1956).

(1956). Delius suggested the behaviour may have a self-activating effect up to a certain number of performances. Bouts of uninterrupted autopreening ranged from two to about 12 movements in the Kea. Jaw-stretching, bill-wiping and foot-leg-nibbling also showed a significant tendency to be followed by themselves, but the results are based on too few figures to be conclusive.

Head-shake + body-shake: This sequence was particularly common after water bathing and in this context may be interpreted as a response to water on the plumage. That head-shaking tended to precede body-shaking may have been a consequence of a co-ordination mechanism in the nervous system.

Body-shake + tail-wag: This sequence, when performed by a dry bird, is probably an example of one activity engendering a stimulus (in this case disarranged tail feathers incurred in body-shaking) which causes another (Delius 1969). After bathing the head-shake + body-shake + tail-wag sequence was common, in which case all movements were likely to have been direct responses to adhering water; thus the primary cause of tail-wagging after bathing was probably the tactile stimulation of water and not disarrangement of feathers caused by body-shaking. Shaking was the first priority after bathing. Quick removal of the bulk of the water would hasten the drying process and so restore full mobility and balance. This may be important since birds when wet appeared to be more vulnerable to attack than when dry.

Head-scratch + head-shake: This positive sequence may be another example of one activity engendering a stimulus which causes another. Head-shaking may be a psychological response or it may serve to remove adhering particles dislodged by scratching.

Head-scratch + jaw-stretch: Jaw-stretching often occurred just as the actual scratching phase of the head-scratching movement began. It may serve to tense head and throat muscles for vigorous scratching.

Wing-leg-stretch + both-wings-stretch (and conversely): These positive correlations have also been recorded for Skylarks by Delius (1969). They may be consequences of simultaneous propriostimulation from inactive muscles, i.e. the different forms of stretching may be required to prepare sets of muscles for action. The wing-leg-stretch (on one side) + both-wings-stretch + wing-leg stretch (opposite side) was a common sequence. The negative correlations shown between autopreening and wing stretches indicate these behaviours tend to be performed separate from each other.

Defaecation from perches was significantly preceded by both-wings-stretching which may contribute toward the muscles tension necessary for faecal ejection. On the ground defaecation was usually performed while walking stiffly backward; both-wings-stretching did not normally accompany it.

It should be stressed that the statistical analysis undertaken indicates only relatively broad trends of comfort movement organisation in bouts. Different methods of data collection and higher order analysis would need to be applied for more refined information (see e.g. Delius 1969 and Morgan *et al.* 1976). It is not known whether the same basic organisation persists when comfort patterns do not occur in bouts i.e. when intervals between patterns are longer than one minute and are interspersed with non-comfort behaviour patterns.

Delius (1969) pointed out that if one were to repeat an analysis of behaviour sequences obtained from a different sample of the same species the two results may not be equivalent in their statistical properties because (1) they stem from different individuals, sexes, ages, aggregations, etc., which may not exhibit the same behaviour frequency and pattern and (2) behaviour frequency and pattern may alter over time due to environmental factors and endogenous changes in individuals.

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K. J. POTTS, *N.Z. Wildlife Service, Department of Internal Affairs, Private Bag, Wellington*