# The feeding ecology, requirements and distribution of Baikal Teal *Anas formosa* in the Republic of Korea

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*An overwintering population of up to 20,000 Baikal Teal was found at the Ch'unam reservoirs in the Republic of Korea in 1984. The first detailed studies at the site were undertaken in December 1989 and January 1990; it comprises three water storage reservoirs, Sannam (75 ha), Ch'unsan (307 ha) and Tongp'an (50 ha), located on the south side of the Nakdong river valley, South Kyongsang Province (35°18'N, 128°14'E), and holds 18-20,000 Teal in large monospecific flocks. Sixty-two percent of the birds were males in full breeding plumage, and 17% were paired. Displaying Teal were noted only twice. Feeding was predominately nocturnal, the lakes being used as a diurnal roost. All birds formed into one flock at dusk and thence flew up to 7 km to feed on agricultural land. Observations and faecal analysis showed that the birds were feeding exclusively on rice from paddy fields which had been harvested by machine in the previous autumn and were completely dry. Seventy-three percent of harvested rice fields were suitable for Teal to feed on, the rest being cleared (9%), burnt (7%) or ploughed (11%). Occasional birds fed during the day on the reservoirs by either dabbling or filter feeding in melt water lying on top of the ice after an overnight freeze. Estimates of energy requirements and food intake suggest that the population requires 111,600-225,000 kg of rice ears for a 90 day season (1.8 million bird days) and that therefore 3392-13,636 ha of suitable harvested rice fields are needed to support them throughout the winter, or more if other granivores are competing. There are 3478 ha of suitable rice fields within 8 km of the reservoir. The birds are threatened by disturbance from fishermen, hunters, visiting tourists and local domestic traffic. Overhead power cables may cause significant mortality. None of these is a major threat at present but the exclusive, monospecific nature of Baikal Teal makes them vulnerable to particular hunting techniques or chance events such as disease. A survey of 12 other potential sites in the southern part of the Korean peninsular found only three suitable, one of which held 200 Baikal Teal.*

La Touche (1925-34) described Baikal Teal *Anas formosa* as "the commonest duck in north-east Asia". This species was formerly abundant throughout southeast China and Japan; groups of 10,000 birds were not uncommon and there were occasional flocks of 100,000 strong (Austin & Kuroda 1953). A dramatic decline in numbers was noted during the late 1970s with fewer than 10,000 birds in the whole of Japan in 1980 (Brazil 1991). In the light of this, the discovery of a flock of 5000 birds at the Ch'unam reservoirs in the Republic of Korea in February 1984 (Won 1988) was of great significance; the duck had only been noted previously as a passage migrant in the republic (Gore & Won 1971). Numbers at Ch'unam varied over the following six winters but reached 20,000 birds at times, which represented over 80% of the known world population. The birds were present at the site from late November until early March.

The reasons for the general decline are unknown. In Japan, hunting pressure may have been a factor but, as little was known of the species' wintering ecology, it was difficult to infer its requirements. As a result it was proposed that a short study of the birds at Ch'unam be undertaken to provide background information for future conservation proposals.

The aims of this study at Ch'unam were to establish baseline data on the ecological requirements of Baikal Teal and, if possible, to assess the age structure of the population. The results of the work have been incorporated directly into Conservation Action Plans for both the species (Poole in press) and the site (Poole *et al.* 1990). An attempt was also made to locate other key areas for Baikal Teal in the southern

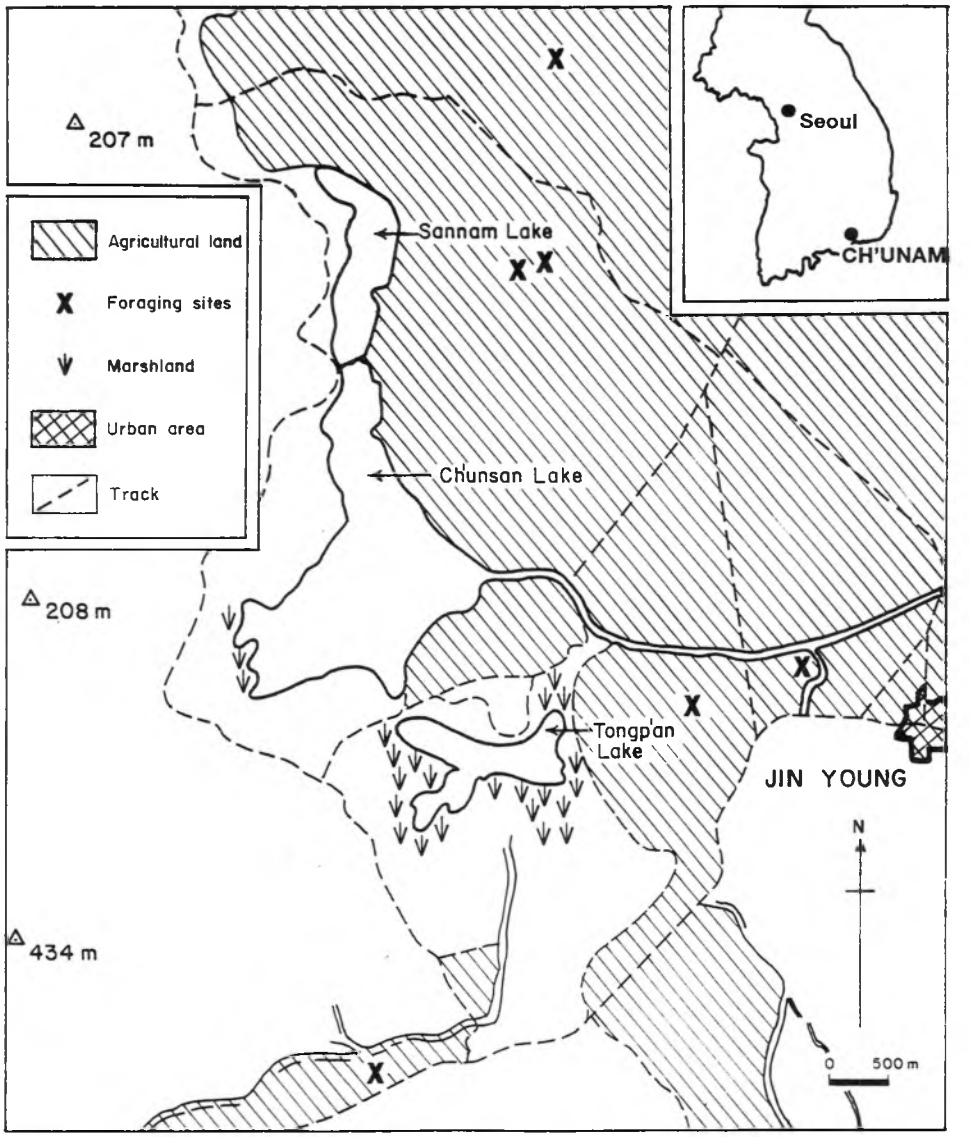


**Figure 1. The location of the Ch'unam reservoirs in the southeast of the Republic of Korea, and the distribution of agricultural land in the vicinity.** The location of Baikal Teal feeding sites are marked "X".

part of the Republic of Korea.

An initial visit was made to Ch'unam by C.M.P., M.I.E. and E.M.P. on 14-16 December 1989. The main fieldwork at the reservoirs took place from 5-16 January 1990 and the survey of potential sites was completed on 18 January 1990.

## Study site

The site comprises three water storage reservoirs, Sannam (75 ha), Ch'unsan (307 ha) and Tongp'an (50 ha) located on the south side of the Nakdong river valley (35°18′N, 128°14′E) 14 km NNE of Masan, Uichang County, South Kyongsang Province (Scott 1989) (Fig. 1).

The reservoirs lie in an area of flat agricultural land relieved by afforested high ground to the northwest and, more remotely, to the south and east. All of the low ground has been developed for agriculture, the land-use in winter being a patchwork of harvested paddy rice, young barley, plough and occasional crops such

as cabbages. Some areas are being covered by large plastic greenhouses in which cut flowers and vegetables are grown. Over the last five years, barley has decreased in popularity but the use of greenhouses has increased markedly (H.S. Noh pers. comm. 1990) although rice still predominates and is usually harvested by a machine which casts the cut heads and straw in separate rows in the field (the structure of a rice plant is shown in Appendix 1). The waste is normally left on the field but is sometimes cleared and gathered, burnt or ploughed-in. The locality is heavily populated, the edges of the valley and occasional low hills being centres for human habitation.

## Methods

### *Habitat and behaviour*

Initial observations concentrated on simple familiarisation with the birds' habits. Further observations were maintained with the objectives of determining their diurnal rhythm - notes were taken on the behaviour of the birds throughout the day over the first three days of fieldwork and their daytime flight activity budget. The proportion of the flock in flight was recorded at five minute intervals during daylight hours and the mean value was used to determine the time spent in flight during the day. These data were used in the calculation of the birds' energy requirements.

### *Food and feeding*

In the first instance, the birds were observed closely whilst on the reservoirs and any feeding activity noted. Attempts were made to follow flocks leaving the roost in order to locate birds feeding in the surrounding agricultural land. Notes were taken on the choice of habitat and feeding techniques.

Faeces were collected and examined using a 20-100x microscope. Ten subsamples were taken from each faecal pellet and spread onto a slide. At 100 random locations on each slide, the food was identified. Areas under power lines were searched for dead birds in order to examine their gut contents.

### *Requirements*

The model formulated by Koplin *et al.* (1980) was used to determine daily energy expenditure using the data from the flight activity budget and daily temperature. Estimates of the digestive efficiency and energy content of the food were determined from the literature and an estimate of daily intake computed. The availability of suitable feeding habitat was outlined by surveying the land-use of the hinterland: 100 points located at random in the cultivated areas were visited and the land-use recorded. Details of the extent of flat agricultural land were determined in radial distance classes from the roost using large-scale maps. Notes were taken of all apparent sources of disturbance.

### *Age and sex structure*

It has been suggested that first-winter birds, particularly males, may show unmoulted juvenile feathers in the plumage of face or body. Captive birds complete a protracted moult by December but wild birds might lag behind because of the poorer quality of their diet (N. Jarrett pers. comm. 1989). Male Baikal Teal attain full breeding plumage by abrasion of the tips of their head and breast feathers, so the plumage condition of males was recorded to give an indication as to the stage that birds had reached in the annual sexual cycle. Any display activity was noted.

A transect was taken through flocks of Teal when at rest. This was done by fixing a telescope on a distant point and then drawing an imaginary straight line to the observer. The age and sex of each bird on the line was recorded where possible; indeterminate individuals were recorded separately. The frequency of pair bonding was determined by randomly selecting individuals from the flock and recording their sexual status by observing their relationships with adjacent individuals.

### *Surveys of other sites*

Based on the results of the ecological investigations at Ch'unam, predictions were made as to the requirements of wintering Baikal Teal. Suitable sites where these requirements might be fulfilled were identified from maps and from a literature review: 12 sites were visited.

## Results

### *General behaviour*

Eighteen to twenty thousand Baikal Teal were present at the site throughout the study period. The birds spent most of the day roosting on

Tongp'an Lake, but Ch'unsan was used on days when the birds were disturbed. Birds were seen only once on Sannam at 15.30 h on 7 January 1990 and had left the area by 16.15 h; all were found in one to three large, monospecific groups during the day but usually regrouped on Tongp'an by dusk (*ca.* 17.00 h). They then left the site - normally in one flock - flying to feed on the surrounding agricultural land. The timing of this flight ranged from 17.20-17.58 h (mean = 17.41 h, $n = 9$). The flight comprised three parts: i) the flock rose from the reservoir, swirled and gathered height, then ii) rapidly flew to the chosen feeding area, sometimes forming into many V-shaped lines and iii) on reaching the site the flock descended, rapidly swirling and fragmenting as Teal settled. These flights were of 5-10 minutes duration. Observations of returning birds were maintained at Tongp'an from first light (06.45 h) and groups of 250-2000 birds were seen to arrive until 07.45 h. Normally all birds arrived from approximately the same direction; however, on two days it was suspected that they flew to Ch'unsan first and then on to Tongp'an when disturbed by fishermen. It was noteworthy that the birds normally returned in the morning from approximately the same direction as they had departed the previous evening. This behaviour suggested that groups of feeding Teal which formed during stage iii) of the evening flight might be maintained overnight.

The large size, coherence and exclusivity of these groups was remarkable. In flight, their speed and manoeuvrability was more reminiscent of a pack of small waders *Calidris* or starlings *Sturnus* than of dabbling ducks.

The proportion of time spent in flight showed peaks in morning and mid-afternoon (Fig. 2, Appendix 2). On average, each bird spent 7.6% of the time (43 minutes) in flight during the daytime roost period.

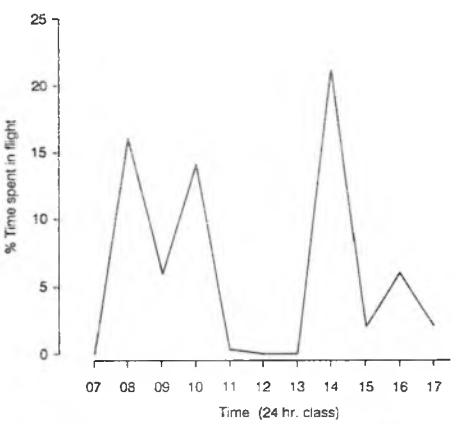


**Figure 2. Percentage time Baikal Teal spent in flight through the day.**

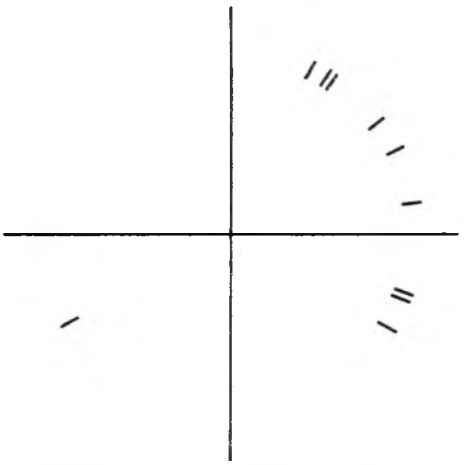

**Figure 3. The direction of Baikal Teal feeding flights from Tongp'an.**

The birds flew up to 7 km from Tongp'an in order to feed (Fig. 1). The poor quality of the roads and the large area covered by the birds made it extremely difficult to locate the feeding flocks. Diurnal feeding was recorded only once (7 January 1990), and nocturnal feeding birds could only be located in the large area of agricultural land if followed successfully by car when flying out in the evening. On several evenings, smog rendered this task impossible. The direction of departure showed a bias to the north and east (Fig. 3), towards the largest expanse of agricultural land (Fig. 1).

*Food and feeding*

The Teal were only occasionally seen feeding on the reservoirs. They employed two methods: i) around 20 birds joined a mixed group of other dabblers picking food from a few centimetres below the surface of open water, ii) occasional birds were seen to filter-feed in the few centimetres of melt-water lying on the surface of the ice on warm mornings after an overnight freeze. This latter behaviour could involve the cleaning of the bill lamellae rather than feeding.

Away from the reservoirs, feeding birds always selected paddy rice fields ($n = 7$) which had been harvested by machine and were completely dry. They were extremely active feeders; groups of 200-1000 birds moved through a field rapidly, never staying in one field longer than 20 minutes (field size was approximately

50x75 m). Teal at the rear of the flock continuously flew up and joined the front, about 10% of the flock being in the air at any time.

Faeces were collected from feeding areas, but sampling from the roost area proved impossible as the birds did not use the peripheral banks. Seven faecal pellets were examined microscopically and the sole constituents were found to be fragments of rice grain and husk.

A bird found dead under power lines had 34 ears of rice (total weight 0.82 g) in the oesophagus, but no other material. Empty husks normally form 30% of waste rice on the field (S.R. Jo unpubl. data); however, only two of the ears in the oesophagus were empty, suggesting that this bird might have been able to select full ears.

*Food requirements*

The model for the calculation of daily energy demand (Koplin *et al.* 1980) uses three variables: body size, mean daily temperature and the proportion of time spent in flight activity. Mean daily temperature at Ch'unam ranges 0-4°C over the period when Baikal Teal are present (Appendix 3). Total daily flight activity comprised three parts: that which occurs during the day, morning and evening flights and nocturnal feeding movements. The birds spent 43 minutes in flight during the day, and evening flights usually lasted 5-10 minutes. Feeding birds spent an estimated 10% of their time in flight - approximately 0.5-1.5 hours flying time overnight. Thus 1.0-2.5 hours of flight per day were estimated and these values were used for the daily energy budget analyses.

Daily energy expenditure ranges 127-171 Kcal $bird^{-1}$ $day^{-1}$ (Table 1). Pink-footed Geese *Anser brachyrhynchus* feeding on grain were found to digest 69.5% of their daily energy intake (Madsen 1985): it is unlikely that Baikal Teal are capable of such a high digestive efficiency since they have a much smaller digestive tract. Taking an estimated range of 40-60% digestive efficiency the daily food requirement can be estimated at 62-125 g D W $bird^{-1}$ $day^{-1}$ of rice ears (Table 2). Thus for 20,000 birds over a 90 day season (1.8 million bird days) the total intake would range 111,600-225,000 kg D W rice ears $season^{-1}$.

The availability of waste rice after the harvest in October has been estimated at 100-200 ears $m^{-2}$ on similar rice cultivated areas near Taegu (S.R. Jo unpubl. data) of which *ca.* 30% were empty husks; thus, the initial availability of suitable food is 1.65-3.29 g D W $m^{-2}$. Extrapolating from these values, an estimated 3392-13,636 ha of suitable rice fields are required to support the winter flock, assuming the birds have the ability to exhaust the resource completely.

The predominant land-use of the agricultural areas in the vicinity of the reservoirs was rice (77%), of which 73% had been machine-cut and the waste left on the fields over the winter (Table 3). The proportion of the total land area cultivated varies between radial distance classes from 19-47%; thus, the availability of agricultural land does not increase directly in step with distance from the roost site (Table 4).

There are a number of sources of disturbance to the birds:

i) Fishermen - all three reservoirs have semi-permanent fish traps which local fishermen visit by punt. The Teal were disturbed in this way on Tongp'an on three occasions during an all-day watch.
ii) Shooting - guards are employed to prevent illegal wildfowling on the reservoirs. Despite this, single wildfowlers were seen on several occasions on the dam at Tongp'an, one of whom was from the village immediately adjacent. Bearing in mind the behaviour of the Teal, it seems unlikely that any would be shot but there was obvious disturbance.
iii People - the dams of all three lakes support local roads and consequently pedestrians and local vehicles are often in view. In

**Table 1. Daily energy expenditure (Kcal $bird^{-1}$ $day^{-1}$) for Baikal Teal (weight 500 g) over a range of mean daily temperatures (°C) and daily flight activity budgets (hrs in flight $day^{-1}$) (Koplin *et al.* 1980).**

| DAILY ENERGY EXPENDITURE (Kcal $bird^{-1}$ $day^{-1}$) | | | |
|---|---|---|---|
| | Temperature (°C) | | |
| Time in flight (hrs) | 4 | 2 | 0 |
| 1.0 | 127 | 131 | 133 |
| 1.5 | 140 | 143 | 146 |
| 2.0 | 152 | 155 | 158 |
| 2.5 | 165 | 168 | 171 |

**Table 2. Food requirements of Baikal Teal (g D W $bird^{-1}$ $day^{-1}$) (rice ears $bird^{-1}$ $day^{-1}$) over a range of digestive efficiencies.** Rice ears have an energy content of 3.41 Kcal g D $W^{-1}$ (Office of Rural Development 1981). Mean weight of rice ears 0.02353 g D W $ear^{-1}$ (n = 35).

| | Digestive efficiency | | |
|---|---|---|---|
| | 40% | 50% | 60% |
| Daily intake | | | |
| Weight | 93-125 | 74-100 | 62-84 |
| Rice ears | 3952-5312 | 3145-4250 | 2635-3570 |

**Table 3. Land-use of the agricultural areas in the hinterland of Ch'unam reservoirs.**

| Land use | % frequency |
|---|---|
| Rice: machine cut and left | 56 |
| Rice; cleared | 7 |
| Rice: burnt | 5 |
| Rice: ploughed | 9 |
| Barley | 5 |
| Greenhouse | 9 |
| Other | 9 |
| | 100 |

addition to this, the dam at Ch'unsan is increasingly popular as a local tourist spot where people come to see swans, geese and other wildfowl. It is unlikely that disturbance from this source has any significant effect because Tongp'an and Ch'unsam are large enough for the Baikal Teal to sit in a group at the middle of the lake.

Mortality from hitting overhead power cables is frequent. The area under 1.7 km of cables was searched and four dead Baikal Teal were found. All had been at least partly consumed, only the wings remaining in one case. Corvids may have eaten the carcasses but it is more likely that the numerous local dogs were the culprits; thus, it is possible that more birds had been killed and the bodies removed. Power lines are frequent around the lakes; however, there was no evidence of these causing disturbance since the birds were seen to feed beneath the lines.

*Age and sex counts*

None of the features previously thought to give an indication of age proved to be of use in the field. Even at close range, the plumage of all males appeared identical. However, the four birds found dead under power lines were aged as adults using the shape of the greater coverts as a guide. All males showed both the full facial pattern and distinct spotting of the breast indicating that they were in breeding condition, surprisingly further advanced than birds examined in the Slimbridge collection in England at the same time.

**Table 5. Pairings of male and female Baikal Teal.**

| | Male % | Female % | Total |
|---|---|---|---|
| Paired | 12 (14) | 12 (21) | 24 |
| Unpaired | 71 (86) | 45 (79) | 116 |
| Total | 83 | 57 | 140 |

Displays were rare. Males were seen displaying on two occasions, performing a simultaneous raising of the head and tail (similar to that of Teal *Anas crecca*) and two females were once seen "head pumping".

In the transects, 61.5 ± 10.6% of the birds were male (mean ± 95% c.i., $n$ = 17x30 bird samples) and in the pairing samples 59.2% were male ($n$ = 140, Table 5). Twenty-one percent of females and 14% of males were paired (Table 5).

*Surveys of other sites*

We selected sites using the following criteria:

i) a water surface greater than 50 ha in extent, preferably with two or three waterbodies within a small area to enable birds to change site to avoid disturbance,
ii) a large area of flat land suitable for rice cultivation in close proximity,
iii) a location in the warm southeast region of the Korean peninsular where waterbodies are less likely to freeze for long periods.

Of the 12 potential sites visited, only three were found to have the combination of large size, freedom from disturbance and rice cultivation. One site - Upo marshes - was found to hold 200 Baikal Teal; these birds were found to be behaving typically, roosting on ice and amongst vegetation during the day alongside *ca.* 1500 Bean Geese *Anser fabalis*.

**Table 4. The availability of agricultural land (ha) and machine-cut paddy rice (ha) in radial distance classes (km) from the Tongp'an.**

| Distance from roost (km) | 0-1 | 1-2 | 2-3 | 3-4 | 4-5 | 5-6 | 6-7 | 7-8 |
|---|---|---|---|---|---|---|---|---|
| Agricultural land | 107 | 435 | 736 | 704 | 681 | 660 | 1376 | 1508 |
| Agricultural land (Cumulative) | 107 | 542 | 1278 | 1982 | 2633 | 3323 | 4699 | 6207 |
| Machine-cut rice | 60 | 244 | 412 | 394 | 382 | 370 | 771 | 845 |
| Machine-cut rice (Cumulative) | 60 | 304 | 716 | 1110 | 1492 | 1862 | 2633 | 3478 |

## Discussion

### *Behaviour*

The general behaviour of the Baikal Teal at Ch'unam reservoirs is consistent with birds observed in Japan (M. Brazil and M. Otsu pers. comm. 1989). The formation of very large, cohesive, monospecific flocks contrasts with the behaviour of other dabbling ducks wintering at similar latitudes (Cramp & Simmons 1977). Perhaps the most similar species is the Garganey *Anas querquedula* which also becomes concentrated in winter, but whose groups are smaller, normally being less than a thousand birds (C. Perrenou pers. comm. 1990). Small groups of Baikal Teal only form when the birds are feeding, an activity characterised by almost frenzied activity. Their social behaviour makes them vulnerable to major mortalities from events such as an epidemic, or from hunting. A successful hunting technique is likely to result in a huge kill: up to 10,000 birds were caught using throw nets in a single day in Japan in the early post-war years (Austin & Kuroda 1953).

### *Feeding ecology*

The incidence of nocturnal feeding is common in dabbling ducks and is thought to be a behavioural adaptation to avoid predation (Tamisier 1974). Baikal Teal are relatively small ducks, so are likely to be very vulnerable; the presence of predators at Tongp'an supports this idea (three female Goshawks *Accipter gentilis* and two Peregrines *Falco peregrinus* were seen daily). However, the fieldwork took place during the full moon and several species of wildfowl, e.g. Pink-footed Geese, have been found to feed nocturnally over this period, although diurnally at the new moon. Behaviour may also vary through the winter.

The selection of paddy fields for feeding by Baikal Teal was referred to by Delacour (1954), but their use of dry areas was not mentioned, and contrasts with other dabblers at the site and other similar-sized waterfowl elsewhere: for instance, Teal and Garganey normally filter-feed from water in winter (Tamisier 1974, Cramp & Simmons 1977). The utilisation of agricultural waste has been noted previously, birds even having been seen feeding on roads at night on grain lost from vehicles (Madge & Burn 1988).

The speed at which the birds move while foraging suggests that their chosen food is easy to locate. The food resource is patchily distributed within fields because waste rice ears tend to fall on the line of cleaned heads left by the harvester. Occasionally whole heads of rice emerge unaffected by the harvesting process. The ears still attached to these would be easier for the birds to detect visually since they naturally lie on top of the other cut heads, in contrast to loose ears which will settle amongst or under the other waste. It is possible that waste rice heads may be an important element in the food resource of these birds.

It is not clear whether Teal stay on the fields for the whole of the night, feeding in one bout, or make a number of journeys. It was not possible to gather data on the peck rate of feeding birds but, if it is assumed that one ear of rice is ingested per peck, the total number of pecks required can be estimated at 2638-5312 pecks $day^{-1}$ (Table 2). Thus if the birds were able to maintain a rate of, say, 25-40 pecks $min^{-1}$ they would only need to feed for 1.1-3.5 hours in order to ingest their daily requirement; for the remaining night they could either rest on the feeding area or return to the roost. Birds seen returning in the morning generally came from the same direction as birds departed the previous evening, suggesting that they stay on the feeding grounds all night.

Baikal Teal seem to ignore a number of other food sources available such as aquatic vegetation and newly sown barley. Madsen (1985) demonstrated the advantages of granivory (seed-eating) as opposed to folivory (leaf eating) in Pink-footed Geese, concluding that by virtue of its digestibility, grain is a more profitable food source. Mayhew (1985) studied Wigeon *Anas penelope* feeding on grass and found that they were only able to maintain themselves on this diet by feeding for 14-16 hours per day. He suggested that, because of the form of the relationship between intake capabilities and maintenance energy needs with decreasing body size, Wigeon were the smallest possible grazing waterfowl. Baikal Teal weigh 400-600 g (Dementiev & Gladkov 1952), approximately 30% lighter than Wigeon (Cramp & Simmons 1977), so are unlikely to be able to exist simply as folivores, particularly in the severe winter conditions of Korea. Assuming that this species has always occurred in large concentrations and has evolved as a filter-feeder, one wonders what winter habitat was selected before rice became available.

### *Food availability and management*

The data indicate that the availability of food within an 8 km radius of the reservoirs is likely

to be limiting. The Teal probably range further from the roost later in the winter. The calculations need further revision to include the intake of competitors such as Rufous Turtle Doves *Streptopelia orientalis*, Bean Geese, White-fronted Geese *Anser albifrons*, Skylarks *Alauda arvensis* and Lapland Buntings *Calcarius lapponicus*, all of which are common on the farmland around the reservoirs. Quantifying the intake of such competitors was beyond the means of this project.

If all waste rice were left on the fields after harvesting, i.e. none was cleared, burnt or ploughed, then the area on which Baikal Teal could feed would be extended by 21% (1300 ha). If a conservation management strategy were to be pursued for the site, 27-55 ha of sacrificial rice crop would provide sufficient food to support the Baikal Teal over the winter (17,500 ears $m^{-2}$ before harvest, Ham 1987). Because the Teal arrive later in the season than their competitors, the area may be depleted before they benefit, so a supplementary feeding policy that enriched key areas might be more effective. This latter option also allows the selection of feeding sites away from power lines and sources of disturbance. A range of feeding sites should be provided to prevent predators (and hunters) from predicting the birds' behaviour. Bearing in mind the potential significance of rice heads to feeding Teal, it may be most effective to gather but not thresh the rice crop, keep the food in store and then return the whole rice heads to the feeding sites over the winter.

Disturbance must have an effect on distribution. Teal normally roost during the day and hence can simply sit in the middle of the reservoir, avoiding the banks and any human interference; however, all three waterbodies are frequented by fishermen, and Tongp'an, the lake most preferred by the Teal, appeared to be the least intensively worked. The flight pattern of Baikal Teal makes them difficult to shoot. At the beginning of December - the start of the overwintering season for the Teal - the birds are likely to be most vulnerable when, presumably, they are feeding on fields closest to the roost site. The proximity of humans may determine the minimum size of roost sites.

The availability of suitable sites for wintering Baikal Teal in the Korean peninsular is probably limited primarily by the availability of an ice-free roost. Although 200 birds were located at one site during the survey, it is unlikely that a large population of wintering Teal has gone unnoticed in this section of the winter range.

*Age structure and sex ratio*

Attempts at analysing the age structure failed due to insurmountable problems in ageing birds in the field. Dabbling duck flocks wintering in the USA and the UK have been shown to have an unequal sex ratio (Bellrose *et al.* 1961, Owen & Dix 1986). There is evidence that females winter further south; however, the 1.6:1 male to female ratio in Baikal Teal does not necessarily indicate that a reservoir of females exists elsewhere as yet undetected.

More display activity might have been expected, since the birds were in breeding condition and only 21% of females were paired; however, it is possible that pair bonds are formed later in the season, or that sexual activity is mainly nocturnal.

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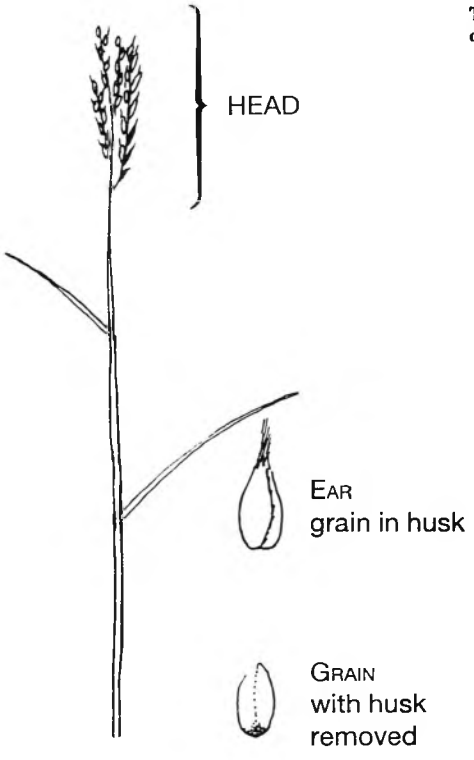
**Appendices**

*Appendix 1*




**The morphology of a rice plant illustrating the terminology used in the text.**

*Appendix 2*

**The percentage of the Baikal Teal flock in flight activity at five minute intervals through the day and time spent in flight per hour (minutes).**

| TIME 24hr | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | 0 | <1 | 0 | 40 | 0 | 0 | 0 | 0 | 1 | 0 |
| 5 | | 0 | 10 | 5 | 2 | 0 | 0 | 0 | 0 | 0 | 10 |
| 10 | | 0 | 0 | 8 | 0 | 0 | 0 | <1 | 0 | 0 | 10 |
| 15 | | 0 | 0 | <1 | 0 | 0 | 0 | 80 | 0 | 0 | |
| 20 | | 0 | <1 | 0 | 0 | 0 | 0 | 80 | 0 | 7 | |
| 25 | | 0 | 5 | 30 | 0 | 0 | 0 | 60 | 0 | 0 | |
| 30 | | 0 | 0 | 40 | 0 | 0 | 0 | 10 | 7 | 0 | |
| 35 | | 5 | 25 | 20 | <1 | 0 | 0 | <1 | 15 | 0 | |
| 40 | | 50 | <1 | 0 | 0 | 0 | 0 | <1 | 7 | 0 | |
| 45 | | 95 | 25 | 0 | 0 | 0 | 0 | <1 | 0 | 0 | |
| 50 | 0 | 40 | 3 | 25 | 0 | 0 | 0 | 0 | 0 | 30 | |
| 55 | 0 | 5 | 10 | 0 | 3 | 0 | 0 | 0 | 0 | 35 | |
| Mean | 0 | 16 | 6 | 14 | .2 | 0 | 0 | 21 | 2 | 6 | 2 |
| Flight time | 0 | 10 | 4 | 9 | .1 | 0 | 0 | 13 | 2 | 4 | 1 |

Total time spent in flight during the day = 43.1 mins.

*Appendix 3*

**Mean daily temperature (°C) for the five winter months at Ch'unam (Environment Administration 1987).**

| Month | NOV | DEC | JAN | FEB | MAR |
|---|---|---|---|---|---|
| Temp (°C) | 9 | 2 | 0 | 2 | 6 |