# Breeding biology of Bewick's Swans *Cygnus bewickii* in Chukotka, Far Eastern USSR

A.YA. KONDRATIEV

*Results of long-term research into the breeding biology of Bewick's Swans in the tundras of Chukotka are presented. The birds usually begin breeding at the beginning of June, 10-16 days after arriving in the breeding sites. Clutch size occasionally numbers 6 eggs, and averages 3.84. Both members of the pair incubate, keeping the clutch warm almost all of the time. The male incubates for 20-50% of the time during the 30 day incubation period. The weight of the newly hatched young varies from 165 g to 197 g, with an average of 177.5 g (63.1-67.1% of the weight of the recently laid eggs). The average brood size is 3.40 just after hatching and 2.96 before the young fledge. Young Bewick's Swans are able to fly in early September when they are 45-50 days old.*

The breeding biology of Bewick's Swans *Cygnus bewickii* has been studied in the zonal tundras of the northeast of the USSR in the Chukotka National District. This paper is primarily concerned with the Chaun Lowland (Fig 1), the most easterly point of Bewick's Swans' mass breeding area. More than 35 months of field work was completed during the 1975-1977 and 1980-1985 seasons. All the stages of the swans' life in the breeding territories were studied.

This study aimed to investigate the breeding biology of the Bewick's Swan and to identify its habitat requirements. Such information is required in order to plan conservation measures and may be useful for devising a general conservation strategy for the northern ecosystems. There is a small amount of information on the breeding biology of Bewick's Swan in the literature (Lebedyev & Filin 1959, Portenko 1972, Zasipkin 1981). However only specific studies of these wary birds can provide comprehensive information and until recently there have been none.

## Study Area

The Chaun Lowland is an extensive, rather uniform landscape dissected by numerous rivers which divide into a great number of channels in their lower courses. The huge expanses of the delta tundras of the Chaun Lowland are covered with tussock or polygonal tundras. Thermokarste lakes are numerous, occupying up to 50% of the study area. The lake shallows are overgown with *Equisetum* spp, *Hippurus vulgaris* L and *Arctophila fulva* And. The characteristic landscape feature of the Chaun Lowland is the abundance of dried-up lake depressions as a result of their breach into the river system. Lake marshlands develop in these depressions. Along the low-lying shores of the sea and lagoons there are coastal salt-marshes with dense low herbage. Here *Carex subspathacea* Worm, *Potentilla anserina* L and *Dupontia* spp predominate. Lagoon lakes with brackish water stretch in a narrow belt along the sea coast. The banks of the numerous river channels are covered with bushes, predominantly *Salix pulchra* Gm, *Salix crylovi* Pal and *Alnus fruticosa*.

The main field station is situated approximately 69° North, near the cold sea which is covered by ice for most of the year. The region's climate is extremely severe. The summer is cold and the air temperature can be below freezing in any of the summer months. The air temperature of the hottest month (July) fluctuates around +7° C. The average annual wind speed is 6-7 m/sec, and the maximum can exceed 40 m/sec. During the winter a compact snow cover forms, 50-70 cm. deep.

## Methods

The number and distribution of Bewick's Swans on their breeding grounds was estimated by


Supplement No. 1 (1991): 167-171

**Table 1. Breeding calendar of Bewick's Swans in the Chaun Lowland.**

| | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|---|---|---|---|---|---|
| First sightings of birds | 23.5 already arrived | 20.5 | ? | 16.5 | 21.5 | 29.5 already arrived | 19.5 | 2.6 already arrived | 21.5 | 16.5 |
| Egg-laying begins | 8-9.6 | 5-6.6 | ? | 29-30.5 | 2-3.6 | 6.6 | 29.5 | 3.6 | 3.6 | 5.6 |
| Young in early nests hatch | 16-17.7 | 14-15.7 | 16.7 | ? | ? | 14.7 | 6-7.7 | 8-10.7 | 9-10.7 | 10-12.7 |
| Young begin to fledge | 4-5.9 | 1-2.9 | about 10.9 | by 1.9 | ? | about 5.9 | by 1.9 | ? | 6-7.9 | ? |

surveys on foot and by boat. Aerial surveys were made during the incubation period (late June) and later (late August). Aerial photography was used to study the large area (5050 km$^2$) of the Chaun Lowland which was mainly comprised of tundra plains. Several visits were made to the most densely populated breeding sites.

A total of 130 nests were found and recorded along routes of 100-200km. Detailed observations of breeding success and cygnet growth were made on nests in the vicinity of the field station in an area of 40 km$^2$, mostly using a telescope and hide. Automatic recording devices were used to record incubation behaviour and the temperature of the eggs (Krechmar & Kondratiev 1986). Records for a total of 57 days of incubation for 5 nests were analysed (Kondratiev 1985). Food composition was studied by direct observation and faecal analysis. Cygnet growth and development was studied by constant observation of broods combined with measurements of individually marked cygnets.

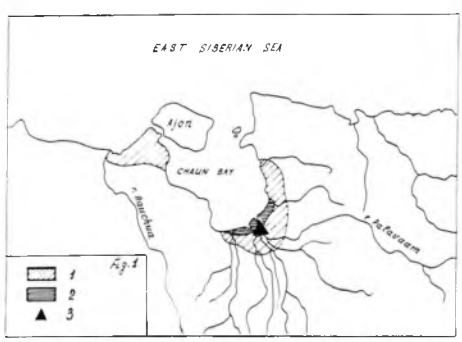


**Figure 1. Map of study area in the Chaun Lowland**
1. Bewick's Swan's nesting grounds
2. Area with high nesting density
3. Field station

## Results

### *Breeding distribution*

It is estimated that approximately 300+ Bewick's Swans inhabit the Chaun Lowland of which 25-50 are breeding pairs and the remainder are non-breeders. Breeding density can be as high as 0.2 pairs per km$^2$ but in some places the average density is 100 times lower (Fig.1). Their preferred nesting area is a relatively narrow belt of delta hollows 10-15 km wide, where 92-96% of breeding pairs nest.

The first sightings of swans in the spring were recorded between 16-21 May. Timing of arrival was almost constant regardless of spring weather conditions (Table 1). In a late spring, groups of 20 or more Bewick's Swans congregate in the lake depressions (which contain meltwater at that time). In an early spring the swans settle on their nest-sites immediately after arrival. Non-breeding swans appear later in the breeding grounds. All swans have arrived by mid-June. The period between arrival and egg-laying takes up to 10-16 days (Table 1). Each year approximately 50% of breeding birds commence egg-laying simultaneously.

Characteristically Bewick's Swans living in the Chaun Lowland use the same nest for many years. Of a sample of 100 nests, between 65-90% had been used the previous year. Some nests were 10 years old. These were shaped as a truncated cone, 120-130 cm at basal diameter and 50-70 cm in height. Nest construction continues during the whole incubation period so that the nest is several times larger by the time of hatching. Nests are built of the remains of vegetation found nearby. Stalks and the basal parts of herbaceous plants make up 15-75%, lumps of peat 0-60%, lichen 8-50% and twigs of birch and shiksha, *Empetrum nigrum*, 0-15%.

**Table 2. Clutch size and egg measurements for Bewick's Swans nesting in the Chaun Lowland.**

| | Mean +/- S.E. | | Range | Number |
|---|---|---|---|---|
| Clutch Size | 3.84 | 0.8 | 1 - 6 | 118 |
| Egg length | 104.6 | 3.4 | 93.5-113.8 | 104 |
| Egg width | 67.7 | 1.9 | 63.3-70.0 | 104 |
| Egg weight* | 272.1 | 17.0 | 248-291 | 104 |

*Recently laid. During incubation eggs lost 14-17.5% of their original weight.

Not much down is used. Eggs are laid at intervals of about two days. Full clutches usually number 3-5 eggs and very rarely one or six eggs. Average clutch size and egg measurements are given in Table 2.

*Incubation behaviour*

The behaviour of Bewick's Swans during breeding differs from that of other members of the genus *Cygnus*. They do not conceal their nests but constantly attend them to protect against predators and humans at all stages of the breeding period. Observations show that Bewick's Swan males take an active part in warming the eggs (Kondratiev 1985). This behaviour has also been recorded in Bewick's Swans breeding in the European North (Kritsov & Mineyev 1986). Male Bewick's Swans spend 20-50% of the day on the nest. This degree of male participation remained constant throughout incubation but decreased significantly after hatching.

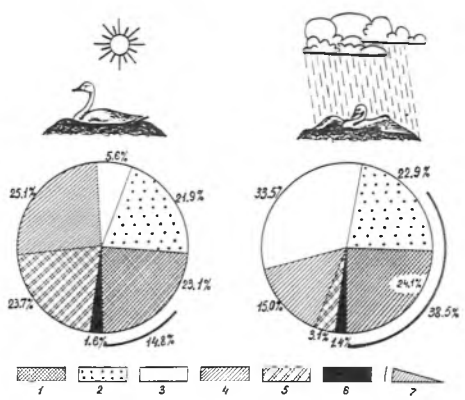


**Figure 2. Daily time budget of incubating Bewick's Swans**
1. Incubating
2. Preening
3. Alert
4. Sleeping
5. Nest building
6. Interruptions in incubation
7. Mate present near the nest

It is interesting to note that Bewick's Swans actively warm incomplete clutches. In one of the observed nests 15% of the day was spent on the nest after the first egg was laid and 91% between the second and third eggs. Uninterrupted incubation commenced when the third egg was laid. Complete clutches were normally incubated between 90-100% of the day (as low as 82.6% in only one of the nests observed).

The time budget remains constant throughout the incubation period but can vary due to bad weather such as rain or fog. In normal weather conditions the birds spend their time sleeping (with bill under feathers), incubating, preening and nest building (Fig.2). Birds become more alert during bad weather. During heavy rain an incubating swan may extend its wings to shelter the nest. In fog the mate spends more time near the nest.

*Cygnet rearing*

The length of the incubation period is constant. The date of clutch completion was known for 11 nests and hatching occurred after 30 days in each case. Cygnets weighed between 165-197g and averaged 117.5g ($n$=18), which is 63.1-67.1% of their original egg weight. Hatching commences in the early morning. If hatching is delayed in some eggs the pair may separate; the male takes the cygnets away from the nest and the female continues to incubate. During this period the swans are very wary and may abandon unhatched eggs or even hatched cygnets if they are unable to follow their parents.

During the first 2-3 days after hatching, broods remain near their nests and parents only move long distances if disturbed. Families usually move slowly within a relatively small area (0.5-1.0 km$^2$) of wet meadows along a lake shoreline. They rarely occupy river banks but have been seen crossing river channels. Parents vigourously defend their broods against enemies including other swans.

Cygnet growth and development was studied for five cygnets from two broods. During the first 10 days after hatching cygnet weight increased 4-5 times and they started to develop plumage. Maximum feather growth was attained by 30 days after hatching when the cygnets weighed 1.6-2.5 kg. Fledging occurs between 45-55 days old, in late August or more often early September. The birds need a further 2-3 weeks to fatten up before migration. They leave the Chaun Lowland in late September when the lakes begin to freeze overnight.

**Table 3. The food of Bewick's Swans (from data by L.F. Kondratyeva, 1987)**

| Food components | June, 36 samples *n* % | July, 37 samples *n* % | Aug. 67 samples *n* % | Sept. 29 samples *n* % |
|---|---|---|---|---|
| Plant remains | 36/100 | 36/97 | 59/88.1 | 25/86.2 |
| Grasses, *Poa* | — | — | 10/14.9 | — |
| *Carex* | 6/16.7 | 30/81 | 21/46.3 | 3/10.3 |
| *Hippurus vulgaris* | — | — | 1/1.3 | 1/3.5 |
| *Potamogeton* spp. | — | — | 14/20.9 | 11/37.9 |
| *Empetrum nigrum* | 9/25 | — | 4/6 | — |
| *Rubus chamaemorus* | — | — | 4/6 | — |
| *Eriophorum* spp. | 3/8.3 | — | — | — |
| *Equisetum* spp. | 1/2.8 | 2/5.4 | — | — |
| Algae | 4/11.1 | 1/2.7 | — | — |
| Other remains | 3/8.3 | — | 4/6 | — |
| Animal remains | 3/8.3 | 6.16.2 | 23/34.3 | 13/44.8 |
| *Notostraca* | — | 1/2.7 | 17/25.4 | 11/37.9 |
| *Conchostraca* | — | — | 5/7.5 | 1/3.5 |
| *Trichoptera* (larvae and pupae) | 1/2.8 | 1/2.7 | — | — |
| Other invertebrates | 2/5.6 | 4/10.8 | 1/1.5 | 1/3.5 |
| Detritus | 3/8.3 | — | 10/14.9 | 7/24.1 |

*Feeding requirements*

Bewick's Swans feed on the vegetative parts of plants. After arriving in spring they feed mainly on *Arctophila* suckers. Later other plants are included in their diet. In early summer they prefer *Carex* spp. and later they often eat cereals. *Empetrum nigrum* is readily eaten and when filiform pondweed, *Potamogeton filiformis* Pers. appears in tundra lake shallows this is included in their diet.

Aquatic invertebrates, in particular the tadpole shrimp, *Notostraca*, a large crustacean, form a significant part of the summer diet of Bewick's Swans. The presence of animal material in faecal samples increased from 8.3% in June to 44.8% in September (Table 3). Animal material forms a more important part of the diet for breeding rather than non-breeding Bewick's Swans. The remains of crustaceans were recorded in 85.8% of faecal samples from one family. Some faecal samples consist exclusively of such remains (Kondratyeva 1987).

## Discussion

The swans inhabiting the tundras of the Chaun Lowland share migration routes and wintering sites with those breeding in the Lower Kolyma (Kondratiev 1991a). Most swans breeding in the Chaun Lowland prefer to nest in the narrow belt of maritime plains. It is considered that the habitat characteristics are more important than the distance from the sea. Nests are built in tundra plains where the birds have a large field of vision. They settle near lakes with shallows overgrown with aquatic vegetation. During the cygnet rearing period animal food forms a significant part of the swans' diet, which may account for why they nest in maritime plains. The thermokarste lakes found there contain abundant large crustaceans and caddis fly, *Trichoptera*, larvae.

The number of pairs nesting in the Chaun Lowland varies from 25-50 annually. A more constant total of 300 swans annually migrate to the breeding grounds. Breeding birds make up around 20-40% of the total. This percentage is likely to vary due to the climate more than due to changes in population age-structure. The percentage of breeders increases during favourable years and decreases in unfavourable ones. The population always has a reserve of sexually mature birds which are potential breeders, but only succeed in breeding if conditions are suitable on the breeding grounds.

Unlike other swan species, Bewick's Swan males take an active role in keeping the eggs warm. This is an important adaptation to the severe conditions in Chukotka. Firstly it is beneficial energetically (Krechmar & Kondratiev 1986) enabling birds to survive the severe climatic conditions. A full clutch can weigh as much as 30% of the female Bewick's Swan's body weight; higher than the 23.7% recorded for Whooper Swans, *C. cygnus* (Scott 1972). Secondly, predators such as arctic fox, *Alopex lagopus* L., large gulls, *Larus argentatus* and *L.*

*hyperboreus*, and skuas, *Stercorarius* spp., present a real danger for nests and nestlings. Under normal conditions swans can easily protect their nests from predators but under these conditions the abundance of predators makes continuous nest protection necessary, which is only possible if both members of a pair sit on the eggs.

*Data for the timing of breeding were kindly supplied by G I Atrashkevich and M B Pospekhova. My colleagues and assistants L F Kondratyeva and T V Vinokurova gave me considerable help in completing the research programme. To all these people the author expresses his deepest thanks.*

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**A. Ya. Kondratiev**, Institute of Biological Problems of the North, Academy of Sciences, Far East Division, Karl Marx Str. 24, SU 685010 Magadan, USSR.