Mute Swans, *Cygnus olor*, breeding in the Volga delta, USSR.

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Introduction

From 1960 to the present day, research on the ecology of the Mute Swan, *Cygnus olor*, has been carried out in the Volga delta (Krivonosov 1962, 1963, 1972, 1987, Krivenko & Krivonosov 1972, Krivonosov *et al.* 1976). This research allows us to describe the course and causes of long-term changes in numbers, to determine the main parameters of the local population of the species and to forecast its future.

Analysis of the history of the development of the population of Mute Swans in the Volga delta shows that the numbers of this species have been influenced by two main factors: the hydrological regime of the habitats and human activity. In the 18th century and the first half of the 19th century, during a period of high rainfall and an associated heavy flow of the Volga, the Mute Swan was a common breeding bird in the Volga delta (Vitte 1856). In the second half of the 19th century, when the climate became drier and there was a reduction in the volume of the Volga, some lakes started to dry out and the numbers of Mute Swans started to decline (Golovashchenko 1875). By the end of the 19th century the area of natural habitat for waterfowl was much reduced. In 1904 Bostanzhoglo (1911) found the Mute Swan was still present in the delta in considerable numbers, but soon after this the scale of bird hunting sharply increased because of the demand for down and decorative feathers (Zhitkov, 1914). It was the hunting in this period which brought the delta population of the Mute Swan to the brink of extinction.

Re-establishment of the population started after the creation of the Astrakhan Reserve. The first nest was discovered in 1938 in the Obzhorovski area of the reserve. An increase in the numbers of the species was made possible by a sharp reduction in the level of the Caspian Sea, which resulted in the formation around the edge of the delta of a wide strip (from 40 to 60 kms) of shallow waters and which since the early 1950s has become overgrown with surface and submerged aquatic vegetation. By the end of the 1940s Mute Swans were regular breeders and in 1953 in the Obzhorovski area 12-15 pairs bred. At the end of the 1950s some of the swans dispersed outside the reserve, although the population density inside the reserve was considerably higher than that outside for several years after this.

Breeding conditions improved noticeably at the beginning of the 1960s. In 1961 in the Obzhorovski area of the reserve 215 pairs bred in an area of 5,000 hectares, 162 nests were in colonies of 5-7 nests. In 1962, 246 pairs bred in the same area, of these, 170 were in colonies of 5-29 nests. Continued vegetational succession from a discontinuous stage to a continuous strip caused a redistribution of the breeding grounds, which moved to the lower reaches of the delta. In addition to typical breeding habitat, *Phragmites* and *Typha*, the Mute Swan began to occupy *Sparganium* beds. In 1962, 15 nests were situated in open, shallow water which was free of emergent vegetation due to the stalks of Sparganium having broken off.

In subsequent years the numbers of the Mute Swan in the Volga delta have shown a steady increase. Numbers declined only after the extremely cold winters of 1963/1964, 1968/1969, 1984/1985, 1985/1986, but within 1-2 years they recovered and growth continued. In 1987 the delta population of the Mute Swan was 11,000 breeding pairs.

Breeding success

In order to determine the breeding success of birds in the delta population, selected nests were systematically monitored. In these nests, the clutch-size was recorded precisely. Analysis of 2,300 clutches shows that productivity fluctuated from year to year; mean clutch-size varied from 5.0 to 7.2 eggs with an average of 6 eggs.

Annual fluctuations in productivity are com-

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paratively small. In years following extremely cold winters, the clutch-size may fall below the average by 20-25%. This occurs as a result of an increase in the number of small clutches (3-4 eggs) as well as a reduction in the number of comparatively large clutches (9 eggs) and the absence of very large clutches (10-11 eggs). At the same time, the proportion of the population which breeds decreases, probably because of the unfavourable wintering conditions.

When the clutch is wholly or partially lost, it is rare for replacement eggs to be laid. In 15 cases when clutches consisting of 7-8 eggs were lost and replaced, 4 of the replacement clutches were of 5 eggs, 3 clutches were of 4 eggs, 2 of 3 eggs and 6 of 2 eggs. Infertile eggs (not more than 2 in a clutch) occurred in 6% of clutches. On the whole, productivity of the Mute Swan does not vary markedly from year to year and is not an important factor in the dynamics of the species in the Volga delta.

Analyses of the fate of 440 clutches and the study of 1,680 broods with cygnets of different ages shows the following losses to occur.

1) Destruction of clutches as a result of rough water: 5%
2) Clutch loss from other causes, mainly predators: 13.8%
3) Mortality of cygnets up to the age of one month: 8%
4) Mortality of older cygnets: 4.4%

Thus, the total mortality from laying to fledging is, on average, about 30%. Predation by hooded crows, *Corvus corone*, occurs during only a short period in the breeding cycle. Usually a crow cannot break a swan's egg with its beak. Therefore, at hatching time, crows thoroughly examine clutches for hatching eggs. They can open such chipping eggs easily and during this short period, they may destroy from 2 to 12% eggs. Nests are seldom destroyed by mammals apart from a few by wild boar.

The mean number of cygnets in a brood on the day of hatching is 5.2, which is slightly higher than in a number of other parts of the range. The highest death rate of cygnets occurs during the first stage of their life up to the size of a mallard. The main causes of death during this time are birds of prey and loss of cygnets by the parents during disturbances. During the later stages of their life, cygnets do not suffer so badly from birds of prey and the main factors of death changes considerably. Mortality of cygnets at this stage is almost half of that during the first stage. The average number of young in broods which fledge is 4.5. Because not all pairs of swans have replacement clutches after the loss of the first one and because some broods are lost completely the average number of young per pair for all breeding pairs is four.

The total mortality rate from laying to fledging (about one third of the number of eggs laid) should be considered low. This allows us to conclude that there are stable and favourable breeding conditions for Mute Swans in the Volga delta. The main summering grounds of immature (1-3 year old) birds which were reared in the Volga delta, are the coastal shallow waters of the Caspian Sea between the mouths of the Volga and Ural, i.e. outside the delta. However, a small proportion of these immature birds spend the spring and summer in the delta, in their natal areas. Their numbers fluctuate from year to year and have not shown a clear tendency to increase in line with the continuous growth of the local swan population. During the period of research, the proportion of non-breeding (immature) birds, spending the summer in the breeding areas, has varied from 2.5 to 8% of the total numbers of birds.

Migration

In order to study migration, more than 2,500 swans were ringed and 297 were marked with plastic leg and neck rings using the methods of Sladen (1973). The ringing and marking was carried out in the Obzhorovski area of the reserve, in an area of 2,000 hectares. The distribution of recoveries of birds ringed in the Volga delta is given in Figure 1. Of 33 adults, marked in 1975, 7 birds (21.2%) were present next spring in the area where they were ringed. Of these, six birds bred and one stayed the whole summer without a partner. All pairs successfully reared young. With the exception of one pair, the swans settled 1-1.5 km from their previous year's nests. This last pair, a male and female which were marked at the same time, bred only 40 m away from their old nest. Four breeding birds which were ringed in 1975 (12.1% of sightings) were discovered breeding outside the ringing area, 2-4 km from their old nests. Of 63 young birds, ringed as cygnets and one-year olds, only one bird was found the next year in the ringing area (in April) and in May it left the area. Thus, 12 birds were observed the following year and, with the exception of one young bird, all birds were recorded more than once. The birds were recorded repeatedly from the moment of arrival (April) until departure from the breeding grounds (end of October).

Of the swans ringed in 1974-75, five birds

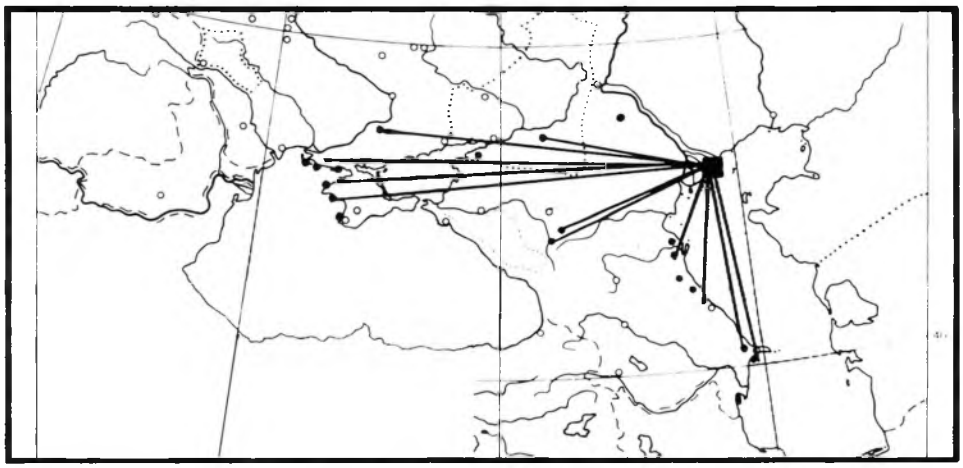

Figure 1. Distribution of recoveries of Mute Swans ringed in the Volga delta.

were seen breeding in the ringing area in 1977, including the same four birds which bred there in 1976. The fifth bird was not recorded after ringing either on the breeding grounds or in the adjoining areas (4-6 km from the ringing area). All the birds ringed were adults. As in the previous years, birds which were ringed as young were recorded mainly during the spring migration in different areas of the lower delta and migrated from the delta in May-June. There are relatively few autumn observations of birds ringed as young or immature in the lower delta.

The largest number of birds marked with neck bands was in 1977, therefore the next year the number of sightings in the ringing area increased considerably. In 1978 out of the birds ringed in 1977 in the Obzhorovski area, 13 breeding birds were noted (26.5% return). In addition, of birds ringed previously, six birds bred (among them a pair which were ringed in 1977). Five more birds were recorded breeding outside the ringing area, of which three were ringed in 1977. In 1979 the number of breeding ringed birds sighted was noticeably reduced. In the ringing area (the Obzhorovski area of the reserve) only seven birds were breeding, of which one was ringed in 1974 and four in 1977. Outside the ringing area another two birds stayed (with mates and judging by their behaviour, one could assume breeding). It is interesting to note that during all the years of observation, there are no recorded cases of ringed birds breeding more than 15 km from the ringing area. In addition to local observations, 21 long-distance returns were received. The recording of birds marked with neck bands, recaptures, distant returns, visual observations of the movements of migrating birds and published papers (Kostin 1979, Kishchinski 1979) allow us to draw the following conclusions.

The greater part of the population of Mute Swans breeding in the Volga delta lives throughout the year within the limits of the Caspian Sea and lakes adjoining it. Birds breeding in the Volga delta return to the delta after wintering on the Caspian Sea. There is no evidence that birds change their breeding grounds. More than 25% of birds return the next year to the ringing area (2,000 hectares) and the adjoining area (not further than 15 km from the ringing area). Some of the immature and non-breeding birds also arrive in spring in the lower delta and stay on the breeding grounds, mostly in flocks of 50-200, but some of up to 400-700 birds. By the beginning of June most of these birds migrate from the lower delta to the shallow coastal waters between the mouths of the Volga and the Ural. A well-pronounced passage of swans to the moulting grounds is recorded in the south-eastern part of the Volga delta, where birds concentrate for a short time before migrating further. Most immature swans wintering near the western and south-western coasts of the Caspian Sea do not stay in the lower reaches in spring. They migrate directly to the shallow waters of the northern Caspian where they spend the summer and autumn until their departure for winter. Immature Mute Swans which winter in the south-eastern part of the Caspian Sea, migrate along the eastern coast and also settle in the northern and north-eastern shallow waters of the Caspian Sea.

After the young birds fledge, many broods of swans, especially those breeding in the eastern part of the lower delta, also migrate in September to the shallow waters between the mouths of

Volga and the Ural. When there is a freeze-up, swans move from the northern Caspian shallow waters, taking two principal routes: along the western and eastern coasts of the Caspian Sea. Some of the birds which migrated eastwards at the end of summer, from the delta to the area of shallow waters between the mouths of the Volga and the Ural, thus, winter in the south-eastern part of the Caspian Sea, going to the Krasnovodski and northern Chelekenski Bays and further south. Other birds migrate along the shallow waters of the north-western coast (the Kizlyarski Bay) and further to the south, wintering mainly in shallow waters on the western coast. In warm winters Mute Swans stay in small numbers on patches of ice-free water in the Volga delta and the area north of the Caspian Sea. The more severe the winter is, the further south the birds winter (the Kura estuary, shallow waters around Shakhovaya peninsula). In particularly severe winters, when the coastal shallow waters freeze, mass migration of swans occurs from the sea to the interior lakes of Azerbaidzhan and Dagestan. Here in such periods, birds die from lack of food, as demonstrated by the remains of dead ringed birds. On the whole, in normal conditions, the Caspian population of Mute Swans does not leave the coastal shallow waters.

Long-distance returns give new information about connections between the northern Caspian and Azov-Black sea parts of the range of this species. Seven young birds ringed in 1977, 1978 and 1983 were found in the first winter after ringing in different areas in the Black Sea region and northern Caucasus. In addition, information was received about sightings on the wintering grounds in the Black Sea region of two birds, which were ringed as young birds in the Volga delta, after two years and sightings of another two birds after five years. Until these reports, Mute Swans ringed on the Caspian Sea were not known to go to the Black Sea region. Now it has been established that there is a movement of young swans from the Volga delta through the area before the Caucasus to the wintering grounds in the Azov-Black sea region. It is still unknown whether these birds return to the delta to breed.

The study of the population of the Volga delta continues. In addition to permanent observations which are carried out over many years, it is planned to carry out detailed studies of the population, a study of the role of the species in the biotope of the delta and coastal shallow waters.

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