

Number, population structure and habitat use of bar-headed geese *Anser indicus* in Ladakh (India) during the brood-rearing period

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Abstract In 1998, 2000 and 2002 expeditions were conducted in Ladakh, India, to study breeding behaviour and population size of bar-headed geese *Anser indicus*. Bar-headed geese in Ladakh bred in small colonies on islets in fresh water lakes but not in trees and apparently not on cliffs. Egg laying started in May. Hatching synchrony within colonies was low. Breeding bar-headed geese or geese with juveniles were not observed on the shores of saline lakes. The area of Ladakh that we surveyed contained between 350 and 1 000 individuals, which makes Lake Tsomoriri (4 650 m altitude) meet the Ramsar Convention criteria for this goose species. We propose this area to be listed as such [*Acta Zoologica Sinica* 50 (5): 738 - 744, 2004].

Key words Bar-headed goose, *Anser indicus*, Juvenile percentage, Ramsar Convention, Himalaya, High-altitude, Wetlands

印度 Ladakh 地区斑头雁的数量、种群结构和栖息地利用

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摘要 于 1998、2000 和 2002 年在印度的 Ladakh 地区进行了野外考察以研究斑头雁的繁殖行为和种群大小。Ladakh 地区的斑头雁集小群在淡水湖泊中的小岛上进行繁殖,不在树上和悬崖上繁殖。5 月份开始产卵。群内孵化的同步性较低。盐水湖岸上没有观察到进行繁殖或带有幼雏的斑头雁。作者所调查的 Ladakh 地区有 350 - 1 000 只斑头雁,该物种的数量满足了 Ramsar 公约的有关规定,建议将该地区列为国际重要地区 [*动物学报* 50 (5): 738 - 744, 2004]。

关键词 斑头雁 幼体百分比 Ramsar 公约 喜马拉雅 高海拔 湿地

Bar-headed geese winter in northern India and in Bangladesh, but breed in Mongolia and Tibet. A small part of their breeding range is also found in the north-western Himalayas of India in Ladakh (Gole, 1982) which is part of the Indian State of Jammu-Kashmir. Total numbers of this goose species are not well known. The breeding population in China, mainly in Tibet, recently was estimated to be some 55 000 birds (Li, 2001; Wetlands International, 2002). On their wintering grounds in India slightly over 14 000 birds were counted (Del Hoyo et al., 1992) while in south-central Tibet another 14 000 individuals are thought to winter (Bishop et al., 1997). These figures are low for a waterfowl species, and together with the reported decline in Ti-

bet (Ogilvie, 1978; Todd, 1996), the bar-headed goose may perhaps be classified as "vulnerable" even though it has not been categorised as such (IUCN, 2002; BirdLife, 2003). Much information on the breeding ecology of the bar-headed goose is relatively dated (Schafer, 1938; Kydraliev, 1967) and comes from north of the Himalayas (Fu and Gu, 1988; Li, 2001). We decided to study this goose species in Ladakh in the Trans-Himalayan range of India, which is relative accessible (see also Mishra and Humbert-Droz, 1998). We wanted to ascertain whether geese in the Trans-Himalayan range breed in trees (e.g., Del Hoyo et al., 1992) or on cliffs and rocky shores (Bauer and Glutz, 1968; Todd, 1996), and study population size and structure,

brood size and habitat preference of this species in this high-altitude environment after and outside the nesting period.

1 Materials and methods

The first expedition took place from 10 August 1998 to 16 September 1998, the second lasted from 8 July 2000 to 12 August 2000, and the third from 31 July to 2 September 2002. The first one started at Kullu (Himachal Pradesh, 1 300 m above sea level) and went via Manali (2 000 m), Kaza (in Lahul Spiti, 3 600 m) to Kibber (in the same area, 4 200 m). From there we went over the Parang-la pass (5 650 m, the highest point), along the Lake Tsomoriri (4 650 m) to the Indus River (at Mahe, 4 300 m). The expedition ended in Leh (in Ladakh, 3 620 m). The second expedition started in Leh, and went via Rumptse (4 275 m) to Lake Tsokar (4 580 m), and from there to Lake Tsomoriri, along Lake That Sang Kasu (4 720 m) and from there to the Indus River (once more at Mahe) and back to Leh again. The highest point reached during the second expedition was 5 240 m. The third expedition also started from Leh, from where we went to the Hemis National Park (till 4 950 m), from there via the Khardung-la Pass (6 150 m) to the Shayok and Nubra Rivers (3 300 m); from these rivers to Leh again, after which we followed the same track as during the second expedition except between Rumptse and Lake Tsokar where we followed a more south-easterly route from where we went straight to Lake Tsomoriri. Locations and altitudes were determined through a global positioning system (Garmin GPS 12). All observations were collected between 32°22' to 34°09' N and 77°12' to 78°30' E. The first expedition used pack-donkeys, the second used packhorses and on the third we used both. The second expedition was badly hampered by a severe monsoon, which resulted in heavy snow and rain, extensive flooding and landslides. Although the itinerary had to be changed, we could reach those breeding areas we wanted to visit.

Seven different types of wetland were distinguished during the expeditions. Together with the altitude, wetland type could be used to describe habitat requirements of the bar-headed geese in the Himalayas of north-western India. The wetland types are as follows.

High altitude marsh: a marshy area with much cryoturbation and impeded drainage due to permafrost.

Rivulets through grassland: two types of rivulets could be discerned, namely, fast-running (faster than 1 m/sec), steep rivulets, and much slower flowing rivulets (slower than 0.2 m/sec);

both types have grassy banks (between 2 and 20 m wide) with shortly cropped sedge vegetation and some grasses.

Large rivers: the Indus, with its steep banks, is approximately 50 m wide and very deep; it generally does not have any vegetation growing along its banks in the range between 4 400 m above sea level and 3 800 m. In lower-lying areas it has agriculture on its banks, or willow plantations.

Freshwater lake: Lake Tsomoriri, with a total bank-length of some 90 km, is filled with good, potable water. Fish occurs, and the lake is some 40 m deep, but it has no outflow. It lies about 4 560 m above sea level. The banks are either rocky (approximately 45 km), covered in shingle (some 35 km), or have grass and sedges growing (some 10 km).

Brackish lake: Lake That Sang Kosu, with a total bank-length of some 15 km, has slightly brackish water. The lake has no outflow, and is situated on 4 720 m above sea level. Its banks are grass and sedge covered over a distance of some 8 km and the remainder is formed by shingle beach.

Saline lake: Lake Tsokar consists of two lakes which are both saline. The two lakes together have a bank-length of some 35 km, and they are surrounded by raised beaches situated some 80 m above the present-day lake level. Their borders consist of salt-marsh (some 8 km), freshwater marsh (some 7 km), sand and gravel (some 10 km), and salty clay deposits (10 km). These lakes lie at 4 580 m above sea level, and are without outflow.

Counts were done on foot from the shores of the lakes using binoculars. Counts were done independently by two, sometimes three observers, who immediately discussed the counts afterwards, and, if different, re-counted. Flight distances of the birds were short (about 100 m only) to very short (less than 50 m) if swimming. Moulting geese, and geese with goslings had a flight distance of approximately 100 to 150 m on land, but geese that could fly again had a very short (less than 50 m) flight distance on land. Geese were observed not to swim further than 200 m from a lakeshore. Total counts were done while trekking through the areas. Treks started between 07:30 a.m. and 08:30 a.m. and lasted till between 02:00 p.m. and 03:00 p.m.; observations continued then between 03:30 and 18:00. Total study time was 25 days in wetlands where there were geese and 52 days in areas where we did not encounter geese. In areas where we stayed longer than one day, geese appeared to be very sedentary from day to day, which makes double counting not to be a likely cause of overestimating the animals, especially since in 1998 and 2002 an estimated 95% of the birds were flightless and in 2000 all birds appeared to be

flightless.

We checked the areas for signs of cliff breeding because breeding by bar-headed geese has been reported to occur on cliffs (Bauer and Glutz, 1968; Todd, 1996). In 1998, predation by red fox *Vulpes vulpes* was reportedly severe by local nomads. We could not ascertain by which standards they made these statements but some families had been grazing their livestock in the area for a period longer than 15 years and we rely on their trustworthiness. In 2000 and 2002, our guides again discussed fox predation with local people, but did not get positive information about cases. We did not find signs of predation either along the treks or shores during these years.

Family sizes of geese were determined when they were swimming. If geese occurred in groups on land, we waited till they were on the water and families drifted apart.

2 Results

Of these seven habitat types, bar-headed geese were only observed on the banks of the freshwater

Lake Tsomoriri, and in small lakelets (with a surface area of less than 5 km²) within the high-altitude marsh around Nurbursumdo (between the Parang-la pass and Lake Tsomoriri at an altitude of 4 900 m). The geese were typically absent from all other wetland types, and were not seen along the larger rivers.

In 2000, we counted a total of 81 families and some individuals without young on Lake Tsomoriri. The sum total of individuals during the last week of July was 464 in that year. In 1998, the number (sum total) during the second week of September was 255 on the same Lake, and an additional 57 individuals in the high altitude marshes of Nurbursumdo (about 25 km to the south of the southern tip of the Lake) and 38 in those of Chhumik-sharte (between Nurbursumdo and the Lake), which adds up to 350 individuals. In 2002 we counted on the shores of Lake Tsomoriri 94 families with 282 juveniles; the total number of adults was 321. During a census conducted by Blaise Humbert in July 1998 the number was 805 individuals (see Table 1). On the shores of the brackish Lake Tsokar there was 1 pair without young in 2002.

Table 1 Number of bar-headed geese in Ladakh (India) in 1996, 1998 and 2000

Year	Lake Tsomoriri			Chhumik-sharte			Nurbursumdo			Total		
	adults	juveniles	total	adults	juveniles	total	adults	juveniles	total	adults	juveniles	total
July 1996	306	499	805	0	0	0	?	?	21	?	?	826
July 1998	n. r.	n. r.	n. r.	n. r.	n. r.	n. r.	n. r.	n. r.	n. r.	±300	±700	±1 000
Sept. 1998	87	136	223	24	14	38	35	22	57	146	172	318
July 2000	197	267	464	est.	est.	est.	est.	est.	est.	±350	±475	±825
August 2002	321	282	603	n. c.	n. c.	n. c.	n. c.	n. c.	n. c.	±330	±300	±630

The estimates in the last column of July 2000 are based on the assumption that the postulated juvenile ratios in Chhumik-sharte and Nurbursumdo are the same as on Lake Tsomoriri (see text), and that the relative number of adults in the three areas was the same as in September 1998. Messrs. Namgyal and Sushil reported the estimates from July 1998, from Kibber, who conducted the census at that time together with Blaise Humbert-Droz. The 1996 data are from Mishra and Humbert-Droz (1998). n. r. stands for "not reported", n. c. means "not counted", and est. means "estimated".

We did not find evidence for tree-breeding because there are no trees at this altitude. Also, although rocky shores abound and cliffs can be found, we did not find any evidence for breeding on these: along the Lake Tsokar the distance to any cliff is farther than 15 km, along Lake That Sang Kosu farther than 12 km; smooth boulders and steep slopes occur at both the eastern and western sides of Lake Tsomoriri but we did not observe anywhere signs of nesting even though we spend in total 25 days in these area over the three years combined (without counting days *en route*). Juvenile percentages varied between the years and months of census. In July 1998, the juvenile percentage (per cent juveniles of the total number) was about 70%, at the beginning of

September that year it had declined to 54%. At the end of July 2000, the juvenile percentage was 57.5%. In 1998 predation by red fox was reportedly severe. The apparent disappearance rate due to mortality from disease, predation or chill can be estimated from the 1998 data if we assume that there was no mortality of adults between mid-July and the beginning of September; we assumed that adults did not start migrating earlier than their young. There were 300 adults and 700 juveniles mid-July, and 146 adults and 172 juveniles during the first week of September, 50 days later. It then may safely be assumed that adults of which the young could fly already had left the area in September, and that the corrected number of juveniles (if they had stayed)

then would have been $(300/146) \times 172 = 353$. The compounded juvenile mortality rate then would have been $(700^{-e} \log 353) / 50 \text{ days} = 1.4 \text{ \%/ day}$. This would represent a possible consumption of between five and 10 goslings per day along a shore habitat of some 100 km. In 2000 or 2002 we did not find any evidence for fox-predation.

We were able to determine family size of bar-headed geese on Lake Tsomoriri during the second expedition to the area. Of 81 families we were able to determine these sizes (Table 2) when geese were either foraging on the shores, or swimming in loose aggregations on the Lake. The average number of goslings per family was 3.30. The distribution of the frequencies (Table 2) resulted in a near-normal distribution of the number of gosling per family although there was a slight skew to smaller family sizes. Juvenile percentages in the different sections of the Lake were similar (Table 3a). There were five (6.2%) single-parent families. They always stayed close to another family, and we did not observe any aggressive encounters or triumph behaviour by the single parents.

In 2002, we could determine the numbers of juveniles (3rd week of August) of 94 families. The average number of goslings per family was slightly lower than in 2000, namely 3.00. There were 2 (2.1%) single-parent families. Juvenile percentages in the different sections of the Lake were similar again (Table 3b). Family size distribution were not different for the two years (Table 2, Mann-Whitney *U*-test; $z = 1.39$, N.S.).

Table 2 Family sizes of bar-headed geese on Lake Tsomoriri (Ladakh, India) in the last week of July 2000 and in the last week of August 2002 *

Family size (No. goslings)	Last week July 2000		Last week August 2002	
	Frequency <i>n</i> (%)	Juveniles (total) <i>n</i> (%)	Frequency <i>n</i> (%)	Juveniles (total) <i>n</i> (%)
1	10 (12.3%)	10 (3.7%)	14 (14.9%)	14 (5.0%)
2	17 (21.0%)	34 (12.7%)	24 (25.5%)	48 (17.0%)
3	19 (23.5%)	57 (21.3%)	26 (27.7%)	78 (27.7%)
4	17 (21.0%)	68 (25.5%)	16 (17.0%)	64 (22.7%)
5	11 (13.6%)	55 (20.6%)	8 (8.5%)	40 (14.2%)
6	6 (7.4%)	36 (13.5%)	4 (4.3%)	24 (8.5%)
7	1 (1.2%)	7 (2.6%)	2 (2.1%)	14 (5.0%)
Total	81 (100%)	267 (100%)	94 (100%)	282 (100%)

*: This distribution is near-identical to the number of eggs per nest as reported by Kydraliev (1967) for Mongolia.

Table 3a Juvenile percentages of bar-headed geese in different sections of Lake Tsomoriri (Ladakh, India) during the last week of July 2000

Lake section	Adults (<i>n</i>)	Juveniles (<i>n</i>)	Total (<i>n</i>)	Juveniles (%)
Northern (1)	80	152	232	65.5
Northern (2)	26	0	26	0.0
North-eastern	18	22	40	55.0
Eastern	14	23	37	62.2
South-eastern	17	21	38	55.3
Southern	12	18	30	60.0
South-western	20	30	50	60.0
Western	6	5	11	45.5

Of two families, with in total four juveniles, we could not determine individual family sizes, which explains the difference in total numbers with Table 2. The group in the northern section consisting of adults only, was a group of moulting adults.

Table 3b Juvenile percentages of bar-headed geese in different sections of Lake Tsomoriri (Ladakh, India) during the last week of August 2002

Lake section	Adults (<i>n</i>)	Juveniles (<i>n</i>)	Total (<i>n</i>)	Juveniles (%)
Northern (1)	187	125	312	40.1
Northern (2)	100	0	100	0.0
North-eastern	9 + 12	8	40	47.1
Eastern	-	-	not counted	-
South-eastern	0	0	0	-
Southern	80	93	173	53.8
South-western	0	0	0	-
Western	33	56	89	62.9

The group in the northern section consisting of adults only, was a group of moulting adults of which 97 could fly already. The group of 12 in the north-eastern section was also a group of moulting adults without offspring.

Within a group of families, the ages of the young were markedly different. Within such a group some families were still with downy young, while others had goslings we already estimated at more than half the body mass of their parents. None of the young had fledged already at the end of July, neither in 1998 nor in 2000. Apparently 10 juveniles (3.5%) could fly at the end of August in 2002, while about 50% of the young had already fledged in the first week of September 1998 (see Table 2).

Families of geese normally lived in groups. These groups ranged between two and 31 families.

The largest groups occurred in an area with satellite lakes, bays, islands and abundant lake shore vegetation at the northern end of the Lake. Small groups were encountered on rocky areas or areas with shingle beaches and no satellite lakes or bays. Creching in the strict sense (i. e. , the grouping of goslings from different families with only one or fewer parents than from the constituting families) was not observed.

3 Discussion

The total number of bar-headed geese in the Lake Tsomoriri area, including the high altitude wetlands of Nurbusumdo and Chhumik-sharte between the Parang-la Pass and the Lake, is approximately 800 to 1 000 individuals (of which about 350 adults) (Table 1). If the total world population of bar-headed geese in winter is truly about 55 000 individuals, as was reported (Wetlands International, 2002), then these extremely high altitude wetlands, which lie between 4 500 m and 5 000 m above sea level, are of international importance given the Ramsar Convention criteria of holding 1 % of a population. At the same time given the decline of bar-headed geese over the last 50 years or so (Ogilvie, 1978; Todd, 1996), Ankney's (1996) *embarras de richesse* definitely does not apply to *this* species. Also other goose and duck species that overwinter in eastern and southern Asia, especially in China, have shown catastrophic declines (Syroechkovski and Rogacheva, 1995).

Ogilvie (1978) stated that bar-headed geese normally lay eggs between the last week of April and the last one of May. According local sources, the geese arrive on their breeding grounds around 1 June, and started egg-laying nearly immediately. When we came to the area during the last week of July in 2000, we observed within groups of families some parents who still were with downy young, while in other families the goslings were already at more than half the body mass of their parents. Since incubation takes 28 to 30 days (Ogilvie, 1978) some birds must have started breeding considerably later than others in the same area. Coupled to the very fast growth rates of goslings, namely up to 80 gram per day in their second and third month of life (Wurding, 1978), our observations suggest that some parents had started breeding at the middle of May but others at the end of June. Because bar-headed geese do not produce more than one egg per day (Lamprecht, 1987a), and because the maximum number of goslings per family was seven (Table 2), and the maximum clutch size is reportedly ten (Ogilvie, 1978 p. 126; Weigmann and Lamprecht, 1991), it is likely that the first bar-headed geese of Ladakh started egg-laying during the first week of May, and

not, as local sources state, after 1 June. This reconstruction also tallies with the observation that about 10 % of the young could fly at the end of August (in 2002), and 50 % of the young had already fledged in the first week of September (in 1998) and had already left for their wintering grounds. Because bar-headed geese normally fledge after 55 to 60 days (Ogilvie, 1978), about half the geese must have minimally started breeding 83 to 90 days before 4 September 1998; these geese must have finished egg-laying then minimally by 5 to 10 June. Since geese normally do not migrate immediately after fledging, these dates can be estimated to have taken place early May. Faulty information on geese arrival dates may have arisen from the fact that the area is then still very difficult to access, because of snow, while very few people come to Lake Tsomoriri even earlier when temperatures may drop to minus 50 degrees Celsius.

Bar-headed geese are reported to be colonial nesters like, for example, snow geese *Anser caerulescens*, or red-breasted geese *Branta ruficollis* but very unlike for example bean goose *Anser fabialis* or white-fronted goose *Anser albifrons* which typically breed dispersed; other geese, such as grey-lag goose *Anser anser* or Canada goose *Branta canadensis*, may breed either colonial or dispersed (Ogilvie, 1978; Todd, 1996; Batt et al., 1992; Del Hoyo et al., 1992). Bar-headed geese are reported to breed very closely together, with inter-nest distances of some 1 m only (Weigmann and Lamprecht, 1991; Batt et al., 1992). Our data do not immediately support these observations because of (a) the small to very small groups encountered, and (b) the disparity in ages of the young within the same "colony" or group of families. The very high altitude at which the bar-headed geese of the Himalayas breed, between 4 500 and 5 000 m above sea level, is characterised by low primary productivity and low standing crop of grasses (often less than 5 g per square meter, pers. obs.). Patches of suitable feeding habitat are small, often only in the order of hectares or even less. These observations on the goose's habitat are not conducive to colony breeding.

The habitat selected by bar-headed geese for brood-rearing was typically along fresh water lakes, and not along saline or brackish waters. Further, they chose small lakes in high altitude marshes. Apparently, they need islands and slow moving water. The islands are needed as safe havens against land-based predators, red fox mainly. Slowly moving water appears to be safer for the goslings. Finally, they need shores with sufficient grass for grazing. In 1998 fox-predation was reportedly an important cause of death. Apparent mortality was in the order of 1.4 percent per day. In the literature predation by

ravens, crows, kites and sea eagles (Todd, 1996) is reported as sometimes severe (see also Kristiansen, 1998), but of these birds only raven *Corvus corax* occur in the area, in very low densities. We observed golden eagle *Aquila chrysaetos* in the area and also kestrel *Falco tinnunculus* and shangar falcon *F. biarmicus*, and even wolf *Canis lupus* and pale weasel *Mustela altaica*, but we did not see any evidence of predation by any of these.

The literature mentions that bar-headed geese select "very shallow, productive, ephemeral waters" (Batt et al., 1992 p. 278) but the habitats selected in Ladakh were neither shallow, ephemeral or even productive, simply because at the very high altitude temperatures are too low for high productivity. Also, it has been claimed that goslings are not grazers but collect their food swimming while hunting for mosquito larvae (Kydraliev, 1967). However, all goslings that we observed were either grazing (92% of their feeding time) or were upending and feeding on submerged *Potamogeton* (8% of their feeding time). We did not observe any mosquito larvae in the high altitude lakes and freshwater bodies between 4 500 m and 5 000 m did although we have seen some freshwater shrimps. Bar-headed geese of Ladakh thus forage like Arctic geese. Also their short breeding cycle is much like those of the Arctic geese on, for example, Spitsbergen and like that area the first snow can already fall at the beginning of September, necessitating a very fast growth rate for the goslings (e.g., Prop and de Vries, 1993). Todd (1979, p. 122) reports bar-headed geese to be "mainly crepuscular or even nocturnal feeders" but we did not find much evidence for this in Ladakh: only in 2002 there was nocturnal grazing during full moon. Foraging constraints for bar-headed geese goslings are thus even more severe than for Arctic geese because of the short day length (in July sunrise at 05:15 h, sunset at 19:30 h) resulting in even shorter days than experienced by the barnacle geese *Branta leucopsis* of Gotland (van der Jeugd, 1999).

The occurrence of single-parent families is noticeable. Of course they may represent bereaved parents but it may also be that they represent so-called "secondary females". These typically are second-year females that attach themselves to a dominant pair of bar-headed geese, and which are then inseminated by the gander. The gander even assists with nest selection after his "primary female" has selected her nesting site and he also chases away other geese (Lamprecht and Buhrow, 1987). Breeding success of secondary females is approximately half that of primary females. The occurrence of these secondary females depends on the sex ratio in the population, with a higher incidence if there is a surplus of females

(Lamprecht, 1987b). Secondary females have also been reported from mute swan *Cygnus olor* and Canada goose, under circumstances of female biased sex ratios (Lamprecht and Buhrow, 1987), and perhaps this is the case with the bar-headed geese of Ladakh.

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