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ORIGINAL ARTICLE

Severe feather deformation in greater white-fronted goose (*Anser alb. albifrons*) goslings during hot summer period on Kolguev Island 2016

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Abstract

In summer 2016, we observed premature feather malformation among goslings of greater white-fronted goose (*Anser alb. albifrons*), between 7 and 10 weeks of age on family gathering areas on Kolguev Island, Russia, the most important breeding island in the Western Palearctic. Rarely reported in wild birds, to our knowledge, this phenomenon has not been recorded in wild geese of this species, despite continuous ringing and marking of thousands of wild geese across Northern Europe and Arctic Siberia. This feather malformations were documented in 36 unfledged goslings showing weak feather basis, deformed or unevenly grown wing feathers or even dead feather buds. Approximately about one-third of all chicks were affected. Feather malformations like this, causing flightless chicks as a result, have never been noticed in any other of our 12 study years since 2006. The lesion was characterised by soft feather buds, weak or incomplete wing feathers and lack of feather development. No other abnormalities were observed in the goslings, so goslings did not differ in weight or body sizes. Affected fledglings never became airworthy and were killed in large numbers by predators or at latest perished during the Arctic winter.

Keywords Arctic breeding geese · *Anser albifrons* · Feather malformation · Disease · Climate change · Barents Sea · Climate change

White-fronted geese breed in several subspecies circumpolar in the arctic tundras (Wilson et al. 2018). The island of Kolguev (North Russia 69.272°N/48.53°E, Fig. 1), 90 km off the mainland coast and comprising an area of about 3,497 km^2, is the main breeding area for Eurasian Greater White-fronted (*Anser albifrons albifrons*), Barnacle (*Branta leucopsis*) and Tundra Bean Goose (*Anser serrirostris*) (Kondratyev and Zaynagutdinova 2008; Kondratyev et al. 2013). Important factors contributing to their high breeding densities are the absence of small mammals and relatively cool, humid weather compared to the mainland tundra areas (Kruckenberg et al. 2008). The island is characterised by extensive tundra with swamps and bogs and some river valleys, which provide suitable conditions for geese and other herbivores to raise their offspring (Kondratyev et al. 2013). While Barnacle geese breed in loose and partly large colonies, white-fronted geese as well as bean geese nest in solitaire pairs in the tundra. Although Kolguev has the highest density of nesting white-fronted geese in the Western Palaearctic (Kondratyev and Zaynagutdinova 2008), the nests are usually several hundred metres apart, although shorter inter-nest distances also occur. The geese start breeding at the end of May and the chicks hatch in the first week of July. Two days after hatching, the families leave the nest and walk up to 20 km through the tundra to suitable meltwater lakes where the young are reared. Here the families gather in groups.

Recent telemetry data show that the geese frequently move between different lakes, depending on food supply, water level and disturbances (unpublished personal observation). Since 2006 in the frame of an international research program, we have been studying the breeding biology,

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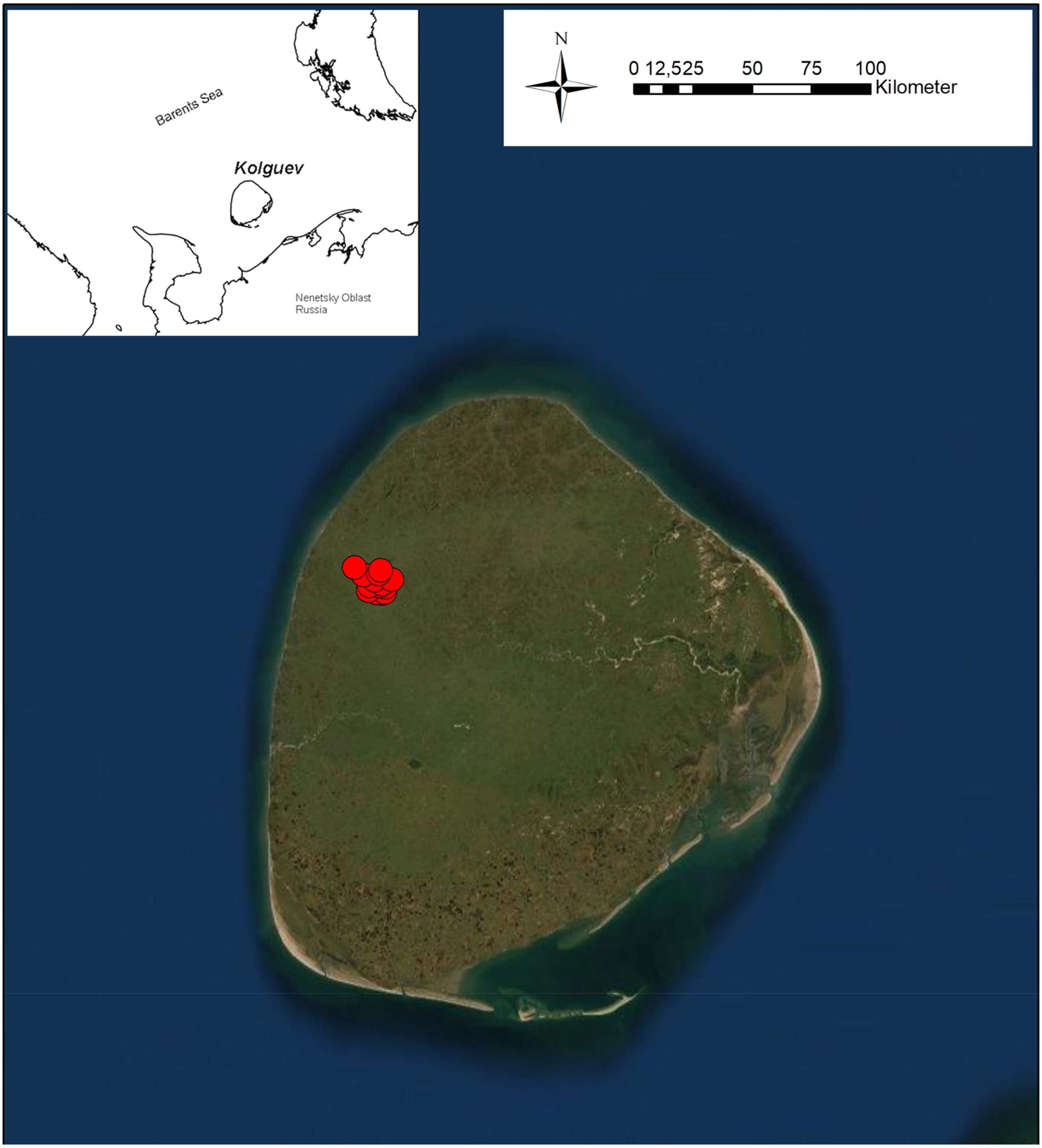


Fig. 1 Kolguev island in the Barents Sea with ringing sites of Greater White-fronted Geese in 2016

migration routes and survival rates of populations of Arctic geese on the Russian island of Kolguev in the Barents Sea by means of colour ringing program. To this end, we used net trapping to capture moulting adult geese of three species, e.g. greater white-fronted, barnacle and bean geese and their offsprings from the end of July to the 10th of August (Kruckenberg et al. 2008). Wild geese were mainly fitted with large coloured and coded neck collars from PVC plastic as well as metal legrings of the ringing centres (see www.blessgans.de). During our catching activities in 2016, 36 unfledged greater white-fronted goose that were ringed showed severe feather deformations (altogether we ringed

Fig. 2 **a-c** Goslings of Greater White-fronted geese aged 3–4 weeks with signs of feather deformations (the open skin-patches in the dune feathering on the back resulted (Fig. 3 and this figure) from the trampling of other geese during the catch)

158 offsprings, a larger number—maybe another 40—of affected goslings was found, but not ringed and measured anymore due to the foreseeable mortal fate). Initial symptoms that we recorded at this time were frayed or deformed feathers that looked like bitten off above the quills, similar in extent to that sometimes resulting from territorial aggression by predatory birds (Fig. 2a–c). There was no laceration, bruising or haemorrhaging. On closer inspection, the newly formed feathers were rather soft or the feather buttons had died off (Fig. 2b). The deformations exclusively affected the wing feathers while those from other areas of the body including head, body and tail remained intact. In general, the wing feathers were so incomplete that the gosling were unable to fly. By using a linear mixed model fit by REML, there was no significant correlation between body measurements and deformation ($n = 36$). Similar deformations were also observed in one juvenile Dunlin (*Calidris alpina*). In contrast, although present in large numbers, juvenile barnacle geese were not affected at all. The significance of these findings was not immediately obvious to us until we found many of the affected and ringed juvenile white-fronted geese to have fallen prey to predators a few days after catching

Fig. 2 (continued)

Fig. 2 (continued)

as proven by carcasses and torn-off neck collars lying on the ground. Therefore, we decided to discontinue ringing of goslings of this species during that season.

Feather deformations of such an extent were never recorded over the entire project duration, during which a total of 1367 white-fronted geese were ringed on Kolguev Island, 445 of these were goslings. Strikingly, weather conditions differed significantly in 2016 compared to other years (Fig. 3). The year 2016 proved to be the warmest year in the Arctic since the beginning of worldwide climate records and measurements (Richter-Menge et al. 2016) with the month of July having been the warmest ever before (Fig. 3, Kolguev weather station, http://www.pogodaiklimat.ru/climate/22095.htm, download15-02–2021). This resulted in a drastic shrinking of meltwater lakes and drying of usually humid areas on the island. Unfortunately, we were not equipped to collect tissue or serum samples to be tested for disease-related agents. While feather loss is rarely reported in wild birds (Ha et al. 2007; Arnold et al. 2016; Müller et al. 2007b), there are no reports on wing feather deformations in wild geese.

In the development of goslings, the weight/head length index correlates well with the age of the chicks. If we look

Fig. 3 Average temperature of Kolguev Island during summer (red = broad-rearing period, blue = last 10 days before catching period), data course: Kolguev weather station

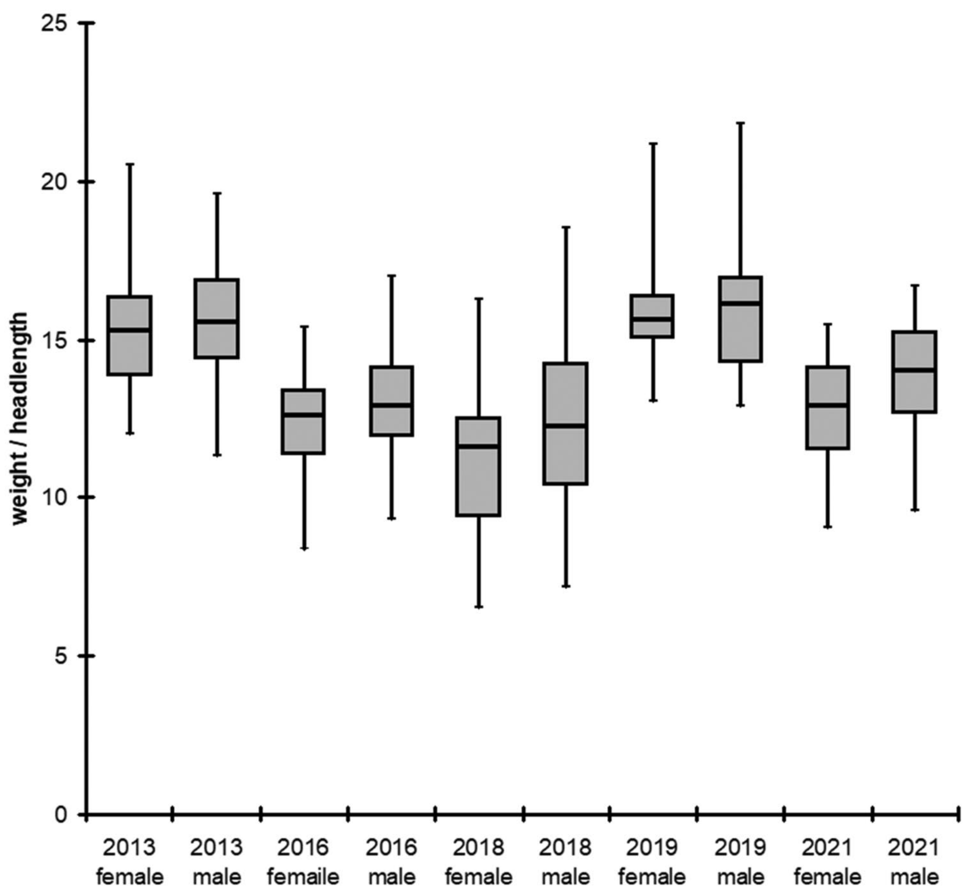
at this for all chicks (female/male) for the different years (Fig. 4), we see that the chicks were about as developed in 2016 as in 2018 and 2021. Only in the cold and wet years 2013 and 2019 were the chicks better developed at the beginning of August. But finally, we were not able to detect a direct relationship between body condition and the feather abnormalities.

The cause of the observed feather deformation remains speculative. While body measurements and general health conditions argue against starvation, malnutrition and ectoparasites, viral-related disease cannot be excluded. Especially malnutrition or skin parasites can cause a variety of diseases: Angel Wing syndrome, for example is caused by malnutrition for young Anatidae (Graham et al. 2016). Comparable feather malformations as we found never have been described for arctic breeding geese before. Under field conditions, we were not able to take appropriate samples and bring them home. We consider a viral infection, possibly favoured by the unusually warm summer, to be the most likely explanation.

Even though our observations of wild goslings in the Arctic are unique so far, malformations of the large plumage formation have been described several times as a clinical picture. This malformation is particularly striking in young birds of prey (pinched-off syndrome, Müller et al. 2007a). Since no pathogen has been found for this disease so far, it is assumed to be a genetic defect.

Avian circoviruses are known from lots of bird species. A number of avian circoviruses have recently been discovered with varying pathogenic effects in a diverse range of passerine hosts which are all naturally susceptible to avian circovirus species. Others like anatids, lariids and columbids are also well represented with circovirus species found in various species of ducks, geese, swans, gulls and pigeons. Pigeon, goose and canary circoviruses have all been officially classified as members of the genus circovirus and they share similar genomic and structural characteristics to other circoviruses. Circovirus can switch their host as Sarker et al. (2015) showed in Bee-Eaters. The appearance of pinching-off syndrome (POS), which has been described mainly in birds of prey, is quite similar to our findings (Chitty 2008). POS has been found in various raptor species. In the white-tailed eagle, POS was first observed in 1975 (Kollmann, www.projektgruppeseeadlerschutz.de), then more frequently (Schettler 2002) and later studied in detail on further finds (Müller et al. 2007a), although here ecto- and endoparasites as well as viruses were excluded as causes. A survey revealed that POS in white-tailed eagles is only known in part of the range (Müller et al. 2007b) and may have genetic causes. Krone et al. (2009), however, describe the cause of the disease as unclear. In addition to genetic causes, environmental

Fig. 4 Weight/head length index of gosling caught on Kolguev in different seasons



factors such as malnutrition can also be considered. POS is frequently observed in nesting Goosehawks (observation by G. Müskens) and has already been described in detail by Ottens et al. (1997). Robitzky (2017) describes a case of POS in a young eagle owl, where only individual feather sections were affected and the bird later became able to fly. Another infection caused other by circoviridae is beak and feather disease virus (BFDV) mainly infecting psittacine. But in this case, the infection progresses with diarrhoea and exhaustion, which we did not state in our findings, also only wing feathers were affected, in contrast to the malformations observed in BFDV. In poultry ducks, an infectious disease, named feather shedding syndrome (FSS), was caused by goose parvovirus–associated virus (NGPV) and duck circovirus (DuCV) (Yang et al. 2020). Further clinical pathogenic clinical pictures can occur (such as post-weaning multisystemic wasting syndrome (PMWS)) and infected birds are often in poor condition and prone to secondary infections. (Todd 2004). Ting et al. (2020) described clinical signs of GoCV infection in geese looking quite similar to our observations in the arctic. Soike et al. (1999) and Stenzel et al. (2018) describe a disease caused by GoCV in poultry and domestic geese. Recently, the goose coronavirus (GoCV) was detected by molecular methods in wild greylag geese (*Anser anser*) shot in Poland (Stenzel et al. 2015). Arctic breeding greater white-fronted geese regular migrate from Northern Russia and Siberia to Western Europe and may get in contact to local waterfowl or (escaped) poultry (see track routes of Greater White-fronts tagged on Kolguev 2016, Fig. 5).

The possible causes of infection are therefore very diverse and cannot be conclusively clarified only on the basis of the collected photographic evidence. In any case, it must be stated that germs only cause infections of numerous chicks on a larger scale if they are susceptible to them, i.e. if they have a health condition or a new or previously unknown pathogen has reached the breeding area. Nowhere on earth is climate change happening faster than in the Arctic with huge consequences for migratory birds. High temperatures in particular mean severe physiological stress for Arctic birds.

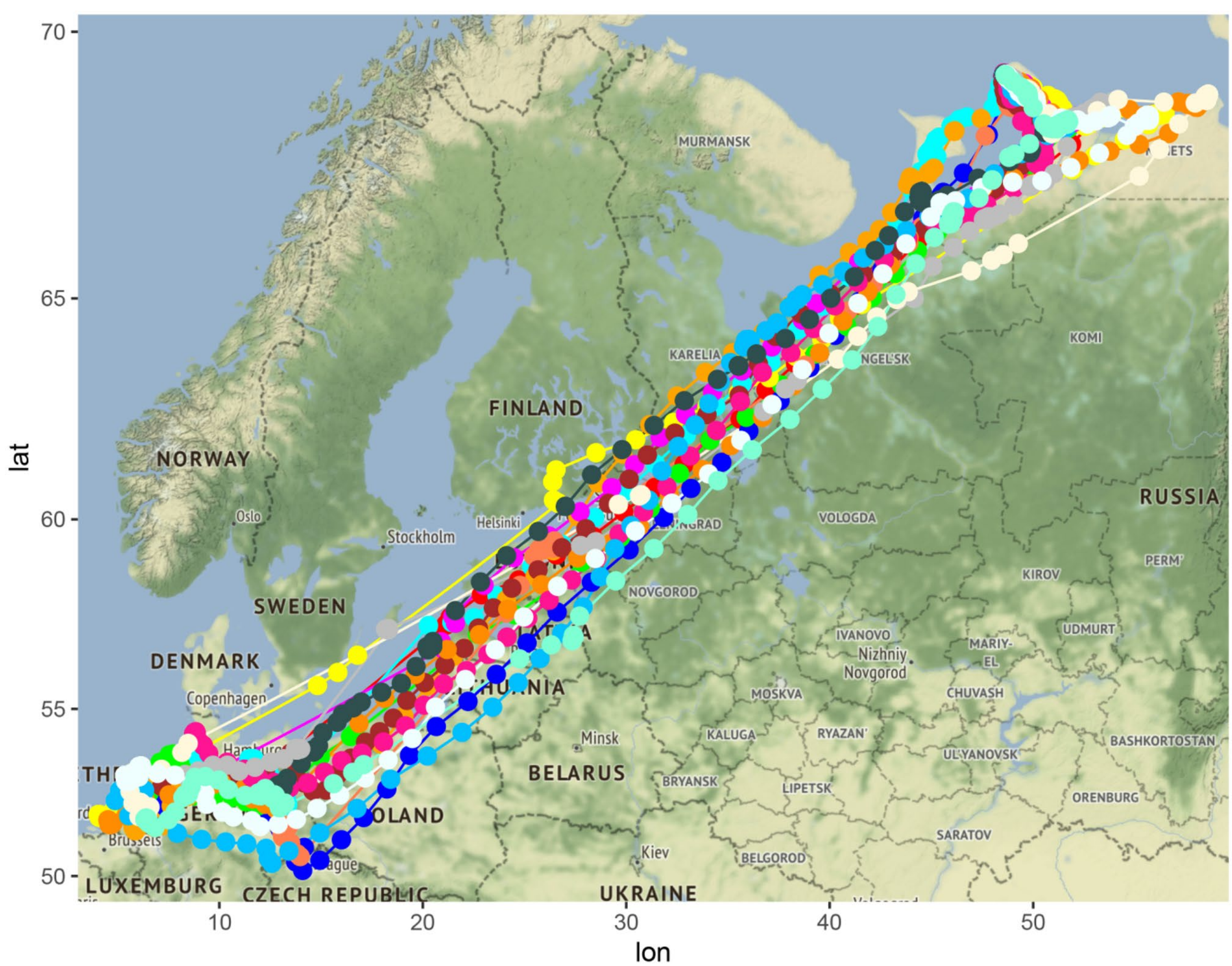


Fig. 5 Autumn migration of greater white-fronted geese tagged on Kolguev 2016

At the same time, heat events cause the bogs and swamps in the tundra to dry out, which has a direct impact on the food availability of the herbivorous geese. Especially the chicks are dependent on fresh, grass with low fibre contain during this phase, which only grows in the humid depressions and along water bodies. Habitat shifts, degradation and loss, phenological mismatches, changing weather patterns and extreme weather events, range shifts and the impact of climate change (Dorémus 2017) can severely weaken the individuals and also lead to the emergence of new diseases in the circumpolar region (Bradley et al. 2005; Kankaanpaa et al. 2020). Due to climate change, we must assume that as new species spread out northwards (van Beest et al. 2021) also numerous infectious diseases previously unknown in the Arctic, caused by bacteria, viruses, zoonoses or parasites, may spread northwards as temperatures rise (Revich et al. 2012; Polgreen and Polgreen 2018). As our unique results presented here may show, this significantly increases the threat to vulnerable Arctic ecosystem and avifauna.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s10344-022-01603-9.

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Declarations

Conflict of interest The authors declare no competing interests.

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