# TIMING OF WING MOULT IN GREYLAG GEESE *Anser anser* IN RELATION TO THE AVAILABILITY OF THEIR FOOD PLANTS

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**ABSTRACT** The moulting period of Greylag Geese in the Oostvaardersplassen, The Netherlands, coincides with a period of rapid growth in their food plant *Phragmites australis*. During moult there is a continuous decrease in quantity and quality of the available food stock. As a consequence of food shortage, a large number of late arriving Greylags did not moult in the Oostvaardersplassen, but showed a reversed migration back to Scandinavia. The significance of this phenomenon is discussed in relation to the phenology of the food plants at different sites in Europe.

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## INTRODUCTION

Non-breeding Greylag Geese perform a moult migration to well defined moulting areas (Paludan 1965, Hudec & Rooth 1970), where they moult their primaries simultaneously and are flightless for about 28 days. In Figure 1, the most important moulting areas in western Europe in recent decades are shown. The fresh-water marsh Oostvaardersplassen has recently become one of those areas. At present, it is the most important moulting site for Greylag Geese in Europe.

The phenomenon of moult migration suggests moult to be a costly activity. Timing of moult influences the moment at which a goose can start building up its body reserves needed for autumn migration (Owen 1980, Prop *et al.* 1984). These reserves may have direct effect on survival as well as future breeding performance (Ebbinge *et al.* 1982). Lebret and Timmerman (1968) reviewed data on the moulting period of Greylag Geese. They concluded that in Norway and Great Britain geese moulted later than in Denmark and The Netherlands. This influences the moment at which Greylags have completed their wing moult.

During moult, Greylag Geese in the Oostvaardersplassen are feeding on reed, *Phragmites australis*. The food supply in the area is not constant over the moulting period, because of rapid growth of the food plant and mass grazing by the birds. The relation between plant phenology and bird usage is the main topic in this paper. We discuss the significance of timing of moult both on the level of a population as well as for individual geese.

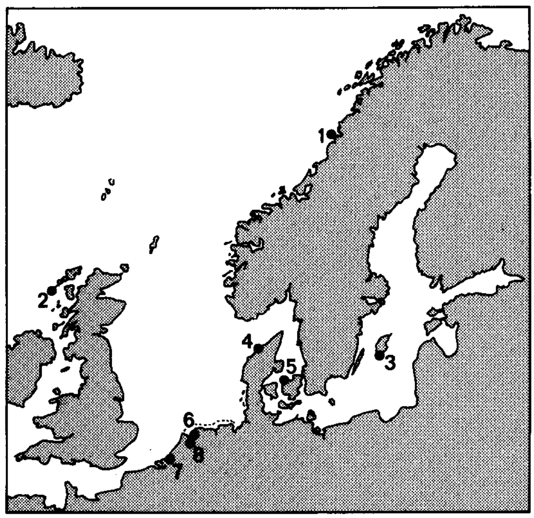


**Fig. 1.** Important moulting areas for the Atlantic Greylag Goose. Vega (1), South Uist (2), Gotland (3), Jutland (4), Sjaeland (5), Friesland (6), Haringvliet (7), Flevoland (8). See Table 4.

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## MATERIAL & METHODS

### Goose observations

Due to various marking programmes in Fennoscandia and (the former) GDR, many geese have been neck-collared and are individually recognizable (Nordic Greylag Goose Working Group 1988). During their moult, geese stay in the poorly accessible reed *Phragmites* stands and birds are hardly visible. Prior to and immediately after wing moult, geese spend a short time on adjacent fields. In this period they can be identified. Almost on a daily basis in 1988, flocks of Greylag Geese were scanned for neck collars, and the proportion of marked individuals in the flock was noted. Whenever possible, abdominal profile indices were recorded. Because of the effect of food intake on abdominal profile, we only scanned birds which were known to have fed for 1.5 h or more. We have applied a scale from 1 (very poor) to 6 (very heavy) based on the shape of the abdomen, including intermediate scores (Van Eerden *et al.* 1991). The geese were indexed by two observers (ME & MZ), who did not differ significantly in their ability to estimate this parameter.

### Vegetation measurements

Standing stock of *Phragmites australis* was measured in an exclosure (1.5 x 2 m) in the moulting area in 1988. Individual shoots were marked around their base with a numbered plastic tape. Every week during the moulting period, the length of all leaves was measured. Also the length of the entire shoot was measured after carefully folding all leaves upward. After the moulting period, these measurements were continued less frequently until 21 September, by which time growth of *Phragmites* had almost stopped.

The total length of all leaves from one shoot was transformed to leaf weight using calibration curves. The standing stock of *Phragmites* has been expressed as dry weight of leaves per shoot in grams (15 shoots per treatment, overall > 2000 leaves measured).

Samples of leaves of *Phragmites* were taken regularly and dried for 48 hours at 60 °C. The plant material was ground in a Wiley mill through a 1 mm mesh-size and analysed for crude protein and indigestible protein. All analyses were carried out twice and the means are expressed as percentages based on dry matter.

Protein content was calculated by multiplying the nitrogen content with 6.25. Total nitrogen was analysed by a modified Kjeldahl technique. Not all protein can be used by the geese. Pepsin-insoluble nitrogen (Goering & Van Soest 1970) was measured as an index for the amount of indigestible protein.

## RESULTS

### Moult phenology

Geese arrive in order to moult in the Oostvaardersplassen from the beginning of May onward. The main period of wing moult ranges from 25 May to 25 June, but geese may start from 10 May up to 10 June. From 241 individuals seen over the moulting period, 88 individuals were seen both before and after wing moult on adjacent fields. A mean duration of stay inside the reeds of 40.3 days (standard error 5.5 days) was calculated from sightings of these individuals. Primary moult in Greylag Geese takes about 35 days, although the flightless period may be somewhat shorter (Lebret & Timmerman 1968). The chance for an individual being missed for a long period while present outside the marsh therefore is considered low.

Abdominal profile index shows a decline during wing moult. Fig. 2 shows the frequency distribution of all geese indexed before and immediately after moult. The average decreases from 4.2 ($SD = 0.9$, $N = 368$) before, to 3.1 ($SD = 0.8$, $N = 362$) after wing moult (MWU-test, $p < 0.001$). Seventeen individuals were indexed both before and after and their scores are also given in this Figure. Their abdominal profile index decreases from 4.6 prior to their moult to 3.1 after moult (MWU-test: $p < 0.001$, $N = 17$). Although most individuals showed a decrease, the index for two birds did not change. The results indicate that weight loss during wing moult varies between individual geese.

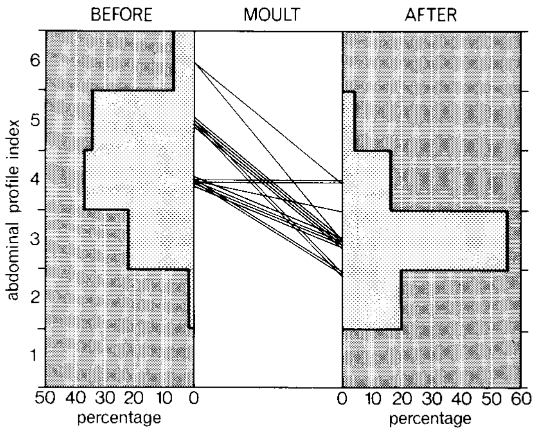


**Fig. 2.** Changes in abdominal profile index during the moulting period. The frequency distributions before and after moult are based on all geese indexed. The solid lines represent marked geese, which have been indexed both before and after their moult.

## *Phragmites* phenology and availability

Figure 3 shows the standing stock per shoot of *Phragmites* in an exclosure. The exclosure was located in the middle of an area in which *Phragmites* was heavily grazed. From 10 May to 10 July, moulting Greylag Geese are present in the reed marsh of Oostvaardersplassen. This period coincides with the period of most rapid growth of

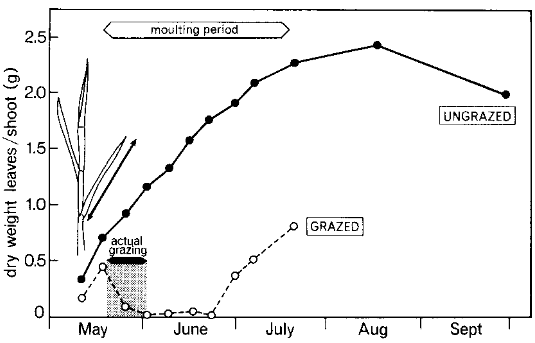


**Fig. 3.** The amount of leaves (dry weight in grams) per shoot of *Phragmites australis* over the growing season. The period of fastest growth coincides with the moulting period. Almost all leaves are removed from grazed shoots, but after the moulting period, the shoots recover.

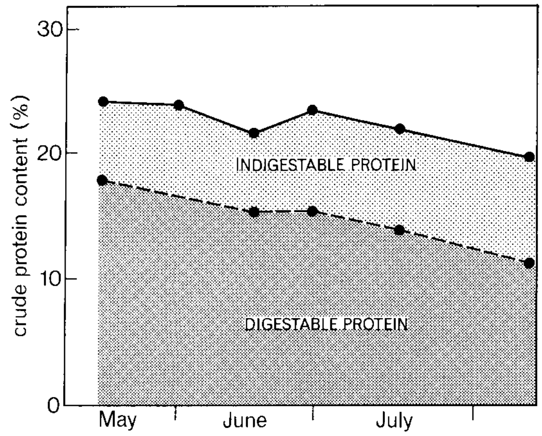


**Fig. 4.** Content of crude and digestible protein of leaves of *Phragmites* in the course of the growing season.

*Phragmites*. In Figure 3, data from grazed shoots outside the exclosure are also presented. Greylags break the shoots and tear off the leaves. At the first visit, they eat c. 60% of the green biomass of leaves from a shoot. Almost all remaining leaf material dies shortly after. After being grazed, new shoots emerge from lateral buds on the grazed shoot. These take over production of the grazed primary shoot (Van der Toorn & Mook 1982).

Over the growing season, food quality of *Phragmites* decreases gradually. This is shown by a decrease in total protein content from 24.0 % on 17 May to 19.7 % on 16 August (Fig. 4). In the same period, the amount of indigestible protein increases from 6.3 to 8.5 % (in-vitro digestibility trial).

During the moulting period more than 30 000 Greylags fed on *Phragmites* in the marsh. Huge areas of *Phragmites* change colour from green into beige after being grazed. This mass grazing has a considerable influence on the amount of *Phragmites* available in the course of the moulting period. Late arriving moulters are faced with an already heavily depleted food supply.

## Switching to other moulting areas

In 1987, 1988 and 1989 we observed frequent migration of several hundreds of geese north over Lelystad late May and the first days of June. These birds left Oostvaardersplassen but could not have moulted there. In 1987, one marked individual (blue Y26) was observed in the Oostvaardersplassen on 25 May and 29 May. This goose arrived in a period when large numbers of birds from Sweden flew in, after the arrival of the bulk of the moulters from GDR. However, this goose did not moult in the Oostvaardersplassen, but in Ellestadssjön (Skåne, Sweden), where it was seen back from 10 June onward. The total number of individuals visiting the Oostvaardersplassen in the moulting period of 1988 could be calculated at 42 000 birds. This number is based on an average proportion of one neck collar per 173 geese, which did not differ over the season, and a total of 241 marked individuals seen. This estimate is a minimum, because several marked birds must have been missed . Using the sightings of individually marked birds, the proportion of birds involved in this reversed migration can be calculated. In the period before moult, 180 different individuals were observed. In the period after moult only 149 individuals were seen. So 1.2 times (180/149) more individuals were seen before moult than after it. There was no difference before and after moult for the period in which individuals are seen on fields outside the reed marsh (2.7 and 2.6 days respectively). Also the frequency of observation did not differ. Only birds seen after moult, which is five-sixths of all individuals observed, are considered to have moulted in Oostvaardersplassen. According to this calculation in 1988 the number of moulting birds would be 35 000 while 7000 birds must have visited the Oostvaardersplassen, but moulted elsewhere. During an aerial survey, at the peak of moult on 14 June 1988, the total number of moulters was estimated at 32 000.

**Table 1.** Number and proportion of marked individuals seen both before and after moult according to timing of arrival in Oostvaardersplassen in 1988 (Chi-square test: $p < 0.05$). Later arriving birds tend to switch more to other moulting areas.

| last sighting before moult | geese seen before moult | geese seen before *and* after moult | |
|---|---|---|---|
| early | 53 | 35 | 66% |
| mid | 74 | 34 | 46% |
| late | 57 | 23 | 40% |

Table 1 shows that especially birds which would have moulted late, migrated back north. Sightings have been divided into early, middle and late, based on the final sighting before moult. Amongst early moulting birds, a large proportion were resighted after moult, while in contrast, fewer late arriving birds were seen subsequently, although overall the frequency of observation did not differ. Hence reversed migration appeared more frequent amongst late moulting geese.

## DISCUSSION

### Timing of wing moult

During wing moult in Oostvaardersplassen, Greylag Geese showed a decline in body condition.

**Table 2.** Latitude, principle food source and main period of wing moult for different sites where flocks of non-breeding Greylag Geese have been found moulting.

| Country | Place | Latitude °N | Food source | Main period wing moult | Source |
|---|---|---|---|---|---|
| Norway | Vega | 65 | grass | 20-6/20-7 | Follestad pers.comm. |
| Gr.Britain | South Uist | 57 | grass | 15-6/(15-7) | Newton *et al.* 1974 |
| Sweden | Gotland | 57 | grass | 15-6/(15-7) | Von Essen *et al.* 1982 |
| Denmark | Jutland | 57 | reed | 15-6/(15-7) | Paludan 1965 |
| | Sjaeland | 56 | reed | | Madsen 1987 |
| Netherlands | Friesland | 53 | pondweed | 10-6/10-7 | Lebret *et al.* 1968 |
| | Haringvliet | 52 | grass | 10-6/10-7 | Ouweneel 1969 |
| | Flevoland | 52 | reed | 25-5/25-6 | this study |

Over the moulting period both quantity and quality of *Phragmites australis* decreased. The timing of moult therefore seems very important for individual geese in order to adjust grazing pressure to food availability as well as to minimize the risk of competition with other geese.

Obviously the geese use their fat reserves to overcome the moulting period, but geese did not use a long period prior to wing moult to build up fat reserves. Only 2.7 days on average were spent on pasture land, the birds being only moderately fat at the start of moult. We suggest that the benefit of an early moult might outweigh the negative consequences of any delay in moult. The role of body condition in relation to timing of moult and its usefulness as a buffer overcoming the competition with other geese needs further study.

Only a few moulting grounds for Greylag Geese are known in Europe (Madsen 1987). Several authors have stated that timing of moult in Greylag Geese is related to latitude (Hudec & Rooth 1970, Owen 1980). Table 2 shows a compilation of data from literature. Phenology of food plants in general terms differs with latitude and may be the ultimate reason for the differences observed in populations throughout Europe. However, the type of food plant is also important. Lebret and Timmerman (1968) found large groups of moulting Greylags in The Netherlands feeding on Pondweed *Potamogeton sp.*, while in the Oostvaardersplassen geese feed on *Phragmites australis*. These food plants differ in timing of growth and peak production. The different growth curves of both species in Fig. 5A are based on recorded growth in Flevoland in 1988. Also indicated in periods of ten days is the percentage of geese that started moult. The data of Lebret and Timmerman (1968) have been smoothed somewhat according to recent findings in Oostvaardersplassen. Moulting in reed-marshes like Oostvaardersplassen thus favours a three weeks earlier start as compared to the macrophyte *Potamogeton*.

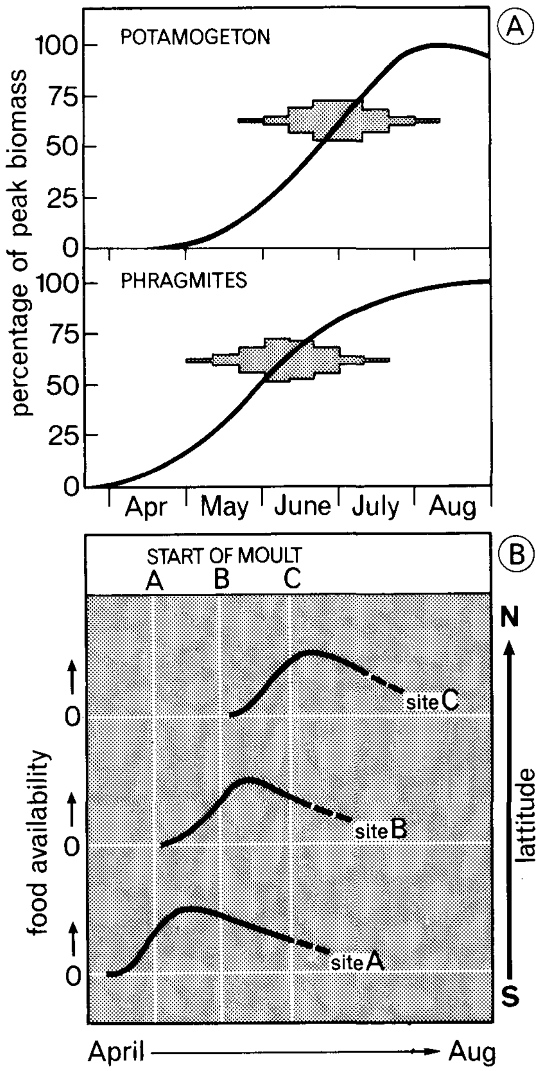


**Fig. 5.** Timing of wingmoult in relation to species specific food production. Growth curves in 1988 for *Potamogeton* after Van Eerden (own obs.), for *Phragmites* this study. Wing moult on *Potamogeton* based on Lebret & Timmerman 1968 (A). Qualitative model illustrating the effect of latitude on possible timing of moult. Deterioration of feeding conditions occurs because of grazing and phenological events (B).

## Switching to other moulting areas

The geese which had flown to Oostvaardersplassen at the end of May 1987-89 in order to moult, faced unfavourable conditions and left again in search for other moulting areas. Figure 5B presents a hypothetical overview of the food situation at different moulting sites. At each site, the moulting period is supposed to be adjusted to the food supply as in Figure 5A. Food supply is thought to decrease as a consequence of grazing during the moulting period, although the rate of decrease is variable and may differ between sites. The advantage for geese moulting at a southerly site like Oostvaardersplassen would be an early return to the summer gathering places (Rutschke 1987). At these areas geese replenish body reserves and complete their moult of body feathers. As the season progresses, geese which come to Oostvaardersplassen will find the food supply less favourable. In northerly moulting areas, moult is then just starting, and switching back to those areas may still be a better alternative concerning the food situation.

Ouweneel (1969) stated that non-breeding Greylag Geese have changed their moulting sites regularly in the past decades. These long term changes (for a review see: Madsen 1987) are probably the consequence of the ability to choose between moulting sites within one year. As the non-breeders only show fidelity to their moulting place in years prior to breeding, the majority of the geese will use a particular site for only a few years. This implies that knowledge about a site as well as the alternatives is available only to a limited fraction of the entire population of moulters. The process of social enhancement in the building up of this tradition as well as the consequences for individuals with different time schedules deserves further study.

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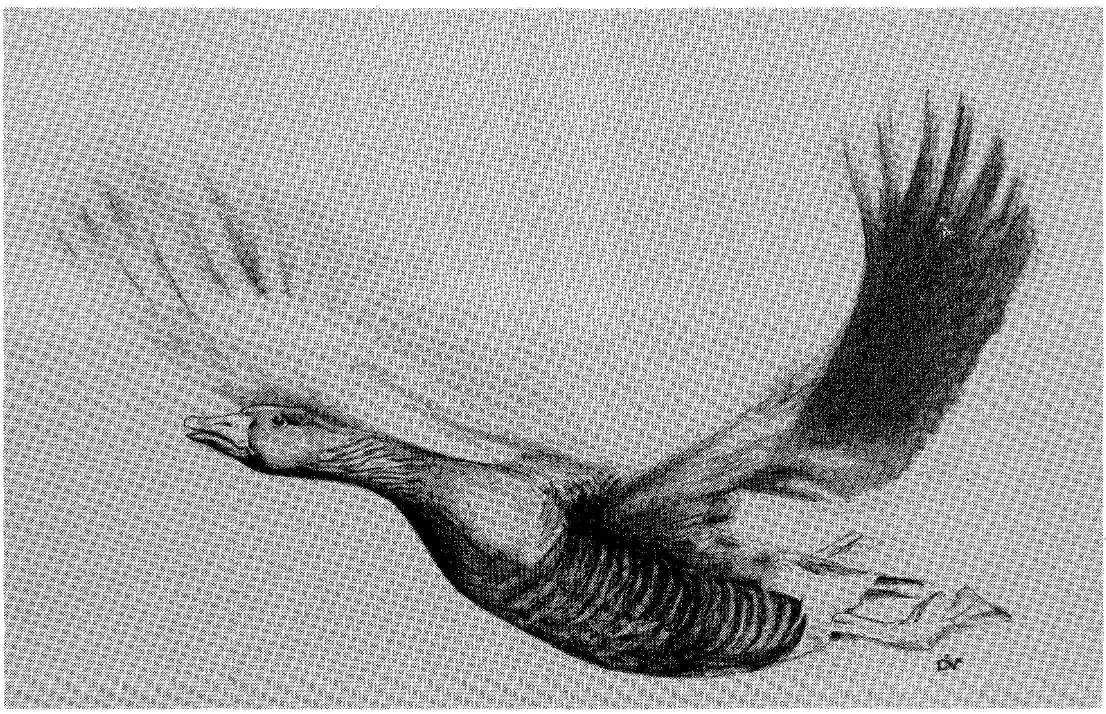
## SAMENVATTING

Niet broedende Grauwe Ganzen ruien hun slagpennen tijdens het voorjaar en het begin van de zomer in speciale gebieden (Fig. 1). De Oostvaardersplassen zijn sinds kort een zeer belangrijk ruigebied voor deze ganzesoort. Bij

de meeste ruiende ganzen neemt de lichaamsconditie enigszins af tijdens de rui (Fig. 2). De ruiperiode in de Oostvaardersplassen valt samen met een periode van snelle groei van riet, de belangrijkste voedselplant (Fig. 3). Tijdens de rui is er een constante afname in kwantiteit en kwaliteit van de voedselplant (figuren 3 en 4). Als gevolg van een voedseltekort, hebben grote groepen ganzen, die laat aankwamen niet in de Oostvaardersplassen geruid (Tabel 1). Ze zijn teruggetrokken naar Scandinavië. Het belang van dit fenomeen wordt bediscussieerd in relatie tot de fenologie van de voedselplant op verschillende plaatsen in Europa (Tabel 2 en Fig. 5).



Drawing Dick Visser.