DOI: 10.17242/MVvK_3.30

THE NUTRITION OF GREYLAG GOOSE AND ITS EFFECT ON THE EUTROPHICATION OF KISBALATON (HUNGARY)

Sándor Andrikovics[1], Géza Gere[2], and Elemér Futó[3]

[1] Department of Zoology, Eszterházy Károly Teachers Training College, H-3300 Eger, Leányka u. 6, Hungary.
[2] Department of Systematic Zoology and Ecology, Eötvös Lóránd University, H-1088 Budapest, Puskin u. 3, Hungary.
[3] Directorate of Kisbalaton Nature Reserve Area, H-8649 Fenékpuszta, Hungary.

ABSTRACT

During a year we estimated the number of Greylag Geese in the area of Kisbalaton, we observed their living habits. In laboratorial studies, we measured the daily consumption, the daily feces and urine output of Greylag Geese feeding on different plant material. We calculated the food consumed by the population of Greylag Geese in the area of Kisbalaton, and the part of the produced feces and urine which enters into the water. From these data we were looking for the answer what role the Greylag Goose plays in water eutrophication of Kisbalaton

INTRODUCTION

More and more studies show that animals, especially waterfowl can influence water quality by their metabolic products. The important role of the birds can be explained by their large number at the same place and by their rapid metabolism. As a consequence they cause high turnover of substances and energy in communities.

We started this study to evaluate the importance of some common waterfowl associated with different food webs in effecting water quality. First, we studied fish-eating Cormorants (*Phalacrocorax carbo*) (Gere and Andrikovics 1986, 1992a, 1992b), then the omnivorous Mallard (*Anas* *platyrhynchos*) (Gere and Andrikovics 1994). Now we are considering the mainly herbivorous Greylag Geese (*Anser anser*).

The aim of our study was not only to find out the importance of these birds in the turnover of substaces and energy, but to study the special hydrobiological situation in a wetland of European significance, the Kisbalaton.

There was a huge territory of marsh land in this area, which was drained to its small fractions by human activity. Therefore the self purification of River Zala running through this marsh decreased to a minimal level. It had an disadvantageous effect on Lake Balaton as well, because pollutants and the substances causing eutrophication got directly into Keszthely Bay without filtering (**Table 1**). The river that carries most of the inorganic materials in Lake Balaton, which cause eutrophication, is the River Zala. This river brings 10-15000 tonnes of floating substances, 1500 tonnes of N and 100 tonnes of P into the lake in a year. According to the OECD Classification (Vollenwerder and Kerekes 1981, *in* Szilágyi *et al.* 1990) Lake Balaton belongs to mesotrophie and hypertrophie categories. Keszthely area, which is the closest bay to the inflow of River Zala, is hypertrophic (**Table 1**).

A large-scale program was started to protect Lake Balaton in 1985, when the first reservoir called Lake Hídvégi was constructed. An area of 18 km^2 was flooded with River Zala. The average depth of the lake is 1.14 m, and the reservoir stores 20 million m^3 of water. The conditions of the late 18th century were practically reconstructed by this technical project at the lower part of Zala valley. The original ecosystem started to recolonisate in the first reservoir. The second part of the reservoir system is under construction now (1995).

The nitrogen and the phosphorus removals have been evaluated every year since the construction of Lake Hídvégi. We can state that the nutrient load on River Zala decreased. The reservoir removed the 26 % of total nitrogen and the 49 % of total phosphorus carried by River Zala (Pomogyi and Süle 1988). So there is an urgent need of construction of the second reservoir but it would be necessary to study the internal load of nitrogen and phosphorus coming from the reservoir itself.

There have already been positive effects of the first reservoir on the waterfowl by now. The lake offers excellent, large habitat for aquatic birds including the Greylag Goose. The chief uncertainity is the possibility that wild bird populations around the new reservoir may cause an increased trophic level of Kisbalaton and Lake Balaton by their metabolic products, which has already been pointed out in studies with other goose species (Manny *et al.* 1975, Sterbetz 1992, Manny *et al.* 1994). But in our studies we observed, that this effect does not work only in one way, and we hope that it could be insignificant in the case of Greylag Goose, which is protected in Hungary.

METHODS AND MATERIALS

We combined laboratory analysis and field observations. In our laboratory experiments Greylag Geese's eggs were hatched and the youngs were brought up in semi-wild conditions. Time by time we put some of the young of different age in a closed box to collect data about their metabolism. The young were put in cage of 1 m^2, adults were put in a cage of 3 m^2 area. The bottom of the cages was made of net, the its holes were 2 by 2 cm mesh size. Plastic sheets were put 10 cm under the cage, on which the feces and urine were accumulated. The birds were fed with measured amount of food. Daily consumption was estimated from the amount of the food which was given in and the amount of the left over food after 24 hours.

During our laboratory study period the birds were given concentrated chicken feed, which is a mixture of both plant and animal materials. This food is said to contain all the nutrients that a growing bird needs. At an other time they were fed with wheat, corn or the root and the stalk of Jerusalem artichoke. At last they were fed with the mixture of green grasses like lucerne (*Medicago sativa*), barley grass (*Hordeum murinum*) and chickweed (*Anagalis arvensis*). Since the birds are usually picking about this kind of food in nature, the grasses were cut into small pieces to help their feeding. Hereon, this mixture will be simply called as grass. We collected and measured their daily excrements and weighed each bird in the beginning and in the end of the 24-hour-periods. According to these data we calculated production-biological parameters. 4 young and 2 adult birds were involved.

In our field study we found the following data on the living habits of Greylag Goose in the area of Kisbalaton. Disregarding the fluctuation of the population, year by year, there was an average of 70 pairs nesting around the reservoir and 100 pairs around the original territory of Kisbalaton in the previous years (1993-1994). There were 1500-3000 of Greylag Geese around the reservoir in winter. These migrating birds obviously arrived from other neighbouring marshes. This number takes up 22-42 % of the whole Hungarian population,which is about 7500 individuals (Faragó, 1991 *in* Roomen and Madsen (eds.) 1991).

Pairs are formed in March. Birds that did not form pairs stay together in groups and migrate with Bean Geese (*Anser fabalis*). Goslings (4-5 in each pair) start hatching out in the beginning of April. The young birds that are unable to fly and their parents spend more time on water than on land between April and June. Between July and November most geese are feeding in groups on the nearby stubble-fields from 4 to 10 o'clock am. Between 10 and 12 a.m. they are usually drinking on the water, then they are again on the stubbles between 12 and 6 pm. They spend the night on water or on the bank from 6 o'clock pm to 4 o'clock am. In winter they feed on the stubbles or they stay on the water or the ice-floe. Their excrements may accumulate on the ice-floes, but some parts of these are consumed by wild ducks.

RESULT AND DISCUSSION

The production-biological parameters of young geese on different foods are shown in **Tables 1-3**. The parameters of adults are shown in **Tables 4-6**. If we consider that these data were obtained from relatively small number of individuals and days, then we should take this study only as a pilot investigation.

Table 1: Production-biological parameters of young Greylag Geese fed on concentrated chicken food (average of 4 birds)

Date	Initial	Late	Growth	C*100	P*100	FU*100	R*100
	Living mass (g)		(g)	G	C	C	C
7-8/05	354.5	431.0	76.5	30.9	18.2	18.3	63.5
16-17	759.0	839.5	8.5	22.2	12.4	18.0	69.6
17-18	839.5	918.5	79.0	26.5	9.2	9.7	81.1
23-24	966.0	1065.5	99.5	17.5	15.3	17.8	66.9
24-25	1065.5	1166.0	100.5	22.2	11.0	17.0	72.0
6-7/06	1658.7	1813.0	154.3	16.5	14.7	16.5	68.8

Table 2: Production-biological parameters of young Greylag Geese fed on different types of food like wheat, corn and Jerusalem artichoke (average of 4 birds)

Date Food type	Initial	Late	Growth	C*100	P*100	FU*100	R*100
	Living mass (g)		(g)	G	C	C	C
5-6/05 wheat	353.5	324.5	- 29.0	4.8	- 22.2	69.5	52.7
6-7 wheat	324.5	354.5	30.0	20.7	11.6	16.8	71.6
30-31 corn + J. artichoke	1099.0	1228.0	129.0	13.3	22.9	15.8	61.2
31-1/05-06 corn + J. artichoke	1228.0	1296.0	68.0	11.8	12.1	19.5	68.4

Table 3: Production-biological parameters of young Greylag Geese fed on grass (average of 4 birds)

Date	Initial	Late	Growth	C*100	P*100	FU*100	R*100
	Living mass (g)		(g)	G	C	C	C
7-8/06	1813.0	1768.5	- 44.5	2.7	- 25.7	56.9	68.8
13-14	1802.5	1690.0	- 112.5	2.7	- 59.6	91.2	67.9
14-15	1690.0	1642.0	- 48	2.1	- 34.6	66.0	68.6
20-21	1647.0	1601.5	- 45.5	0.7	-	-	-
21-22	1601.5	1674.0	45.5	5.9	18.8	46.1	35.1
14-15/09	1986.0	1900.5	- 85.5	4.4	- 25.3	98.2	27.1
15-16	1900.5	1945.0	44.5	5.8	10.4	43.3	46.3
20-21	2006.0	2009.0	3.0	3.3	25.8	68.6	5.6

Table 4: Production-biological parameters of adult Greylag Geese fed on concentrated chicken food (average of 2 birds)

Date	Initial	Late	Growth	C*100	P*100	FU*100	R*100
	Living mass (g)		(g)	G	C	C	C
7-8/06	3345	3258	- 87	4.5	- 17.8	11.7	106.1
16-17	3611	3284	- 327	1.4	- 196.2	67.8	228.4
17-18	3284	3241	- 43	1.1	- 34.9	17.5	117.4
23-24	3111	3213	102	7.2	25.5	14.3	60.2
24-25	3213	3219	6	13.7	0.6	13.2	86.2

Table 5: Production-biological parameters of adult Greylag Geese fed on different types of food like wheat, corn, concentrated chicken food and Jerusalem artichoke (average of 2 birds)

Date Food type	Initial	Late	Growth	C*100	P*100	FU*100	R*100
	Living mass (g)		(g)	G	C	C	C
5-6/05 wheat	3500	3500	0.0	4.8	0.0	20.8	79.2
6-7/05 wheat	3500	3345	- 155	1.7	- 80.2	19.6	160.6
6-7/06 wheat + chicken food	3193	3227	34	3.4	9.4	12.0	78.6
30-31/05 corn + J. artichoke	3276	3244	- 32	5.4	- 5.4	20.5	84.9
31-1/05-06 wheat + corn + J. artichoke	3244	3254	10	4.1	2.4	17.2	80.4

Table 6: Production-biological parameters of adult Greylag Geese fed on grass (average of 2 birds)

Date	Initial	Late	Growth	C*100	P*100	FU*100	R*100
	Living mass (g)		(g)	G	C	C	C
7-8/06	3227	3183	- 44	1.3	- 31.1	56.2	74.9
13-14/06	3201	3081	- 120	0.8	- 210.4	14.1	296.3
14-15/06	3081	3064	- 17	0.4	- 45.1	34.3	110.8

It is well known that geese, especially the young ones, need mixed, protein-rich food. Concentrated chicken feed is the most suitable for this purpose from the nutrients which we have used. They ate this food the most intensively. They used it up at the highest degree, the lowest amount of the excrement was found in these cases (**Tables 1, 4**). Geese are known as grazing animals, so it was surprising that they did not want to eat the grass we had given them and they couldn't use it up. This study shows that `grazing' alone is insufficient, it is only a supplementary way of feeding, geese need protein-rich food as well. It can't be a question that protein-rich food is especially important for growing animals.

We have to know several data to estimate the effect of geese on eutrophication. These are the followings:

1. the quantity and the quality of the food they consume
2. the quality of their utilization of food
3. the number of the geese staying at the area and its daily and seasonal fluctuation.

If we want to answer the first point, according to the data of Sterbetz (1992) we could say that adult geese consume daily as much food calculated in dry weight as about the 5.6 % of their body weight. Young birds' demands of food were calculated in three periods, the average of them was 10.4 %.

The excrements (dry weight) of young birds were 23.3 % of their consumed food and 21.5 % at the adults (the data which were obtained from the birds fed on grass were not included). These results look reasonable and we would like to mention that similar data were obtained from young and adult Cormorants, which were 31.5 % and 21.1 % (Gere and Andrikovics, 1986, 1992a,b).

We can estimate the quantity of the food the adults consume from the data shown in **Tables 4** and **5**. The average of Cx100/G was 5.6 % and 3.9 %. If we consider the higher mobility of birds in nature, we should use 6 % of live weight as Cx100/G to calculate the basic consumption (in dry weight) of the adult population. We calculated the consumption of the goslings in three of 30-day-periods according to their age. The average of daily consumption is 100 g between the age of 1 and 30 days, 200 g between the age of 31 and 60 days and 300 g between the age of 61 and 90 days. The consumption of adult birds is about 200 g of dry weight a day. (This data was used in our calculations.)

We based our estimates for four period of the year that were winter, nesting time, growing time of the young and summer-autumn period.

In winter, from December to February, which is altogether 90 days, at Kisbalaton 2000 Greylag Geese spend 4.32 million goosehours. (Goosehour = number of geese x the hours spent by one goose at the pointed area.) According to our field studies the half of it, 2.16 million of goosehours are spent on water. The consumption of an adult goose during a goosehour is 8.39 g, the total consumption is 35,986 kg in dry weight.

The nesting period is 31 days in March. If we calculate with all the 340 adult Greylag Geese, it makes 2.52 million of goosehours. An adult goose spend only two hours a day on water, so the number of goosehours spent on water is 2.108 million, which is only 8.3 % of the total goosehours. The total consumption during the nesting period is only 2107 kg.

The growing time of the young lasts from April to June, which is 91 days. There are 340 adult geese and 850 young geese at the area. There are about 5 goslings in each pair in this period, but we will calculate with 4 in the next period because of their mortality. The total number of geese is 1190 in this period, which makes 2.59896 million goosehours. The geese spend 16 hours a day on water, which is 66.6 % of the total goosehours. Considering that the average of the consumption of the young birds is the same as the the adults, we do not have to differentiate the different ages of young birds. The consumption during the total goosehours is 2.165 kg.

In the summer and autumn period from July to November, which is 153 days, geese (340 adults and 170x4 youngs) spend 3.74544 million goosehours at the area. They spend the 6.25 % of this on water and they are on the stubbles or on the bank or on the islands of the reservoir at the rest of the time.The consumption of this period is 31200 kg of dry weight.

According to the data showed above here is the summary of the parameters of Greylag Geese living at the area of Kisbalaton:

Period	consumption in a year (kg)	feces and urine in a year (kg)
winter	35986	8960
nesting	2107	524
growing of youngs		
adults	6235	1552
youngs	15415	2497
summer-autumn	31200	7769
Total	90943	21302

The next step is to calculate the distribution of feces and urine (FU) between water and land.

In the winter period (December-Febrruary) the half of the produced FU gets into the water and half of it gets on the land.

In the nesting period (March) 91.67 % of the FU remains on the land, only 8.33 % of it gets into the water.

In the growing period (April-June) we can calculate the 90-day-FU of young geese if we substract their growing in dry weigh from the 90-day-FU of the adults. The Cx100/G at this time is 17 %. According to other studies a young bird contains 74% water and their dry weight is 26 % (Austin 1971). The N content of the birds is 11.6 % and the P content is 2 % of their living weight (Kear 1963). A goose grows about 1940 g living weight in three months, this is 504,4 g in dry weight. The N content of it is 58.5 g (calculating with 11.6 %) and the P content of it is 10.09 g (calculating with 2 %). 49.7 kg of N and 8.5 kg of P are built in all growing birds (850) a year. We found that the proportion of consumption (C) and FU is 16.2 % in the youngs and 24.9 % in the adults fed on concentrated chicken food. The total amount of FU is 21302 kg a year and 2.2 % of it is the gross N, which is 468.6 kg of N. If we substract the N built in the body of the youngs (49.7 kg) from the gross N that will make 418.9 kg, so feces and urine contain altogether 418.9 kg of N. The total amount of FU is 21302 kg a year and 0.41 % of it is the gross P, which is 87.3 kg, from which we have to substract the P buildt in the body of the youngs (8.5 kg), so feces and urine contain altogether 78.8 kg of P.

In the summer and autumn period (July-Nov) 93.5 % of the FU remain on the land, only 6.25 % of it get into the water.

If we compare the goosehours spent on water to the total goosehours in the different periods, we will get the following summary:

Period	goosehours total	percent on water	goosehours on water
winter	4320000	50.00 %	2160000
nesting	252960	8.30 %	21071
growing of the youngs	2598900	66.60 %	1732640
summer-autumn	3745400	6.25 %	234090
Total	10917360		4147801

Greylag Geese spend 38 % of the total goosehours on water and 62 % on land. If we consider N and P causing eutrophication, we find that the inner load is only the 38 % of the total N of excrements(418.9 kg), which is 159.2 kg N, and 38 % of the total P of excrements(78.8 kg), which is 30.0 kg, these amount of nutrients get into the water of Kisbalaton a year. This amount of nitrogen and phosphorus produced by the population of Greylag Goose is insignificant for the inner load of Kisbalaton and Lake Balaton.

ACKNOWLEDGEMENT

This research was supported by the Hungarian Scientific Research Foundation (OTKA, Project No. 2231).

REFERENCES

Austin, G.T. (1971). Body composition and organ weights of the verdin (*Auriparus flaviceps*). Gt. Basin Nat 31:66-68

Gere, G. and S. Andrikovics (1986). Untersuchungen über die Ernahrungsbiologie des Kormorans (*Phalacrocorax carbo sinensis*) sowie dren Wirkung auf den trophischen Zustand des Wassers des Kisbalaton I. Opusc. Zool. Budapest. 2:67-76

Gere, G. and S. Andrikovics (1992a). A kárókatonák (*Phalacrocorax carbo*) szerepe a Kisbalaton szervesanyag-forgalmában (The role of Cormorants /Phalacrocorax carbo/ in the organic matter cycle of the Kisbalaton) Aquila. 99:27-32

Gere, G. and S. Andrikovics (1992b). Effects of waterfowl on water quality. Hydrobiol. 243/244: 445-448.

Gere, G. and S. Andrikovics (1994). Feeding of ducks and their effects on water quality. *In*: J. Kerekes and B. Pollard (eds.), Aquatic Birds in the Trophic Web of Lakes. (Dev. Hydrobiol. 96) Hydrobiol. 279/280 : 157-161.

Kear, J. (1963). The agricultural importance of wild droppings. The Wildfowl Trust. 14. Annual Rep., 1961-62: 72-77

Manny, B. A., R. G. Wetzel and W. C. Johnson (1975). Annual contribution of carbon, nitrogen and phosphorus by migrant Canada geese to a hardwater lake. Ver. Internat. Verein. Limnol. 19: 949-951

Manny, B. A., W. C. Johnson and R.G. Wetzel (1994). Nutrient additions by waterfowl to lakes and reservoirs: predicting their effects on productivity and water quality. *In*: J. Kerekes and B. Pollard (eds.), Aquatic Birds in the Trophic Web of Lakes. (Dev. Hydrobiol. 96) Hydrobiol. 279/280: 121-132.

Pomogyi, P., and Gy. Süle (1988). A Kis-Balaton védőrendszer hatása a Zala tápanyagtartalmának alakulására. XXXII Hydrobiological Days. 25 pp.

Roomen, V. M., and J. Madsen (eds.) (1991). Waterfowl and agriculture: rewiew and future perspective of the crop damage conflict in Europe. IWRB Special Publication No. 21. 184 pp.

Sterbetz, I. (1994). A Balatonon telelő északi vadludtömegek exkrétumprodukciója (The excretum production of northern wild goose masses wintering on the Lake Balaton). Aquila. 99:33-40

Szilágyi, F., L. Somlyódi and L. Koncsos (1990). Operation of the Kis-Balaton reservoir : evaulation of nutrient removal rates. Hydrobiol. 191: 297-307

Vollenweider, R. A. and J.J. Kerekes. (1981). Background and summary results of the OECD Cooperative Programme on Eutrophication. *In*: Restoration of lakes and in land waters. Cut. Symp. on Waters and lake Restoration. Sept. 8-12,1980. Portland, Maine. EPA, Washington, D.C., EPA 440/5- 81-110: 25-36.