Hydrobiologia **279/280**: 157–161, 1994.
J. J. Kerekes (ed.), Aquatic Birds in the Trophic Web of Lakes.

Feeding of ducks and their effects on water quality

Géza Gere & Sándor Andrikovics
Department of Systematic Zoology and Ecology, Eötvös Loránd University, H-1088 Budapest, Puskin u. 3. Hungary

Key words: ducks, feeding, excrements, eutrophication

Abstract

Birds possess fast metabolism, and therefore they ingest and egest relatively large quantities of organic materials. Effects on the eutrophication depend on the site where they release their excrements. Mallards were studied as model animal to evaluate this process. Mallards of different ages have different ecological roles. In the beginning of their individual life they reduce the trophic level but later they contribute to the eutrophication processes.

Introduction

The Kis-Balaton (Small Balaton) is situated in the western part of Lake Balaton in the Carpathian basin. River Zala, is the greatest water inflow to the lake crossing the area of Kis-Balaton. In the last century the water carried by the River Zala through the Kis-Balaton with quite sufficient biological purification processes. In consequence of the reduction of the swampy areas and the increased pollution of River Zala, the biological purification processes did not work sufficiently. The water flowing into the Lake Balaton has very high P and N content and this is causing strong eutrophication in the western part of Lake Balaton (Herodek, 1980). The reservoir system was planned to stop these processes. The first part of this system is now operational, while its second one is under construction. The Hídvég reservoir of 20 km^2, as the first element of the total Kis-Balaton Control System of 70 km^2 surface area, started to operate in 1985. As a result of the first reservoir, nutrient loads in the western part of Lake Balaton have been reduced. Improved water quality can not be expected immediately, due to the high internal *P* load from the lake sediments (Szilágyi *et al.*, 1990). The basic concept of the establishment of this reservoir system is to form a shallow lake consisting different biotypes. It may be expected that the biological purification processes will be more efficient than in the Zala River before flowing into Lake Balaton.

This new wetland ecosystem is extremely a good feeding habitat for waterfowl and it will make possible to study of their feeding habits on the water quality. The effects produced by the cormorants eating only fishes on the eutrophication has been studied by us earlier (Gere & Andrikovics, 1986, 1992).

Another very important group of waterfowl is represented by the ducks. Most ducks eat mixed food thus they have quite different role in the food web in comparison to the fish eating birds.

We studied how food is consumed by growing (young) and adult mallard (*Anas platyrhynchos*) and how do they utilize the consumed food, and what is the proportion of the consumed and digested food which they return in form of feces into the water. Preliminary investigations were done also on Tufted Duck (*Aythia fuligula*) and Gadwall (*Anas strepera*).

Hydroecological characters of Kis-Balaton

The remaining part of the ancient Kis-Balaton, ($\pm$ 14 km^2) is presently a natural reservation area.

The first part of the reservoir system which is completed now, has an open water surface area 17.8 km and its volume 19.6 million m^3 water. The whole reservoir will be 87 km^2 and its volume will be 85 million m^3. The water of River Zala and water reservoir (Lake Hídvégi) is Ca-Mg-HCO_3 chemical type.

The hydrochemical parameters of River Zala are as follows (Pomogyi, 1991):

pH	7.3–8.2
Conductivity ($\mu s\ cm^{-1}$)	620–670
Suspended material ($mg\ l^{-1}$)	30–80
Ca^{2+} ($mg\ l^{-1}$)	80–90
Mg^{2+} ($mg\ l^{-1}$)	40
HCO_3^- ($mg\ l^{-1}$)	350–420
SO_4^{2-} ($mg\ l^{-1}$)	50–60
Total N ($mg\ l^{-1}$)	4–5
NO_3-N ($mg\ l^{-1}$)	2–3
Total P ($mg\ l^{-1}$)	0.4–0.8
PO_4-P ($mg\ l^{-1}$)	0.25–0.44

The water quality component significantly changed during its retention in the reservoir. Dissolved materials and the conductivity generally decreased whereas the pH increased. The water quality varied widely not only according to time and season, but also among habitats.

Every year about 300 tons of *P* 3000 tons of *N* and 30000 tons of suspended material flow in the Lake Balaton (Joó-Pomogyi, 1989). About 30–40% of this load originate form the watershed of River Zala. These substances are great importance for the recent trophic status of Lake Balaton. We estimated that the cormorants of this area, 1500 pairs and their young, provide *N* and *P* equivalents with 2.2 and 2.0%, respectively, of the whole impact from Zala River (Gere *et al.*, 1986, 1992.)

Methods

The birds were put one by one or two or three specimens in wire net cages. Under the cage there was PVC layer to retain the feces. The birds were fed every day with measured food. The birds were fed with concentrated chicken food which was comparable to natural mixed food. In an other period birds were fed with ground corn. The remains of the food and feces were gathered separately measured. Food consumption has been calculated as the difference between the given and residual food. One or two times a day, changes in the living body mass of the ducks were measured. The water content of the bird's body was not determined directly but according to the data of other birds (Gere, 1983) it was calculated as 70%.

Our investigations were not carried out continuously. In the intermediate periods the birds were kept in closed court simulating wild conditions.

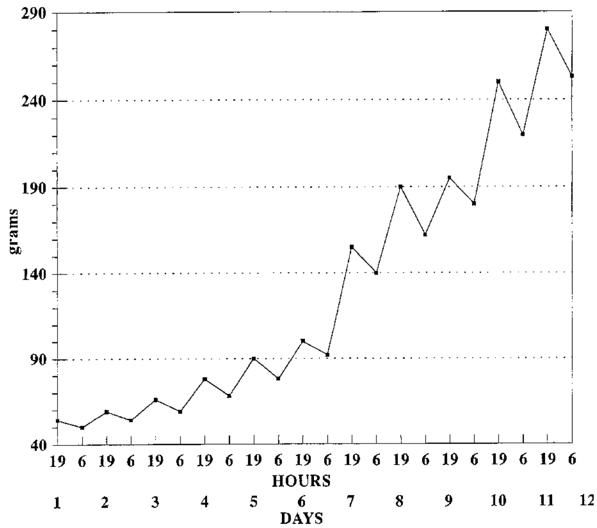

Fig. 1. Increase of a mallard body mass during the experiment.

Table 1. Production-biological parameters of young mallards (number: 1–4) were fed by concentrated chicken food. C = Dry weight of food consumed per day, G = living weight of a duck, P_D = dry weight increasing of a mallard, FU = dry weight of the excreted faeces + urine R = dry weight of material using for respiration (mean values obtained from 4 birds).

Days	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
Living weight (g)	291.80	328.40	352.80	–	–	464.10	485.30	512.40	540.60	558.40	585.10	605.70	639.20	649.50	684.00
Dry weight (g)	87.50	98.60	105.80	–	–	139.20	145.60	153.70	162.20	167.50	175.50	181.70	191.80	194.90	205.20
P (g)	36.60	24.40	24.60	–	–	21.20	27.10	28.>20	17.80	26.70	20.60	34.10	10.30	34.50	15.20
P_D (g)	11.10	7.20	7.40	–	–	6.40	8.10	8.50	5.30	8.00	6.20	10.20	3.10	10.30	4.60
$\frac{C \times 100}{G_{Living}}$	34.27	37.00	32.17	–	–	24.79	30.64	26.40	16.29	23.20	22.45	21.62	19.70	20.70	20.90
$\frac{P \times 100}{C}$	11.10	5.92	6.52	–	–	5.56	5.45	6.28	6.02	6.15	7.72	7.79	2.46	7.66	3.22
$\frac{FU \times 100}{C}$	33.68	39.61	32.83	–	–	30.42	33.96	42.87	53.56	33.31	40.89	35.52	41.74	35.58	40.05
$\frac{R \times 100}{C}$	55.22	54.47	60.55	–	–	64.02	60.59	50.85	40.42	60.54	54.39	56.69	55.80	56.76	56.73

Results and discussion

The body mass of the studied ducks during the individual development changed mainly according to a numerical row or can be expressed a S-shaped curve as it is known form other birds (Ricklefs, 1968; Schare & Balfour, 1971; etc.). The first phase of this growth can be seen very well then body mass have been measured two times a day. Further the body mass of these ducks strongly change during a day according to the phrased feeding and fullness of the alimentary canal (Fig. 1).

Comparing with their body mass the young mallards consumed more food than the adults (Tables 1–3). Food requirements of the smaller Tufted Duck are higher than the mallards having a greater body weight (Table 6). Similar food consumption were estimated in the case of Gadwall. The food consisting of only plant does not satisfy the physiological requirement of ducks. If the young ducks were fed during their growing period only corn, the body mass did not increase or sometimes in the case of older specimens dropped (Tables 3, 5). In hydrobiological respect this means that the ducks must acquire plant and ani-

Table 2. The same characters of young mallards (number: 5–8).

Days	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.
Living weight (g)	189.20	205.90	220.20	236.40	256.10	290.40	302.70	316.60	339.70	354.00	365.00	381.50	394.00	403.20	416.10	433.00
Dry weight (g)	55.00	61.80	66.10	–	–	87.10	90.80	95.00	101.90	106.20	109.50	114.50	118.20	121.00	124.80	130.00
P (g)	22.70	14.30	16.20	–	–	12.30	13.90	23.10	14.30	11.00	16.50	12.50	9.20	12.90	17.20	–
P_D (g)	6.80	4.30	4.90	–	–	3.70	4.20	6.90	4.30	3.30	5.00	3.80	2.80	3.90	5.20	–
$\frac{C \times 100}{G_{Living}}$	36.18	36.22	34.46	–	–	26.86	28.31	25.48	34.65	21.69	22.34	34.33	31.95	33.34	34.35	–
$\frac{P \times 100}{C}$	10.26	5.77	6.46	–	–	4.74	4.90	8.55	3.65	4.30	6.13	5.00	3.33	5.34	6.12	–
$\frac{FU \times 100}{C}$	34.44	37.14	26.03	–	–	39.74	30.96	37.19	25.43	29.86	36.31	35.50	40.50	40.37	39.61	–
$\frac{R \times 100}{C}$	55.30	57.09	67.51	–	–	55.52	64.14	54.26	70.92	65.84	57.56	59.50	56.17	54.29	54.27	–

Table 3. Production-biological parameters of young mallards (number: 9–11) were fed by ground corn.

Days	17.	18.	19.	20.	21.	22.	23.	24.	25.
Living weight (g)	605.10	587.10	617.70	625.70	618.50	616.80	626.50	627.80	630.00
Dry weight (g)	181.50	176.10	185.30	187.70	185.60	185.00	187.90	188.30	189.00
P (g)	– 18.00	30.60	8.00	– 2.10	– 0.60	2.90	0.40	0.70	–
P_D (g)	– 5.40	9.20	2.40	– 0.60	– 0.20	0.90	0.10	0.20	–
$\frac{C \times 100}{G_{Living}}$	–	10.15	16.97	16.28	10.63	10.13	13.96	6.61	–
$\frac{P \times 100}{C}$	–	15.43	2.29	– 0.59	– 0.30	1.44	0.11	0.49	–
$\frac{FU \times 100}{C}$	–	27.35	14.43	18.03	17.99	18.13	39.67	84.06	–
$\frac{R \times 100}{C}$	–	57.22	83.28	82.56	82.31	80.43	60.25	15.45	–

Table 4. Production-biological parameters of adult mallards were fed by concentrated chicken food.

Date	26/06	27/06	28/06
Living weight (g)	1193.40	1193.40	1193.40
Dry weight (g)	358.00	358.00	358.00
$\frac{FU \times 100}{C}$	37.55	33.08	29.90
$\frac{R \times 100}{C}$	62.45	66.92	70.10
$\frac{C \times 100}{G_{Living}}$	8.61	7.90	7.23

mal foods. We found that the young ducks until 70 days have consumed 5880 g food, whereas later adult birds eat every day on average 89,5 g concentrated chicken food (Tables 1, 2, 4). According to the ornithological estimations, the ducks inhabiting the natural reservation area and the reservoir system of Kis-Balaton in 1991, there were nesting about 500 pairs of mallard. Every pair raised 5–6 youngs. About 10% of them died. Majority of the adult ducks arrived to the area at the end of February and left in the middle of December.

It could be estimated that the total food-stuff requirement of the adult ducks was equivalent to 25 955 kg granulated chicken food. This may be somewhat larger in the case of free living ducks which move in the natural habitat.

Until the age of 70 days, young ducks consumed 15 700 kg food and until their migration 26 850 kg. The whole food consumption of mallards was 67 505 kg. The fact is that 35% of the dry material of food were transformed into feces, it can be concluded that the whole mallard population produced during a year 23 626 kg feces.

Table 5. Production biological parameters of adult mallards were fed by ground corn.

Days	16/06	17/06	18/06	19/06	20/06	21/06	22/06
Living weight (g)	1200.40	1210.50	1165.30	1155.80	1169.30	1145.00	1134.30
$\frac{C \times 100}{G_{Living}}$	7.98	4.81	7.34	10.60	7.94	7.71	15.26
$\frac{FU \times 100}{C}$	19.73	29.21	20.12	11.84	30.03	23.10	29.58

Table 6. Production-biological parameters of two adult Tufted Ducks fed by concentrated chicken food. (In June the avg. living weight of a bird is 533 g, in August during the time of moulting 640 g.)

Date	$\frac{C \times 100}{G}$	$\frac{FU \times 100}{C}$
19/06	12.9	–
20	11.0	29.9
21	16.9	26.1
22	23.2	11.3
23	12.5	21.3
17/08	19.4	28.8
18	19.8	35.3
19	14.5	26.9
20	13.0	39.0

There are 2164 kg *N* and 675 kg *P* in the calculated food, disregard the *N* and *P* which were assimilated into the 2983 kg body material which will be excreted in the form of feces and urine.

Ducks spend only a part of their time on water. The young feed on the water but they rest on the shore and so they put their feces mainly on the land. This is the main part of the substances taking up from the water, the young ducks transport the material to the land, in this period they reduce the trophic level of the reservoir. But, later their ecological role will change because the young being able to fly and feed more and more on the land (e.g. in the stubble-fields). The digested materials originating from the foodstuffs taken up on the land they get partly into the water which they look for. Ducks of different ages have antagonistic ecological role. In the beginning of their individual life they reduce the trophic level but later they contribute to the eutrophication processes.

The consumed *N* is equivalent to 480 000 m^3 water being in the reservoir system. The metabolized *P* seems to equal with 1 125 000 m^3 reservoir water.

From this data it is obvious that the trophic states of small lakes or ponds can be easily changed by a dense duck population.

Acknowledgements

We are grateful to Elemér Futó for providing the field data on the mallard population of Kis-Balaton. This research was supported by the Hungarian Scientific Research Fundation (OTKA, Project No. 2231).

References

Gere, G., 1983. The role of birds in matter and energy flow of the ecosystems. Puszta 1/10: 37–54.

Gere, G. & S. Andrikovics, 1986. Untersuchungen über die Ernährungsbiologie des Kormorans (Phalacrocorax carbo sinensis) sowie deren Wirkung auf den trophischen Zustand des Wassers des Kis-Balaton I. Opusc. Zool. Budapest. 2: 67–76.

Gere, G. & S. Andrikovics, 1992. Effects of waterfowl on water quality. Hydrobiologia 243/244 (Dev. Hydrobiol. 79): 445–448.

Herodek, S., 1983. The eutrophycation of Lake Balaton and the possibilities of protection (in Hungarian). Magyar Tudomány 7-8: 506–517.

Joó, O. & P. Pomogyi, 1989. Water management and environmental control on the western catchment of Lake Balaton (in Hungarian). Magyar Vizgazdálkodás 7: 19–24.

Pomogyi, P., (ed.) 1991. Chemical, biological and mass balance investigations on Kis-Balaton Control System (in Hungarian). Szombathely – Keszthely, 258 pp.

Ricklefs, R. E., 1968. Weight recession in nestling birds. Auk 85: 30–35.

Scharf, W. C. & E. Balfour, 1971. Growth and development of nestling hen harriers. Ibis 113: 323–329.

Szilágyi, F., L. Somlyódi & L. Koncsos, 1990. Operation of the Kis-Balaton reservoir: evaluation of nutrient removal rates. Hydrobiologia 191 (Dev. Hydrobiol. 53): 297–306.

Varga, L., 1954. About lakes concerning with Hungarian standing waters (in Hungarian). Állatt. Közlem. 44: 243–255.