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Breeding ecology of the Tufted Duck *Aythya fuligula* on the West Pomeranian (NW Poland) lakes in the years 1987–1989

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Abstract. Breeding season timing and breeding success of Tufted Duck were studied on three lakes in the years 1987–1989. Clutch laying began in mid May, earliest in a Black-headed Gull colony, and continued to the first days of July. Clutch size ranged between 3 and 18 eggs ($\bar{x}$ = 9.3, SD = 2.8, n = 331) and did not differ significantly between lakes and years. There was a significant reduction in clutch size as the nesting season advanced (from 13.3 eggs in May to 6.3 in July). Nesting losses (25–90% failed nests or clutches) grew as the breeding season progressed. Ducklings came to the water beetween the end of June and the beginning of August. Duckling losses (20–90%) were inversely correlated with nesting failures and due mainly to predation. The investigated populations were characterized by very limited production of young in most lakes and seasons and, as a consequence, by a decline in the population to half that noted in the 1970s.

Key words: Tufted Duck *Aythya fuligula*, breeding phenology, breeding ecology

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INTRODUCTION

The European range of the Tufted Duck *Aythya fuligula* is expanding (Nowak 1975). Since the end of the 19th century, the species has extended westwards, with populations rising in the newly occupied areas. This phenomenon has been linked with both suitable trophic conditions (the spread of the bivalve *Dreissena polymorpha*), the use by the species of anthropogenic biotopes like fishponds, and the increases in population noted for the Black-headed Gull *Larus ridibundus*, in whose colonies the Tufted Duck enjoys relatively high breeding success (Bauer & Glutz 1969, Cramp & Simmons 1977, Mlikovsky & Burič 1983, Nowak 1975).

The Tufted Duck colonized Pomerania around 1880 (Robien 1928, Tomiałojć 1990), and by the 1930s the population had already reached relatively high densities, e.g. at Lake Jasień (Robien 1935). Some 70 breeding sites with 410–470 pairs were noted in Pomerania in the years 1976–1985, along with c. 115 sites with females in the breeding season, giving a total of 780 females (Górski & Wiatr 1986). The detailed distribution of breeding sites in the Pomeranian Lakeland was presented in Górski (1991). Large breeding season totals were shown to be confined to two areas:

1) Coastal lakes Gardno and Łebsko within Słowiński National Park, where large colonies of Black-headed Gulls were present (Bednorz 1983). Drastic decline in the latter species led to the abandonment of the site by Tufted Ducks in the late 1970s (Górski *et al.* 1991a).

2) Narrow belt of the West Pomeranian Lakeland, where a particularly abundant breeding population at least 50–60 pairs strong was recorded from Lakes Kwiecko, Borzyszkowskie and Jasień in the east of the Lakeland, and from fishponds near Ińsko in the Bytowo area of the western part (Górski *et al.* 1991b).

The three most abundantly colonized breeding sites in the W. Pomeranian Lakeland (Lakes Kwiecko, Borzyszkowskie and Jasień) provided the subject for a programme of detailed population studies carried out in the years 1987–1989. The aims were to present the abundance and density of the breeding population, the chronology of the breeding period, clutch size, the level of nest failures and duckling stages and the production of young, as well as the influence of these variables on the dynamics of the local population of Tufted Ducks.

STUDY AREA

The work was done at three lakes in the eastern part of the West Pomeranian Lakeland. Lake Jasień (54°17'N, 17°37'E) is formed from southern and northern bodies of water joined by a channel. The former covers 336.7 ha, has a maximum depth of 22.6 m and includes 6 islands, while the latter covers 240.5 ha, has a maximum depth of 32.2 m and includes 2 islands. The emergent vegetation is mainly of reeds *Phragmites communis*, which grow in clumps along up to 20% of the shoreline. The islands are tree-covered and swampy in parts. 2–3 pairs of Hooded Crows *Corvus corone cornix* nested during the study period, while up to 5 White–tailed Eagles *Haliaeetus albicilla* flew in, as well as 1–2 pairs of Marsh Harriers *Circus aeruginosus*.

Lake Borzyszkowskie (54°03'N, 17°21'E) covers 101.2 ha and has a maximum depth of 31 m. The shores are sandy and almost devoid of emergent vegetation. Tufted Ducks were confined to one 0.71 ha island with herb vegetation and five trees. Black-headed Gulls had a colony here until 1988, while the area of the lake had nesting Hooded Crows, as well as visiting White-tailed Eagles (1 pair) and Marsh Hariers (1 pair).

Lake Kwiecko (55°00'N, 16°41'E) covers 83.5 ha and has a maximum depth of 6.5. The level of Lake Kwiecko varied markedly when the storage power station (which pumps water up to Lake Kamieniczno, or repumps it down to the lower lake) was in operation. Most of the shoreline is covered by a narrow belt of reeds. The 4.7 ha island in the Lake is overgrown with self-sown Scots pines *Pinus sylvestris* and broom *Cytisus scoparius*. Only the fringes are covered by herb vegetation. *Dreissena polymorpha* is plantiful and provides food for ducks. 1–2 pairs of Magpie *Pica pica* nested on the island, while Hooded Crows, and single pairs of White-tailed Eagle, Marsh Harrier and Red Kite *Milvus milvus* visited the lake.

METHODS

Research was done between May and the end of August in the years 1987–1989. The size of the breeding population of Tufted Ducks was estimated from the maximum number of females present at a lake at the start of the breeding season (10 May – 14 June) and the maximum number of nests occupied simultaneously.

Counts of the female Tufted Ducks present at each of the 3 lakes were made 2 or 3 times between 10 May and 14 June from a boat or from the shore. It was assumed that the highest figure obtained reflected the local breeding population. Nests were controlled from the beginning of May to mid July, with the islands being searched every 10–20 days by teams of 2–4 observers. Nests were marked discreetly with numbered tape, and located on a detailed plan. The location and contents of each nest were described and changes in the numbers and degree of development of eggs, nesting failures and hatching success were noted on subsequent visits. Eggs were marked and 2–3 selected for checks on the degree of delevopment using the submergence method (cf. Majewski 1980). If differences in the degree of incubation were noted, or if more than 12 eggs were found in a nest, then all eggs were subjected to the above test. If a nest was found to have two or three groups of eggs differing markedly in the degree of incubation, it was assumed that the clutches of two or three females were present. An auxiliary criterion in distinguishing multiple broods were differences in shell colouration or clear differences in size. The presence of multiple broods made it necessary to distinguish between the number of nests and the number of clutches. The former was used to estimate the size and density of the breeding population, the dynamics of hatching, nest failures, losses of eggs, hatching success, and the production of young; while the number of clutches served to establish the chronology of the nesting period, and clutch size — on the basis of incubated clutches, as well as to determine losses of clutches, and eggs in clutches.

The maximum number of simultaneously occupied nests includes all nests with brooding birds, nests at the laying stage and nests destroyed or abandoned since the last check. Approximate times for the onset of laying of particular clutches were calculated on the basis of data from a brood calendar (Keller 1984). The date of laying of the first egg in a clutch was estimated on the basis of clutch size, on the assumption that one egg per day had been laid. Where a nest found was incubated, the age of the clutch was calculated as above was added to the number of days of incubation, calculated on the basis of the water test. In the case of an abandoned nest, all that was described was the half-month period in which laying commenced.

The presentation of the dynamics of clutch-laying made use of all information on nests with clutches (including destroyed ones). The dates and dynamics of hatching were given for nests with hatching success. Data used in assessing clutch size were confined to those on clutches from incubated nests. Where the incubation of a nest was interrupted before hatching, the causes of the loss were determined in relation to3 categories: brood abandonment if eggs were destroyed by predator, the disappearance of a clutch and the flooding of the nest. Hatching success was used to describe those nests (and, respectively, clutches) for which the hatching of at least one chick was established. Proof of hatching entailed the presence of egg membrane, as well as broken-off tops of egg and small pieces of crushed shell. Unhatched eggs left in a nest were also counted, as were the numbers of eggs disappearing from nests in the course of incubation.

Between mid June — after the hatching of the first ducklings — and the end of August, the area of each lake was traversed by boat and on foot every two weeks, when the numbers of family groups and ducklings were counted. Young noted on a lake in the last third of August were considered reared, and the total number of such birds used to estimate losses in the chick period, in relation to the total number of hatched ducklings. The production of young, in relation to the maximum number of females noted on a lake at the start of the breeding season, and to the maximum number of simultaneously occupied nests.

To determine statistical significance, the difference in variance was first calculated using the F test. Where differences were non-significant, the Student t test was applied to compare means. In turn, where differences were significant, the Cochran-Cox test was used. The u test was used to compare two results from samples (Strzałko & Rożnowski 1992).

RESULTS

Distribution, number and density of nests

At all three lakes, nests of Tufted Ducks were confined to islands. At Lakes Borzyszkowskie and Kwiecko, nests were found on the whole area of islands, but were not distributed evenly. On the former, 92.5% of nests were found within a dense colony of *Larus ridibundus* encircling the elevated part of the island. The remaining 7.5% of nests were found around the highest part. The island in Lake Kwiecko had similar relief, and there Tufted Ducks nested most abundantly (54.3% of nests) on the grassy slopes of the elevation which create a strongly defined scarp in some places. 31.3% of nests were on the summital part of the island with *Pinus sylvestris* and *Cytisus scoparius*, and fewest of all (14.5%) in the lowest, periodically flooded parts. In contrast, nests were confined to the margins of the Lake Jasień islands, which are much flatter and overgrown with forest.

The largest population bred on Lake Kwiecko, and the smallest on L. Jasień (Tab. 1). In the first two years of study, Tufted Ducks nested in relatively large numbers at Lake Borzyszkowskie. However in 1989 the number of nests have fallen abruptly, along with the abandonment of the island by Black-headed Gulls due to the collection of eggs by people (Tab. 1). On that island, while the gull colony was present, the highest density of nests was noted. This was 3–6 times higher than the density at L. Kwiecko and c. 40–50 times higher than the overall figure for density on the islands in L. Jasień (Tab. 2). However, density at the latter site was very variable, with the highest values noted for the smallest islands.

The ornithological literature emphasizes the preference shown by Tufted Ducks for breeding sites on islands (e.g. Bauer & Glutz 1969, Cramp & Simmons 1977, Havlin 1966a, Hill 1984, Mlikovsky & Burič 1983, Stawarczyk 1995). This attests indirectly to the significance of predators in shaping breeding succes. In the West Pomeranian Lakeland, the species mainly

Table 1. Breeding populations of Tufted Duck at the three lakes studied.

[Tabela 1. Liczebność lęgowej populacji czernicy na trzech badanych jeziorach.]

Lakes	Season	Females	Nests (% of females)
Kwiecko	1987	68	43 (63.2)
	1988	74	72 (97.3)
	1989	76	72 (94.7)
Borzyszkowskie	1987	43	39 (90.7)
	1988	35	33 (94.3)
	1989	16	14 (87.5)
Jasień	1987	28	13 (46.4)
	1988	26	14 (53.8)
	1989	32	28 (87.5)
Total	1987	139	95 (68.3)
	1988	135	119 (88.1)
	1989	124	114 (91.9)

Table 2. Breeding density (maximum no. of nests occupied simultaneously per ha of island area occupied by tufted ducks).

[Tabela 2. Zagęszczenie czernicy na wyspach badanych jezior na podstawie maksymalnej liczby równocześnie zajętych gniazd.]

Lake	Islands	ha	Nests/ha		
			1987	1988	1989
Kwiecko	1	4.70	9.1	15.3	15.3
Borzyszkowskie	1	0.71	54.9	46.5	19.7
Jasień	7–8	11.16–7.75	1.2	1.3	3.6

nested on lakes with islands, too (Górski & Wiatr 1986, Górski 1991). Michelsons *et al.* (1967) showed that densities of duck nests on islands were inversely proportional to island area, and this was confirmed for Lake Jasień, though did not explain differences between three lakes. This was due to the gull colony on the island in L. Borzyszkowskie, which was clearly attractive for ducks. Lack of Tufted Duck nests on a second island in this lake which had no nesting gulls, as well as the already mentioned drastic decline in the density of ducks (even down to 2.8 nests/ha in 1990), following the gulls' abandonment of their colony further point to this. The importance of Black-headed Gulls to the security of Tufted Duck broods has been stressed by many authors, e.g. Bauer & Glutz (1969), Bergman (1957), Bengtson (1972), Cramp & Simmons (1977), Festeticts (1967), Hilden (1964), Mednis (1968), Mlikovsky & Burič (1983), Newton & Campbell (1975) and Stawarczyk (1995).

Chronology of the nesting

The first clutches were usually started in mid-May, with the earliest date being the 13 May — at Lake Borzyszkowskie. Tufted Ducks within the gull colony on L. Borzyszkowskie commenced broods earlier in comparison with those on the other islands,. The population at Lake Jasień was usually the last to start, although it was the first in the 1989 season. The period of most intensive inititiation of clutches came in June (Fig. 1), or in the second half of May in the case of L. Borzyszkowskie. The occasional very late seasons were exemplifed by 1987, when the first eggs at L. Jasień did not appear until 2 June. The laying of eggs in the latest broods began in the last days of June or even the first week of July, with the extreme date (again for L. Jasień) being 7 July 1989 (Tab. 3).

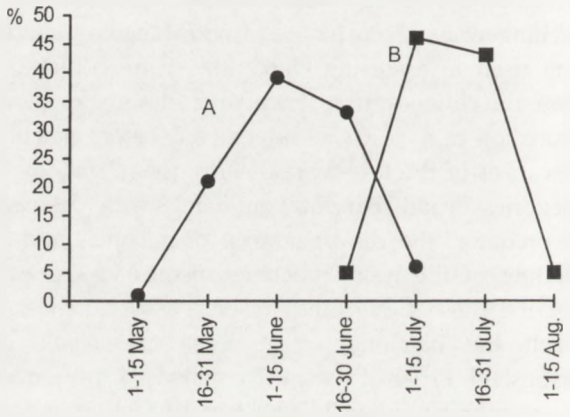

Fig. 1. Dynamics of (A) clutch laying (n = 418 clutches) and (B) hatching (n = 231 successful nests).

[Ryc. 1. Dynamika (A) składania zniesień i (B) klucia kacząt.]

First chicks usually hatched in the last days of June or first days of July. The earliest, exceptional, date was 18 June 1988 — at L. Borzyszkowskie (Tab. 3). The greatest numbers of broods were brought on to the water in the first half of July (first 2 years of study), or the second half (in the last year). In total, the young from almost 90% of broods hatched in July (Fig. 1). On the second half of June or the first days of August saw the remaining 10% of ducklings appeared on the lake. Latest clutch (L. Jasień) hatched on 7 August (Tab. 3).

On the different lakes, the nesting season (from the laying of the first eggs to the hatching of the last duckling) lasted between 56 days (L. Borzyszkowskie, 1989) and 81 days (L. Jasień, 1989) — Tab. 3. The nesting

Table 3. Timing of nesting season. B, J, K — Lakes: Borzyszkowskie, Jasień, Kwiecko — respectively.

[Tabela 3. Chronologia sezonu gniazdowego. B, J, K — jeziora: Borzyszkowskie, Jasień, Kwiecko.]

Calculated date	1987	1988	1989
Commencement of earliest clutch (1)	18 V (B) – 2 VI (J)	13 V (B) – 28 V (J)	17 V (J) – 22 V (B)
— latest clutch (2)	1 VII (K) – 6 VII (B)	29 VI (J) – 2 VII (K)	27 VI (B) – 7 VII (J)
Hatching of earliest ducklings (3)	29 VI (B) – 25 VII (J)	18 VI (B) – 30 VI (J)	30 VI (B) – 4 VII (K)
— latest ducklings (4)	26 VII (B) – 7 VIII (J)	23 VII (B) – 3 VIII (K, J)	18 VII (B) – 5 VIII (J)
Approximate length of nesting season — no. of days between (1) and (4)	82 64 (B) – 76 (K)	82 68 (J) – 76 (K)	81 57 (B) – 81 (J)

seasons in different years for the three lakes taken together were very similar, at 81–82 days (Tab. 3).

European populations of the Tufted Duck do not differ excessively in the timing and chronology of the breeding period (Keller 1985). The onset of breeding in this species, as compared with other ducks, is relatively late. Laying usually begins in mid May throughout the breeding range, with April clutches being exceptional (Bauer & Glutz 1969). The greatest intensification in laying occurs after mid May and into June, though it may also extend into early July (Bengtson 1972, Boyd & Campbell 1967, Cramp & Simmons 1977, Fiala 1972, Górski & Wiatr 1986, Havlin 1966b, Hilden 1964, Keller 1985, Mednis 1968, Mlikovsky & Burič 1983, Newton & Campbell 1975, Stawarczyk 1995). The nesting season for the population studied here coincides with the timing given in the literature, with the earliest nesting associated with protection from Black-headed Gulls.

Clutch size

The clutches laid had 3–18 eggs, with 92.3% including between 6 and 14. Small and large clutches (< 6 and > 14) accounted respectively for 4.2 and 3.5% of the total (Fig. 2).

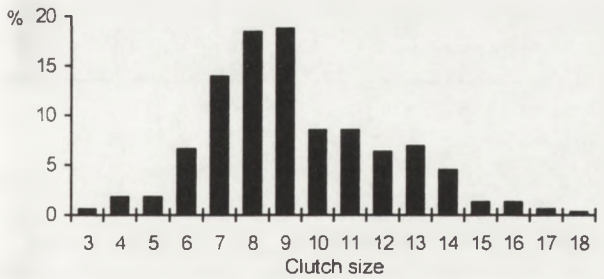

Fig. 2. Percentage (%) distribution of clutch size (n = 331 clutches).

[Ryc. 2. Procentowy rozkład wielkości zniesienia.]

Mean clutch sizes at different lakes in the different years (Tab. 4) ranged from 8.4 (L. Jasień, 1988) to 9.9 (L. Borzyszkowskie, 1988), and did not differ significantly either between lakes in a given year or between years in the studied populations (*t* test, Cochran-Cox test). The largest clutches on average were those at L. Borzyszkowskie (9.7 eggs), and the smallest those at L. Kwiecko (9.2), though the difference was not significant.

Table 4. Mean clutch size.

[Tabela 4. Średnia wielkość zniesień.]

Lakes	Season	x	SD	n
Kwiecko	1987	9.1	2.2	43
	1988	8.9	2.8	82
	1989	9.5	2.8	72
	1987–1989	9.2	2.7	197
Borzyszkowskie	1987	9.8	2.5	44
	1988	9.8	3.1	33
	1989	8.9	2.1	9
	1987–1989	9.7	2.7	86
Jasień	1987	8.7	2.5	9
	1988	8.4	3.2	11
	1989	9.7	2.2	28
	1987–1989	9.3	2.5	48
Total		9.3	2.7	331

Mean clutch size declined as the breeding season progressed (Tab. 5). The clutches noted in the first half of May were the largest, and were significantly larger than those commenced in the second half of the month. Clutches begun in the subsequent half-month periods of the season were in each case significantly larger than those begun after them (Tab. 5). Mean clutch size in the first half of May was 2 eggs greater than that for the second half of the month, while the further reductions

Table 5. Mean clutch size and progression of nesting season (combined data for three lakes). R — clutch size reduction (no of eggs) in comparison with previous half-month period; t — t-test, CC — Cochran-Cox test.

[Tabela 5. Srednia wielkość zniesienia w ciągu sezonu gniazdowego — dane łączne dla trzech jezior.]

Onset of laying	x	min–max	SD	n	R	P
1–15 May	13.2	13–14	0.5	4	–	–
16–31 May	11.3	7–18	2.6	56	2.0	p < 0.01 CC
1–15 June	9.6	3–17	2.5	125	1.7	p < 0.001 t
16–30 June	8.0	3–13	1.8	117	1.6	p < 0.001 CC
1–15 July	6.3	4–9	1.4	15	1.7	p < 0.001 t

between successive half-months were of 1.7 (second half of May/first half of June), 1.6 (first and second halves of June) and 1.7 (second half of June/first half of July). Thus the average clutch begun in July had 6.9 fewer eggs than that begun in the first half of May, a difference significant at $p < 0.001$ (Cochran-Cox test).

As in other parts of the breeding range (e.g. Bengtson 1972, Havlin 1966b, Hilden 1964, Mednis 1968, Mlikovsky & Burič 1983, Newton & Campbell 1975, Stawarczyk 1995), the mean clutch size in the studied population of Tufted Ducks varied between years, seasons and localities, albeit not statistically significantly.

Table 6. Nesting failures.

[Tabela 6. Straty gniazdowe.]

Lakes, years	Failed (%): nests	clutches
Kwiecko	43.7	46.6
Borzyszkowskie	36.3	35.2
Jasień	48.4	50.7
1987	44.3	45.0
1988	34.8	37.6
1989	48.9	52.4
Total	42.6	44.9

In the case of the Tufted Duck, an important cause of differences in clutch size may be multiple broods, of which the proportion increases with population density (Hilden 1964, Stawarczyk 1995). In the studied population, only 3.5% of clutches were large (> 14-egg) ones which could not be divided on the basis of differences in the degree of incubation. Like very small clutches (of 3–5 eggs), these were too infrequent to exert a significant influence on mean clutch size in the population. Inclusion resulted in a mean of 9.32 (SD = 2.67, n = 311), while exclusion gave a mean of 9.31 (SD = 2.21, n = 306). These values did not differ significantly (t test). Nevertheless, the mean clutch size given may still be considered somewhat exaggerated, because the methods applied did not allow for the discovery of single eggs, or eggs laid in small numbers — i.e. for precisely those cases accounting for most of the mixed broods in this species (Stawarczyk 1995).

Losses and the production of young

The incidence of failure (Tab. 6) was significantly lower at Lake Borzyszkowskie than at the other lakes (u test, $p < 0.01$).

For the three lakes taken together, the level of failure was lowest in 1988, at 34.8% of nests (Tab. 6). This level differed significantly from those noted in the other 2 years (u test, 1988:1987, $p < 0.01$; 1988:1989, $p < 0.001$). The results for 1987 and 1989 did not differ significantly.

Losses increased during the season (Fig. 3), being smallest in nests founded in May and greatest in clutches commenced in July, when they occured in 72.7% of nests at all 3 lakes combined were affected. The level of failure in successive months of the breeding season differed significantly (u test, Fig. 3).

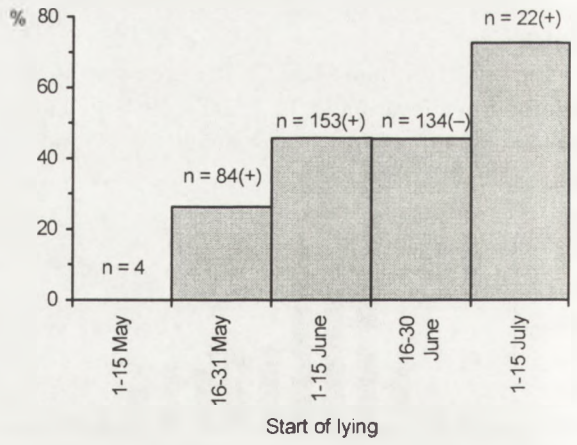

Fig. 3. Nest failures (%) with progress of nesting season (combined data). (+) — statistical signifcance in comparison with previous period (u-test).

[Ryc. 3. Straty gniazdowe (%) w ciągu sezonu gniazdowego (dane łączne).]

An inverse relationship was found between the level of failure (Tab. 6) and the density of nests (Tab. 2). The correlation coefficient for losses expressed as the percentage of affected nests was r = –0.511 (t test, NS).

49.1% of failed nests were destroyed or abandoned at the egg-laying stage, while 50.9% failed during incubation (Tab. 7). The major cause of losses was predation, with 71.4% of the clutches abandoned at the laying stage bearing traces of such damage, along with 52.6% of the broods being incubated. Losses attributable to predators should probably be augmented by all of the clutches which vanished without trace from nests being incubated (17.6% of clutches lost). A particular type of failure noted at Lake Kwiecko, but not elsewhere, involved the abandonment of nests due to flooding of part of the island during operations at the pumped-storage power station in Żydowo. Such losses accounted for 12.9% of all failures noted at this lake, and for 24% of the failures at the incubation stage.

Table 7. Types of nesting failures. ( ) — no.of nests with eggs destroyed by predators.

[Tabela 7. Rodzaje strat gniazdowych. ( ) — liczba gniazd z jajami uszkodzonymi przez drapieżniki.]

Season	No. of nests failed at:			
	Laying stage	Incubating stage		
	lost	lost	disappeared	flooded
1987	28 (28)	21 (14)	6	–
1988	23 (20)	17 (8)	–	8
1989	31 (22)	19 (8)	9	5
Total	82 (70)	57 (30)	15	13
%	49.1	34.1	9.0	7.8

Over the 3 years, partial losses affected 7.6% (L. Borzyszkowskie) to 13.6% (L. Kwiecko) of eggs in nests from which Tufted Ducks brought off young (Tab. 8). The most lost and unhatched egss were noted in 1987 at Lake Jasień (23.2% of all laid), and in 1989 at L. Kwiecko (19.2%).

On the basis of a u test with combined data for the three years, levels of partial losses were found to be significantly lower at Lake Borzyszkowskie than at Lakes Kwiecko and Jasień ($p < 0.001$).

Post-nest losses (i.e. those from the time of transfer of ducklings to the water up to the end of August) were relatively high and involved between 65.6% of ducklings (on Lake Jasień) and 92.4% of those at L. Borzyszkowskie over the three years combined (Tab. 9). Levels of loss at the different lakes varied markedly from year to year — between 20–30% and 80–95%. Total losses at the different lakes over the three years differed significantly (u test, $p < 0.001$).

Table 8. Partial losses in successful nests (%) — 1987–1989.

[Tabela 8. Straty częściowe (w %) w gniazdach, gdzie wykluły się młode.]

Lakes, years	Failed eggs (min–max)
Kwiecko	13.6 (10.1–19.2)
Borzyszkowskie	7.6 (4.6–10.3)
Jasień	13.2 (10.0–23.3)
1987	10.8
1988	8.2
1989	17.0
Total	11.8

Table 9. Duckling losses (%) — 1987–1989.

[Tabela 9. Straty pogniazdowe — w %.]

Lakes, years	Lost ducklings (min–max)
Kwiecko	76.5 (31.7–94.8)
Borzyszkowskie	92.1 (20.0–96.7)
Jasień	65.6 (30.4–80.5)
1987	64.2
1988	84.8
1989	88.5
Total	79.3

Post-nest losses were inversely correlated with the level of losses in the nest ($r = -0.801$, $p < 0.01$) — Fig. 4. This indicates that the greater the proportion of nests in which incubation ended successfully, the more drastic the subsequent loss of ducklings as the young grew up. This rule was well-illustrated by data from all three lakes.

The production of young varied between 2.8 (L. Kwiecko, 1987) and 0.2 (L. Borzyszkowskie, 1987), when expressed as the numbers reared to the end of August per female present at the start of the breeding season, and between 4.5 (L. Kwiecko, 1987) and 0.3 (L. Borzyszkowskie, 1987), when expressed as the numbers per statistical nest from the pool of the maximum number of nests occupied simultaneously (Tab. 10). The greatest variation in the production of young was noted at Lake Kwiecko (10–20 fold in

relation to the index considered), and the most limited at L. Jasień (a 3-fold range across the different years).

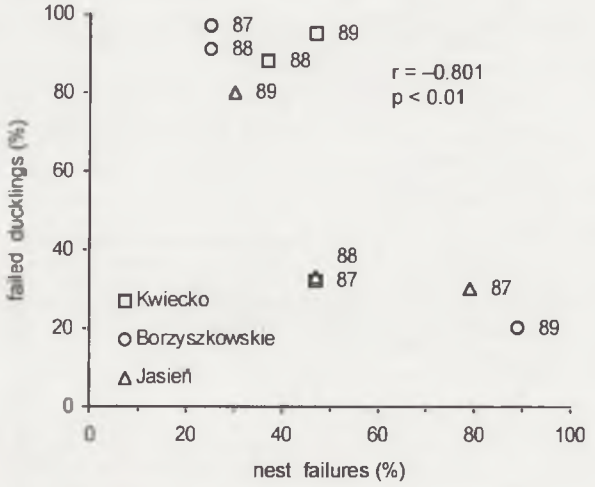

Fig. 4. Relationship between nast failures and proportions of ducklings lost. Data for 1987, 1988, 1989 (87, 88, 89).

[Ryc. 4. Zależność między wysokością strat gniazdowych i pogniazdowych. Dane z lat 1987, 1988, 1989 (87, 88, 89).]

Table 10. Production of young. B, J, K — Lakes: Borzyszkowskie, Jasień, Kwiecko — respectively.

[Tabela 10. Produkcja młodych.]

Three lakes	Mean number of young surviving up to end of August	
	per female	per nest
1987	1.6 (0.2 B–2.8 K)	2.3 (0.3 B–4.5 K)
1988	0.9 (0.7 K–1.6 J)	1.0 (0.7 K–3.0 J)
1989	0.6 (0.3 K–1.2 J)	0.6 (0.3 K–1.3 J)
Total	1.0 (0.2 B–2.8 K)	1.2 (0.3 B–4.5 K)

Losses from the nests of Tufted Ducks vary greatly from year to year and from place to place across the range (e.g. Bengtson 1972, Havlin 1972, Hilden 1964, Hill 1984, Keller 1985, Mednis 1968, Mlikovsky & Burič 1983, Newton & Campbell 1975, Stawarczyk 1995). The majority of these authors emphasized that the decisive factor was differences in the presssure imposed by nest predators, mainly *Corvidae*. The model for nest losses presented in Fig. 3 points to increased loss as the season progresses, but this is because nests were flooded by operations at the Lake Kwiecko power plant in the second half of the season, while visits to the islands by people were also more frequent in summer. Nests were sought most actively by corvids between the end of May and the middle of June, when the number of nests was great, but the vegetation not yet tall enough to prevent searches.

The significance of vegetation in influencing the nesting success of ducks has been underlined by many authors, including Duebbert & Kantrud (1974), Havlin (1966a, 1972), Hilden (1964) and Shranck (1972). It is worth noting that all the earlier nests — established before 15 May — at Lake Borzyszkowskie, had hatching success, in spite of the fact that the eggs had been laid before nests were concealed by vegetation. However, these nests were within the shield provided by the colony of Black-headed Gulls and were highly-dispersed, thus ensuring that searches for them by corvids would "not pay".

Although offering high rates of success for as long as gulls were present (75% with successful hatching), Lake Borzyszkowskie would seem to have constituted a kind of "ecological trap" for Tufted Ducks. The impressive hatching success did not continue into success in the rearing of young, because the near-complete lack of shoreline vegetation ensured that the lake gave no protection to family flocks and left losses among ducklings very high. Fig. 4 shows the inverse correlation between success in the nest and the survival of ducklings. Other authors (e.g. Bengtson 1972, Newton & Campbell 1975) have also confirmed dramatic reductions in the numbers of Tufted Duck ducklings by predators, in places where large numbers of families are gathered. For birds hunting ducklings, this kind of predation pays well, and further losses may be inflicted by predatory fish (like Pike *Esox lucius*) (Boyd & Campbell 1967, Hilden 1964). The weather provides a further serious (sometimes dominant) factor in the survival of ducklings (Bengtson 1972, Hilden 1964).

CONCLUSIONS

In the years of study, the breeding population of Tufted Ducks in the three most abundantly colonized lakes of Western Pomerania was considerably, more than by half, smaller than that in the years 1976–1983. Downward trends intensified further at the beginning of the 1990s (1990).

The production of young per statistical female and in relation to the maximum number of simultaneously occupied nests only exceeded 2 reared young/ breeding pair/year. Results above, together with literature data suggest that, in some areas of Europe, the quantitative maintenance of even a relatively large population of Tufted Ducks is dependent on immigration from other parts of the breeding range. This points to the necessity that breeding sites for the species be protected, as well as to the current problem with protecting this duck, which is hunted in many European countries.

Translated by dr. James Richards

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STRESZCZENIE

[Ekologia lęgów czernicy na Pojezierzu Zachodniopomorskim w latach 1987–1989]

Badano chronologię okresu lęgowego, liczebność populacji lęgowej, wielkość zniesień, rozmiary i przyczyny strat gniazdowych i pogniazdowych oraz produkcję młodych populacji gniazdujących na jeziorach Kwiecko, Borzyszkowskie i Jasień (woj. koszalińskie i słupskie) stanowiących w latach 70-tych i 80-tych główne lęgowiska czernicy w północno-zachodniej Polsce (Górski i Wiatr 1986, Górski 1991).

Jez. Kwiecko (83,5 ha) jest dolnym jeziorem elektrowni szczytowo-pompowej w Żydowie, w związku z czym poziom wody ulega tu znacznym wahaniom. W jeziorze występuje masowo racicznica *Dreissena polymorpha*, stanowiąca pokarm czernicy. Czernice gniazdują na jedynej wyspie (4,7 ha). Drapieżnikami były tu sroka i wrona siwa a potencjalnymi drapieżnikami piskląt — bielik, błotniak stawowy i kania rdzawa.

Jez. Borzyszkowskie (101,2 ha) ma brzegi prawie całkowicie pozbawione roślinności wynurzonej. Na jeziorze są dwie wyspy (2,6 ha i 0,7 ha). Czernice zasiedlały tylko mniejszą z nich, tworzącą pokryty roślinnością zielną pagórek, zajmowaną przez kolonię śmieszki, która jednakże porzuciła wyspę w ostatnim roku badań. Drapieżnikiem gniazdowym była wrona, a potencjalni drapieżcy kacząt to bielik i błotniak stawowy.

Jez. Jasień tworzą dwa zbiorniki (336,7 ha i 240,5 ha) z 8 wyspami całkowicie zalesionymi. Czernice zasiedlały wszystkie wyspy, gniazdując na ich obrzeżach. Drapieżnikiem gniazd była wrona siwa a do potencjalnych drapieżników kacząt należały bielik i błotniak stawowy.

Badania prowadzono od maja do końca sierpnia w latach 1987–1989. Liczebność populacji lęgowej oceniano na podstawie maksymalnej liczby samic obecnych na jeziorze u progu sezonu lęgowego (10 V – 14 VI) oraz maksymalnej liczby równocześnie czynnych gniazd. Przyjęto, że najwyższy wynik odzwierciedla liczebność lokalnej populacji lęgowej.

Od maja do połowy lipca (co 10–20 dni) wyszukiwano i kontrolowano gniazda na wyspach. Gniazda i jaja znakowano w terenie, a miejsca znalezienia gniazd zaznaczano na mapach. Stopień inkubacji jaj badano testem wodnym. W przypadku znalezienia w jednym gnieździe grup jaj różniących się stopniem inkubacji uznawano je za zniesienia różnych samic. Liczba jaj w gnieździe i stopień ich inkubacji pozwalały na określenie terminu rozpoczęcia składania jaj w danym gnieździe (metoda kalendarzy lęgowych). W przypadku strat gniazdowych notowano rodzaj i rzyczynę strat (porzucenie lęgu, uszkodzenie jaj przez drapieżniki, zniknięcie czy zalanie zniesienia). Sukces wyklucia przypisano tym gniazdom (zniesieniom), gdzie ustalono wylęg przynajmniej jednego pisklęcia.

Od połowy czerwca do końca sierpnia co dwa tygodnie jeziora opływano łodzią lub obchodzono pieszo zapisując stadka rodzinne i ich wielkość. Przyjęto, że młode, które przeżyły do końca sierpnia to ptaki odchowane i na podstawie ich liczebności wyliczono produkcję młodych i straty pogniazdowe.

Przy ocenie istotności statystycznej różnicy średnich obliczono różnicę wariancji testem F, a następnie, gdy różnice wariancji okazały się nieistotne stosowano test t-Studenta, natomiast gdy były istotne — test Cochrana-Coxa. Przy porównaniu dwu wyników z prób stosowano test u (Strzałko i Rożnowski 1992).

Na wszystkich jeziorach czernica gniazdowała wyłącznie na wyspach. Gniazda nie były rozmieszczone równomiernie. Na jez. Kwiecko 54% gniazd znajdowało się na pokrytych trawą stokach pagórka wyspy, 31% w porośniętej sosną i żarnowcem szczytowej części wyspy, a tylko ok. 15% gniazd umieściły czernice w zalewowej strefie wyspy. Na wyspie jez. Borzyszkowskiego 92,5% gniazd rozlokowanych było na obrzeżach wyspy, zajętych przez kolonię śmieszki. Na zalesionych wyspach jez. Jasień wszystkie gniazda ulokowane były w wąskim (do 0,5 m) pasie turzyc i pokrzyw w strefie brzegowej.

Najliczniejsza populacja lęgowa występowała nad jez. Kwiecko, najmniej liczna — na jez. Jasień (tab. 1). W pierwszych dwóch latach badań czernica stosunkowo licznie gniazdowała na jez. Borzyszkowskim, jednakże w roku 1989 nastąpił tam dramatyczny spadek liczby gniazd, związany z porzuceniem wyspy przez śmieszkę, która opuściła lęgowisko z powodu wybierania jaj przez ludzi. Najwyższe zagęszczenie gniazd czernicy odnotowano na wyspie jez. Borzyszkowskiego (tab. 2).

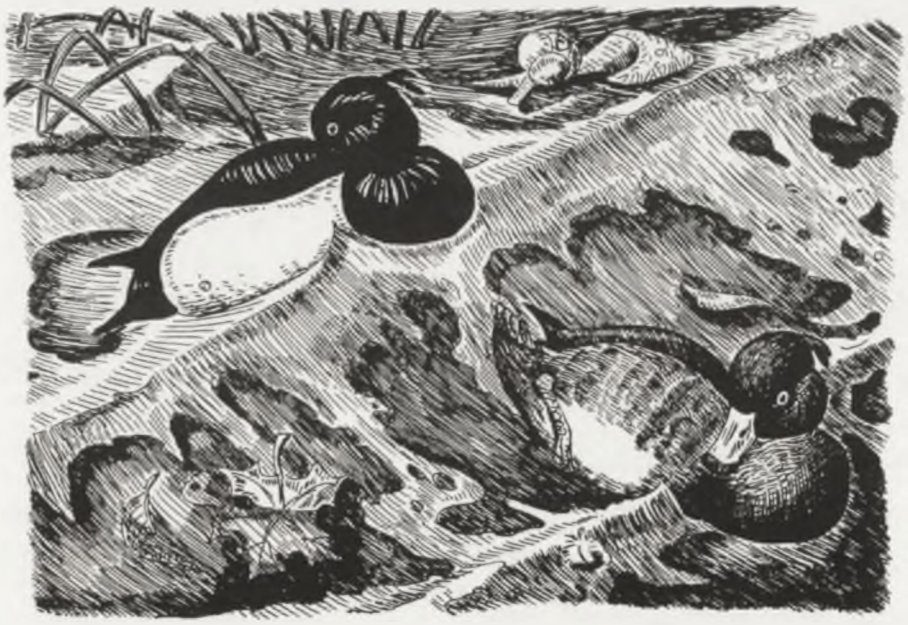
Sezon gniazdowy czernicy zaczynał się w połowie maja, najwcześniejsze inicjowanie zniesień notowano

w przypadku ptaków gniazdujących w kolonii śmieszki na jeziorze Borzyszkowskim. Składanie jaj trwało do początków lipca. Młode kluły się od drugiej połowy czerwca do początków sierpnia, najliczniej — w lipcu (tab. 3, ryc. 1). Wysiadywane zniesienia liczyły od 3 do 18 jaj (ryc. 2). Na średnią wielkość zniesień rzutowały najmocniej zniesienia liczące 6–14 jaj (92,3% wszystkich zniesień). Średnia wielkość zniesienia (tab. 4) zawierała się między 8,4 a 9,8 i nie różniła się istotnie pomiędzy badanymi populacjami, jak i w różnych latach w obrębie poszczególnych populacji.

Średnia wielkość zniesienia zmiejszała się wraz z upływem sezonu lęgowego (tab. 5) — redukcja wielkości zniesienia między majem a początkiem lipca wynosiła 6,9 jaj (różnica istotna dla $p < 0{,}001$).

Najniższe straty gniazdowe odnotowano na jez. Borzyszkowskim w latach gniazdowania kolonii śmieszki (tab. 6). Straty gniazdowe wzrastały wraz z upływem sezonu lęgowego (ryc. 3). Straty gniazdowe okazały się odwrotnie skorelowane z zagęszczeniem gniazd, jednak zależność ta nie była statystycznie istotna. Prawie połowa utraconych gniazd została zniszczona na etapie składania jaj, pozostałe — na etapie wysiadywania (tab. 7). Dominującą przyczyną strat było drapieżnictwo gniazdowe. Straty częściowe, w gniazdach, z których czernice wyprowadziły młode obejmowały w poszczególnych latach 5–23% jaj z udanych lęgów (tab. 8).

Straty pogniazdowe (tab. 9) były stosunkowo wysokie i mocno zróżnicowane w poszczególnych latach. Okazały się one odwrotnie zależne od wysokości strat gniazdowych (ryc. 4), co oznaczało, że w im większym odsetku gniazd wysiadywanie kończyło się sukcesem, tym drastyczniejsza redukcja piskląt następowała w okresie dorastania młodych. Produkcja młodych (tab. 10) osiągnęła poziom pozwalający utrzymać reprodukcję prostą tylko w roku 1987 na jez. Kwiecko i w roku 1988 na jez. Jasień. Poważne obniżenie liczebności lęgowej populacji czernicy na głównych lęgowiskach pomorskich (2–4 krotne w porównaniu ze stanem z lat 1976–1983) w latach badań i pogłębienie się tego zjawiska w roku 1990 (dane J. Karwackiego) może wskazywać na konsekwencje niskiej produkcji młodych dla dynamiki liczebności lokalnej populacji.



V World Conference on Birds of Prey and Owls (4–11 August 1998, Midrand (Johannesburg), Rep. of South Africa)

[V ŚwiatowaKonferencja n.t. Ptaków Drapieżnych i Sów]

The Conference is joint venture between the World Working Group on Birds of Prey and Owls, the Raptor Conservation Group of the Endangered Wildlife Trust, and Vulture Study Group. It will be hosted at the Eskom training and Exhibition Centre in Midrand, halfway between Johannesburg and Pretoria in Rep. of South Africa.

Lectures and posters will be presented during 5 days. One day (8 Aug.) has been set aside for excursions to sites where birds of prey can be viewed, and to the Wildt Cheetah Research Centre. Another day (9 Aug.) is planned for workshops, where interested parties can discuss matters concerning certain topics. Apart from the formal proceedings a number of special events are planned — e.g. the celebration of the Endangered Wildlife Trust 25th anniversary.

The Conference registration fee will be 150 British pounds and that will include meals, all printed matterials, etc. Accomodation priced from about 25 to 50 US dollars, will be of high standard. Shuttle services to and from the airport and business areas, will be available.

All participants of the XXII International Ornithological Congress are automatically invited for the Conference above.

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