

## Behaviour of Black-throated Diver *Gavia arctica* and Red-throated Diver *Gavia stellata* during autumn migration stopover

*Storlommens Gavia arctica och smålommens G. stellata beteende på en rastplats under höstflyttningen*

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### Abstract

The stopover behaviour of Black-throated Divers *Gavia arctica* and Red-throated Divers *Gavia stellata* during autumn migration was observed in two sites in Poland. Differences in time-activity budget and diving pattern were recorded from mid-October to mid-January of 2004 and 2005. A total of 1516 minutes of observation was achieved. Birds spent their time diving (60.7%), followed by preening (14.8%), surface swimming (12.5%), and other activities (12%). The feeding pattern of Red-throated Divers and Black-throated Divers was similar. Immature birds had significantly longer dives than adults and they made longer dive-pause intervals. This is suggested to be caused by the differences between age classes in

detecting and capturing prey. Moreover, our results show that, in autumn, first-year divers spent less time foraging than adult birds, instead spending more time resting and surface swimming.

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### Introduction

In Poland Black-throated Diver *Gavia arctica* and Red-throated Diver *Gavia stellata* are non-breeding, but regularly migrating species, and their autumn migration continues from the beginning of October to mid-December (Tomiałojć & Stawarczyk 2003). Numerous studies concerning different aspects of behaviour, feeding ecology and time-activity budgets have been made on Common Loons *Gavia immer* (e.g. Rummel & Goetzinger 1975, McIntyre 1978, McIntyre & Barr 1983, Barr 1996, Gostomski & Evers 1998, Nocera & Taylor 2000, Nocera & Burgess 2002). However, to our knowledge, no study has focused on the behaviour of Black-throated Diver and Red-throated Diver during the autumn migration. Feeding pattern is a most important component of the complex of adaptations known as stopover ecology and behaviour (Alerstam & Lindström 1990). The main aims of the study were to determine time-activity budgets and to detect the effect of age on diving performance of both species during the autumn migration stopover.

### Material and methods

The material was collected during fieldwork conducted at Zemborzycki Reservoir (51°10' N; 22°31' E, Lublin region) and Dobczycki Reservoir (49°52' N; 20°04' E, Małopolska region) in south-east Poland. Zemborzycki Reservoir has an area of 280 ha (maximum length 3850 m, maximum width 1350 m) with an average and maximum depth of 2.2 and 4 m respectively. The eastern part is surrounded with pine-oak forest and the western shore is adjacent to agricultural areas. Dobczycki Reservoir has an area of 970 ha (maximum length 9000 m, maximum width 1500 m) with an average and maximum depth of 10.2 and 28 m respectively. It is surrounded with mixed woods and agricultural areas. Both reservoirs lack big patches of emergent vegetation.

Diver behaviour was sampled using a 20–60×spotting scope and recorded using a held hand recorder. During the study from 1 to 8 Black-throated Divers and from 1 to 4 Red-throated Divers used a reservoir. Only one arbitrarily chosen individual was observed during an observational bout. Two age categories (adult and immature) of both spe-

cies were identified on the basis the differences in the plumage (Jonsson 1996). All birds were distinguished by scope from short distances (< 50 m). Birds were identified before the start of an observation bout and data from uncertain individuals (observed too short and/or from far distance) were not included in the analysis. The observations were conducted in stable weather without strong winds or rainfall. Continuous sampling methods were used for the behavioural study (Tacha et al. 1985). Observations were made between 17 October and 12 January in 2004 and 2005 for a total 1516 minutes (*Gavia arctica*: 987 minutes, *Gavia stellata*: 529 minutes) of arbitrarily distributed diurnal observation (N = 32 observations, mean observation time = 47.4 min. per bout, range = 11–109 min per bout, Table 1). Following Gostomski & Evers (1998) and Nocera & Taylor (2000), behavioural states were catalogued as diving (foraging), preening, surface swimming, resting, bathing and flying (take-off from a water surface). Start and finish of the behavioural states were collected with an accuracy of one minute. Time-activity budget was presented as the total amount of time spent by individuals in each activity (see Nocera & Taylor 2000). According to Strong & Bissonette (1989), a bird was considered foraging if the dive-pause interval was 120 s or less. In addition, the following behavioural events were observed and quantified (any behaviour typically lasting less than 5 s; see Martin & Bateson 1993): foot-wagging, stretching, splash-diving, peering, underwater peering and aggressive acts (Nocera & Taylor 2000). Due to the difficulty in distinguishing successful and unsuccessful dives (most prey are swallowed underwater – see Barr 1996) no data on diving success were recorded. During the study, a total of 734 dive durations and 686 dive-pause intervals were collected (with 1 s precision) for both species. Following Nocera & Burgess (2002), to normalise the distribution of the data for dive-pause periods and dive durations, the variables were log<sub>10</sub> transformed and differences tested by t-tests (Statistica 6.0, Statsoft, Inc. 2001).

## Results

During the autumn stopover period, divers spent their time diving (60.7%), followed by preening (14.8%), surface swimming (12.5%), and other

Table 1. The range and mean observation time per bout (seconds) in relation to age categories of Black-throated Divers *Gavia arctica* and Red-throated Divers *Gavia stellata* during the autumn migration stopover in south-east Poland.

*Dyktider (sekunder) i förhållande till ålder hos storlom och smålom på en rastplats i sydöstra Polen under hösten*

	<i>Gavia arctica</i>		<i>Gavia stellata</i>	
	Immatures	Adults	Immatures	Adults
Mean <i>Medel</i>	46.5	72.5	39.1	44.3
Minimum	11	23	15	21
Maximum	103	94	86	109
Number	15	4	9	4

activities (12.0%, Table 2). As a visually oriented predators, divers peer below the water surface in search of prey before diving in pursuit, and for both species the most frequent behavioural event was underwater peering (12.9 events per hr), followed by peering (5.5 per hr), splash-diving (3.9 per hr), stretching (2.8 per hr) and foot wagging (1.2 per hr). Aggressive behaviour between conspecifics was observed twice during this study (0.1 per hr). In both cases, an immature Black-throated Diver chased away another immature of this species. The average dive duration for adult Black-throated Divers was  $20.6 \pm 7.9$  sec ( $N = 199$ ) and for immatures  $25.5 \pm 14.2$  sec ( $N = 261$ ). This difference was statistically significant ( $t = 2.97$ ,  $P < 0.005$ ). The mean dive-pause interval differed between first-year (mean =  $17.8 \pm 19.1$  sec,  $N = 229$ ) and adult Black-throated Divers (mean =  $12.4 \pm 17.2$  sec,  $N = 190$ ,  $t = 4.30$ ,  $P < 0.0001$ ). The feeding pattern of Red-throated Divers was similar – young birds made longer dives (mean =  $26.6 \pm 11.6$  sec,  $N = 158$ ) than adults (mean =  $23.3 \pm 5.5$  sec,  $N = 113$ ,  $t = 1.82$ ,  $P = 0.07$ ) and they had longer dive-pause intervals (mean =  $15.3 \pm 16.1$  sec,  $N = 155$  vs mean =  $9.1 \pm 9.5$  sec,  $N = 112$ ,  $t = 4.90$ ,  $P < 0.0001$ ).

## Discussion

In this study, the most common behaviours were: diving, preening and surface swimming. First-year divers spent less time foraging than adult birds, instead spending more time resting and surface swimming. Moreover, this study showed marked differences in the diving durations between age classes. Adult divers had shorter dives and dive-pause intervals than young birds. Several studies have documented behaviour and diving pattern of divers and other bird species with similar foraging

Table 2. Percentage of time devoted to different activities by first-year and adult Black-throated Diver *Gavia arctica* and Red-throated Diver *Gavia stellata* during the autumn migration stopover in south-east Poland. Procent tid som används till olika aktiviteter av förstaårsungar och adulta individer av storlom och smålom under rastning på höstflyttningen i sydöstra Polen.

Behaviour Aktivitet	<i>Gavia arctica</i>		<i>Gavia stellata</i>		Total
	Immatures	Adults	Immatures	Adults	
Diving <i>Dykning</i>	46.8	79.6	63.4	79.2	60.7
Preening <i>Putsning</i>	14.2	17.6	15.3	11.3	14.8
Surface swimming <i>Ytsim</i>	18.1	0.7	14.2	6.2	12.5
Resting <i>Vila</i>	17.9	2.1	7.1	2.8	10.6
Others <i>Övrigt</i>	3.0	0	0	0	1.4
Total	100.0	100.0	100.0	100.0	100.0

habitats (Rummel & Goetzinger 1975, McIntyre 1978, McIntyre & Barr 1983, Pettay 1982, Wanless et al. 1988, Barr 1996, Mori 1997, Gostomski & Evers 1998, Nocera & Taylor 2000, Nocera & Burgess 2002). The majority of the authors found a time-activity budget hierarchy for non-breeding Common Loons that was similar to the one we found: foraging > preening > swimming > other (review in Nocera & Taylor 2000). Our results show that there were more marked behavioural differences between age classes than between species. Adult divers spent more time feeding during autumn stopover than first-year birds. Several factors could have caused these differences. It could be related to faster migration (shorter stopovers) of adult divers. Migrant behaviour at staging sites is mainly shaped by the aim to maximise food intake and fat deposition for onward flight (Alerstam & Lindström 1990). The theory assumes that during migration, adult birds move faster than immature, because they are more experienced and better prepared than naive birds (Fransson 1995). Another explanation may be related to the later migration of adult birds. There should be strong selective pressure on late migrants, which try to catch up with the earlier passage of conspecifics (see also Yosef & Chernetsov 2004).

The mean dive durations detected in our study were shorter compared to another study on Black-throated divers at the coast of northern Norway in deep water (range 44–95 sec; Pettay 1982). It has been assumed that dive duration is affected by dive depth during foraging (Mori 1997, Nocera & Burgess 2002). In this study, adult divers generally made short dives separated by very short pauses compared to first-year birds. It could be due to differences between age classes in detecting and capturing prey. It has been found that diving birds

lengthened the time spent in a dive to compensate for reduced foraging efficiency (Wanless et al. 1988, Mori 1997, Nocera & Burgess 2002). Unfortunately, we could not judge whether a dive was successful (see Material and methods) and data from this study does not give any support for the hypothesis.

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## Sammanfattning

Storlom och smålom flyttar regelbundet genom Polen men häckar inte. Under höstflyttningen rastar de från början av oktober till mitten av december. Med denna studie avsåg vi att kvantifiera deras tidsbudget, d.v.s. bestämma hur mycket tid de ägnade åt olika aktiviteter när de rastade, och vi ville undersöka om ettåriga och gamla fåglar skiljde sig åt när det gällde dykförmåga.

## Undersökningsområde och metodik

Studien utfördes i två vattenreservoarer, dels Zemborzycki i Lublinregionen, dels i Dobczycki i Malopolskaregionen. Den första är 3850 m lång, 1350 m bred, täcker 280 ha och har medel- och maxdjup på 2,2 resp. 4 m. Den andra är 9000 m lång, 1500 m bred, täcker 970 ha och har medel- och maxdjup på 10,2 resp. 28 m.

Observationer gjordes mellan 17 oktober och 12 december åren 2004 och 2005. Lommarnas beteende registrerades stickprovsvis med hjälp av tubkare (20–60 gångers förstoring och inom 50 m) och bandspelare. Under observationssessionerna fanns

1–8 storlommar och 1–4 smålommar närvarande. En godtyckligt vald individ följdes under varje session. Fåglarna åldersbestämdes till ungfåglar från samma år eller adulta. Registreringar skedde under 32 sessioner som i medeltal var 47,4 minuter långa och varierade mellan 11 och 109 minuter. Totalt skedde registrering under 987 minuter för storlom och 529 minuter för smålom. Vi kunde inte identifiera fåglarna individuellt och vet därför inte helt säkert om vi följde samma individ mer än en gång. Det var dock stor omsättning bland fåglarna, varför de 32 sessionerna nästan säkert motsvarar nästan 32 olika individer. Vi separerade följande beteenden: dykning (födosök), putsning (vård av fjäderdräkten), ytsim, vila, bad och flygning (lyfte från vattenytan). En fågel räknades som dykande (födosökande) om pausen mellan två dykningar var mindre än 120 sekunder. Det var inte möjligt att avgöra om en dykning var lyckad eller inte eftersom lommarna svalde sina byten under vattnet. Under hela studien registrerade vi 734 dykningar och 686 pauser mellan dykningar (med 1 sekunds precision). Dessa data normaliserades genom att tiderna logaritmerades, varefter t-test användes.

## Resultat

Lommarna tillbringade 60,7% av tiden med dykning, 15,8% med putsning, 12,5% med ytsim, och 12% med andra aktiviteter (Tabell 2). Eftersom lommar använder synen när de jagar, spanade ofta med huvudet ner i vattnet (12,9 gånger i timmen). Putsning utfördes också ofta (5,5 gånger i timmen). Aggressiva beteenden mot andra lommar noterades bara två gånger under hela studien. De genomsnittliga dyktiderna för storlom var 20,6 sekunder (199 dykningar) för adulta och 25,5 sekunder (N=261) för ungfåglar, en skillnad som var signifikant. Dykpauserna skilde sig också signifikant, 17,8 sekunder för ungfåglar (N=229) mot 12,4 för adulta (N=190). Skillnaderna hos smålom var likartade och signifikanta: ungfågeln hade genomsnittlig dyktid på 26,6 sekunder (N=158) och adulta 23,3 sekunder (N=113). Dykpauserna var 15,3 sekunder (N=155) för ungfåglar och 9,1 sekunder (N=112) för adulta. Sammanfattningsvis skiljde sig ungfåglar av båda arterna klart från gamla fåglar genom att ha både längre dyktider och längre pauser mellan dykningarna.

## Diskussion

I tidigare studier av lommar och andra dykande fåglar utanför häckningstiden har man funnit en

hierarki mellan olika aktiviteter som liknar vad vi funnit: längst tid ägnas födosök, och sedan kommer i ordning putsning, ytsim och övrigt. De dyktider vi registrerade var kortare än de som registrerats i en annan studie på djupt vatten utanför Norge (44–95 sekunder), varför vattendjup sannolikt spelar en roll. Sikt och tillgång på föda är också av betydelse, och man har funnit att dyktider kan förlängas vid försämrade födosöksbetingelser. Tyvärr har vi inga uppgifter om bytestillgång och fiskelycka i vårt

fall. Vår studie visade dock tydligt att det var större skillnad mellan åldersklasserna än mellan arterna. Skillnaden mellan åldersklasserna skulle kunna påverka flyttningshastigheten. Under rastningen är maximering av födosöket en nyckelfaktor. Eftersom de unga fåglarna visade sämre jaktförmåga i form av längre dyktider och längre pauser mellan dykningarna, kan de gamla fåglarna lämna en rastlokal snabbare än de unga och därmed genomföra en snabbare flyttning.