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AGE STRUCTURE OF THE LONG-EARED OWL (*Asio otus*) MIGRATION AT BUKOWO-KOPAŃ STATION (SOUTHERN BALTIC COAST) IN AUTUMNS 1996-2003

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ABSTRACT

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Over 2000 Long-eared Owls were caught (217 adult and 1827 immatures) at Bukowo-Kopań station (54°21'N, 16°17'E / 54°28'N, 16°25'E), in the central part of the Polish Baltic coast, during autumn seasons 1996-2003. Migration of this species had wave-like pattern with three distinguished passage waves. There were differences between young and adult birds passage in subsequent passage waves (statistically significant only in autumns 2000 and 2003, in other seasons they were non-significant. The value of χ^2-test calculated for all seasons together was high and differences were significant (χ^2 = 10.96, p < 0.01). Generally, very high variation must be stressed. Young birds dominated during autumn migration (on average they constituted 89%) but this number varied distinctly in different years. The immatures were the most numerous in the second and third wave (they were especially numerous in the third wave in years with the highest number of caught birds). Adult owls migrated a bit earlier – average passage data was earlier by 1 to 16 days in various seasons. All data point at very high variability of the Long-eared Owl migration and necessity of deeper studies on this phenomenon.

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INTRODUCTION

Knowledge of the Long-eared Owl migration is rather rough and fragmentary. It is known that this owl species is mostly sedentary in southern parts of its distribution range and migratory or even nomadic in the north – over 50°N (Mikkola 1983, Cramp and Simmons 1985, Glue and Nilsson 1997, Scott 1997). First-year birds predominate during autumn migration because of their lower site fidelity than adult ones, and usually disperse widely from the breeding place (Cramp and Simmons 1985, Glue and Nilsson 1997). On the other hand young birds can stay in the territory even two months after fledging or occasionally until the following year (Cramp and Simmons 1985). Most of these postnatal dispersions are short distance passages, but some long distance movements were observed: over 2000 km (Cramp and Simmons 1985) and 3279 km (Scott 1997). The Long-eared Owls migrate in autumn to SW, S (Cramp and Simmons 1985, Dobrynina 1994) and SE (Dobrynina 1994). Finnish birds, which fly in most cases in S and SE directions, often stay for winter in Karelia, Leningrad, Zaroslavl and Penza regions, Belarus and Ukraine or winter on the northern coast of the Black Sea. Individuals, which move to SW, spend winter in Poland, Germany, Czech Republic, Slovakia, Holland, northern Italy (Dobrynina 1994) or even in northern Spain (Cramp and Simmons 1985). Owls wintering in Britain are mostly Fenno-Scandian birds (Cramp and Simmons 1985, Harvey and Riddiford 1990). Birds caught at Bukowo-Kopań station originate from the Baltic Republics and Scandinavia while their winter-quarters cover northern part of Germany, Belgium, Holland and France (Busse and Busse 2003). In the east and central Europe passage of these owls starts in October and lasts till first half of November. Their migration has wave-like pattern with few peak days after nights with no individuals caught (Michalonek *et al.* 2004).

Such general information is not enough to understand model of the Long-eared Owl migration. Till now there is no information on age structure of passing birds. It is known that different taxonomic groups of birds have various migration age structure. Adult waders migrate earlier than immatures (Meissner 1996, 1997; Krupa 1997, Gromadzka and Serra 1998, Meissner and Koziróg 2000, Meissner and Ściborski 2002) and often have shorter migration routes (Gromadzka and Serra 1998). The same, in some raptor species adults can start migration earlier, *e.g.* the Hen Harrier *Circus cyaneus* (Vogrin 1997), the Common Buzzard *Buteo buteo* (Kjellen 1999), the Short-toed Eagle *Circaetus gallicus* (Urcun and Kabouche 2003), or there is no statistically significant difference in migration time between age categories – the Montagu's Harrier *Circus pygargus* (Bengtsson and Jonzen 2001). Percentage of migrating adult and young birds can be various in different species or larger taxonomic groups as well. There are many reasons for these differences, *i.e.* breeding success – including such factor as rodent number fluctuation in northern Scandinavia (Kjellen 1998), breeding site fidelity of adult birds, passage strategy – *e.g.* less tendency of adults to follow guiding lines (Kjellen 1998) or coastal effect in passerine birds as discussed by Payevsky (1998). The aim of this paper is to find and understand relation between migration of age categories in the Long-eared Owl.

MATERIAL AND METHODS

Data were collected at Bukowo-Kopań station (54°28'N, 16°25'E), in autumns 1996-2003. Owls were caught in raptor nets (mesh sizes 45-80 mm), ringed and measured according to the Operation Baltic standards (Busse and Kania 1970). In total 217 adult and 1827 immature birds were caught. Immature bird category includes the first- and second-year birds (aged according to plumage characteristics). These two groups were analysed together because young birds were aged so precisely only from year 2000. In 1997 and 1998 number of caught owls was very low so it was necessary to exclude these years from some detailed analyses.

Seasonal migration dynamics of the above age categories was analysed and presented. As the owl migration is much differentiated in subsequent nights (very high catches separated by lack of migration) that make lower catches invisible on a graph, we present daily dynamics as smoothed using moving 5-day average (Fig. 1). We distinguished three general passage waves during autumn migration. In subsequent years these can be few days earlier or later – so we defined time of them for each year separately. We used χ^2-test to check whether a share of the age categories in the passage waves differed. We made calculations both for each season separately and for the whole studied period (1996-2003). We calculated values of χ^2-test for waves in autumns 1996-2003, but without year 2000 (601 owls caught) and 2002 (736 owls caught) to exclude influence of these extremely numerous seasons that could dominate the results. To find relation between age and migration time, we calculated median and average passage date for both age categories in a standard

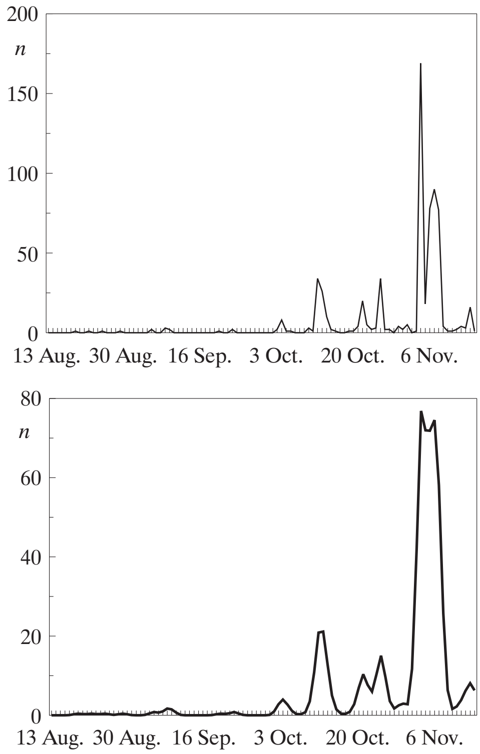

Fig. 1. Raw data (above) and smoothed migration patterns (below) of the Long-eared Owl migration in 2002. Note better visibility of low migration peaks at the beginning of the passage at the lower panel.

period (Busse and Kania 1970) *i.e.* from 15 September to 2 November. Bar type charts were prepared to analyse percentage relation between young and adult birds in each passage wave for each season from 1996-2003.

RESULTS

Immature birds dominated during autumn migration of the Long-eared Owls in the south coast of the Baltic Sea (Table 1). On average adult share was only 14.5% of all caught birds but this number varied distinctly in different years. The highest percentage of adult owls was recorded in 1997 – 30% but the number of caught birds was very low as well ($N = 27$). In average years when number of caught owls was *ca* 140-190 individuals, percentage of adults varied from 10.2% (1999) to 16.5% (2001). The lowest share of young owls was noted in 2000 – 4% when the number of caught birds was very high.

Table 1
Numbers of immature and adult Long-eared Owls caught at Bukowo-Kopań station in autumns 1996-2003. Percent shares of adults are given.

	Total	*Imm.*	*Ad.*	*Ad.%*
1996	147	124	23	15.65
1997	27	19	8	29.63
1998	8	2	6	-
1999	147	132	15	10.20
2000	601	577	24	3.99
2001	188	157	31	16.49
2002	736	653	83	11.28
2003	190	163	27	14.21
All years	**2036**	**1825**	**211**	**14.49**

General migration pattern of the Long-eared Owl by age categories is shown in Figure 2. The Figure 2 comprises two panels – the upper panel illustrates the migration pattern using raw data (sum of numbers of individuals caught daily in all years of the study), so dynamics of the passage in the most numerous years has bigger influence on general pattern than in these when number of owls was low. The lower panel presents averaging of yearly dynamics expressed in percents of the yearly catches – thus it gives more weight to years with the lowest catches. Differences observed between these two patterns suggest that the migration pattern depends on numbers of migrating owls.

Adult birds were caught at Bukowo-Kopań station mostly in the middle of migration period, *i.e.* from 11 to 28 October. That means that the highest number of adult birds migrate in the second passage wave. It is well visible when we take a look at distribution of adult owls in following waves (Table 2) – on average over 56 per-

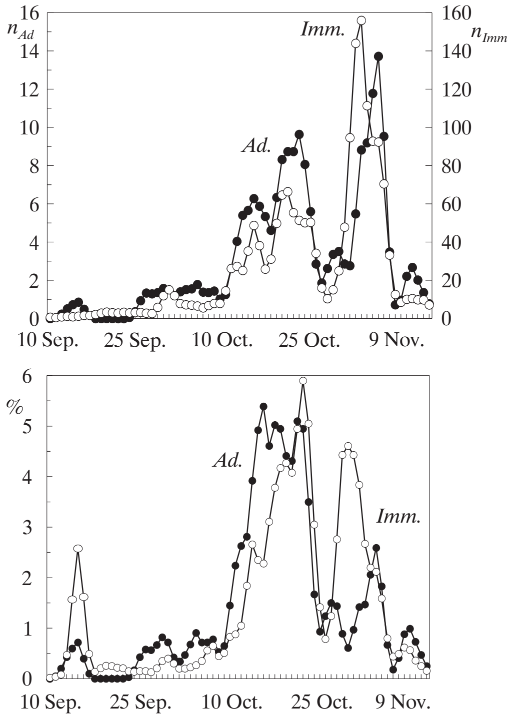

Fig. 2. General autumn migration dynamics pattern of adult and young Long-eared Owls at Bukowo-Kopań station. Raw data (above) and average percent distributions (below).

Table 2
Percent distribution of adult Long-eared Owls
in migration waves in autumns 1996-2003;
N – number of adults in the year; I, II, III – passage wave

	N	I	II	III
1996	23	0.00	65.22	34.78
1997	8	12.50	87.50	0.00
1998	6	16.70	83.30	0.00
1999	15	20.00	66.67	13.33
2000	24	50.00	16.67	33.33
2001	31	9.68	90.32	0.00
2002	83	10.84	7.23	81.93
2003	27	0.00	59.26	40.74
Total	**211**	**14.72**	**56.12**	**29.16**

cent were caught in the second wave. Young birds are numerous in the second wave also, but their number in the third wave is as high as in the second one or even higher (Table 3). It should be stressed that both age groups show extremely high fluctuations of the seasonal migration patterns (Fig. 3).

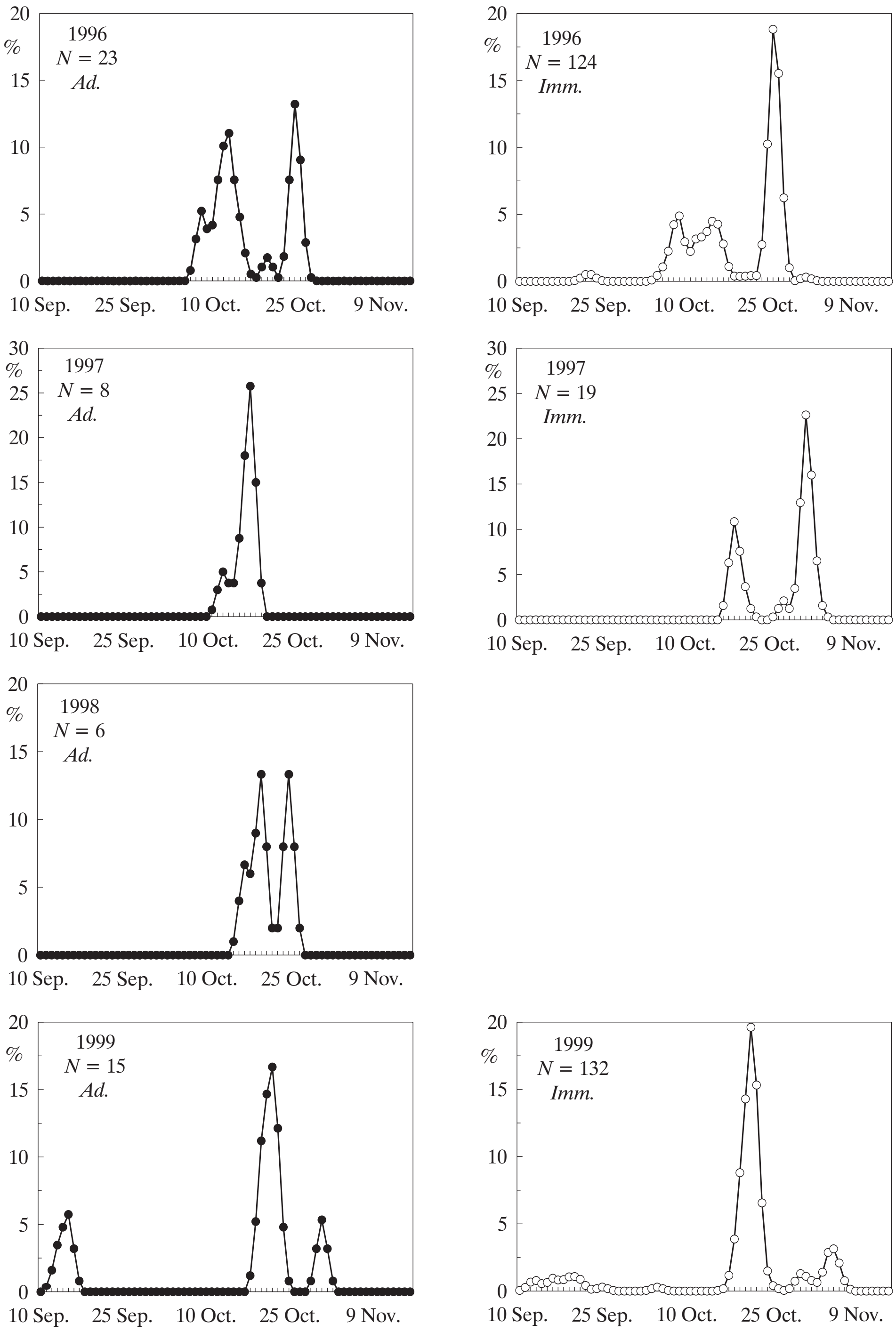

Fig. 3. Autumn migration dynamics patterns of adult (*Ad.*) and young (*Imm.*) Long-eared Owls at Bukowo-Kopań station in 1996-2003.

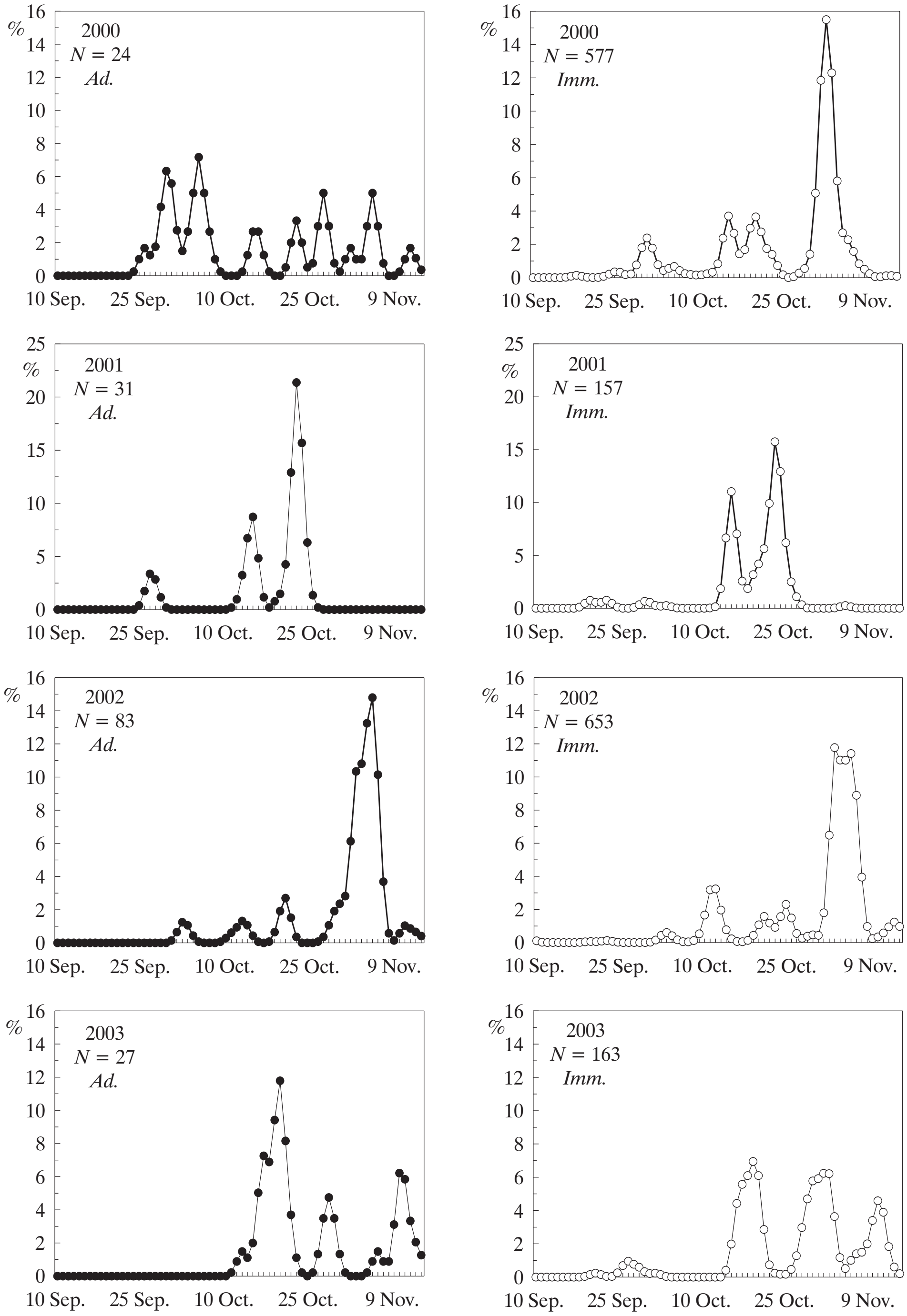
%
2000
N = 24
Ad.
2000
N = 577
Imm.
2001
N = 31
Ad.
2001
N = 157
Imm.
2002
N = 83
Ad.
2002
N = 653
Imm.
2003
N = 27
Ad.
2003
N = 163
Imm.
10 Sep.
25 Sep.
10 Oct.
25 Oct.
9 Nov.

Table 3
Percent distribution of immature Long-eared Owls
in the migration waves in autumns 1996-2003;
N – number of immatures in the year; I, II, III – passage wave

	N	I	II	III
1996	124	1.61	42.74	55.65
1997	19	0.00	31.58	68.42
1998	2	-	+	-
1999	132	12.88	71.97	15.15
2000	577	11.79	26.86	61.31
2001	157	6.37	92.99	0.64
2002	653	15.77	11.33	72.89
2003	163	4.91	35.58	59.51
Total	**1825**	**7.62**	**44.72**	**47.65**

Seasonal migrations patterns (1996-2003) of adult and immature Long-eared Owls can be divided into three waves. There are some differences in timing of corresponding waves in several years but generally the first wave is very low and lasts till the beginning of October, the second one starts in the middle of October and continues to the end of this month and the third wave occurs in the first half of November. In all years adult owls were caught mostly during second wave period, with exception of 2002 when their highest number was observed during the third one. They comprised 81% of all adults caught in that year (Table 2). The share of adult and young owls in following passage waves is shown in Figure 4. Immature birds dominated in all passage waves (except autumn 1997). Percentage of adult birds was the highest in the first or second wave (except autumn 2002) and immatures in second and third (except years 1996, 2002 and 2003).

Differences between shares of adult and young birds in passage waves in following passage waves were statistically significant only in autumns 2000 and 2003 (Table 4), in other seasons they were non-significant and for 1999 and 2001 values of χ^2-test suggested rather similarity than differentiation of migration of both age

Table 4
Comparison of adult/immature proportion in passage waves
in the studied years (years with low numbers of owls are excluded);
χ^2 – value of χ^2-test, *p* – level of significance.
Statistically significant differences ($p < 0.05$) are given in bold.

	χ^2	*p*
1996	3.7	p < 0.1
1999	0.6	p < 0.9
2000	**29.2**	**p < 0.001**
2001	0.3	p < 0.9
2002	3.1	p < 0.3
2003	**4.5**	**p < 0.05**

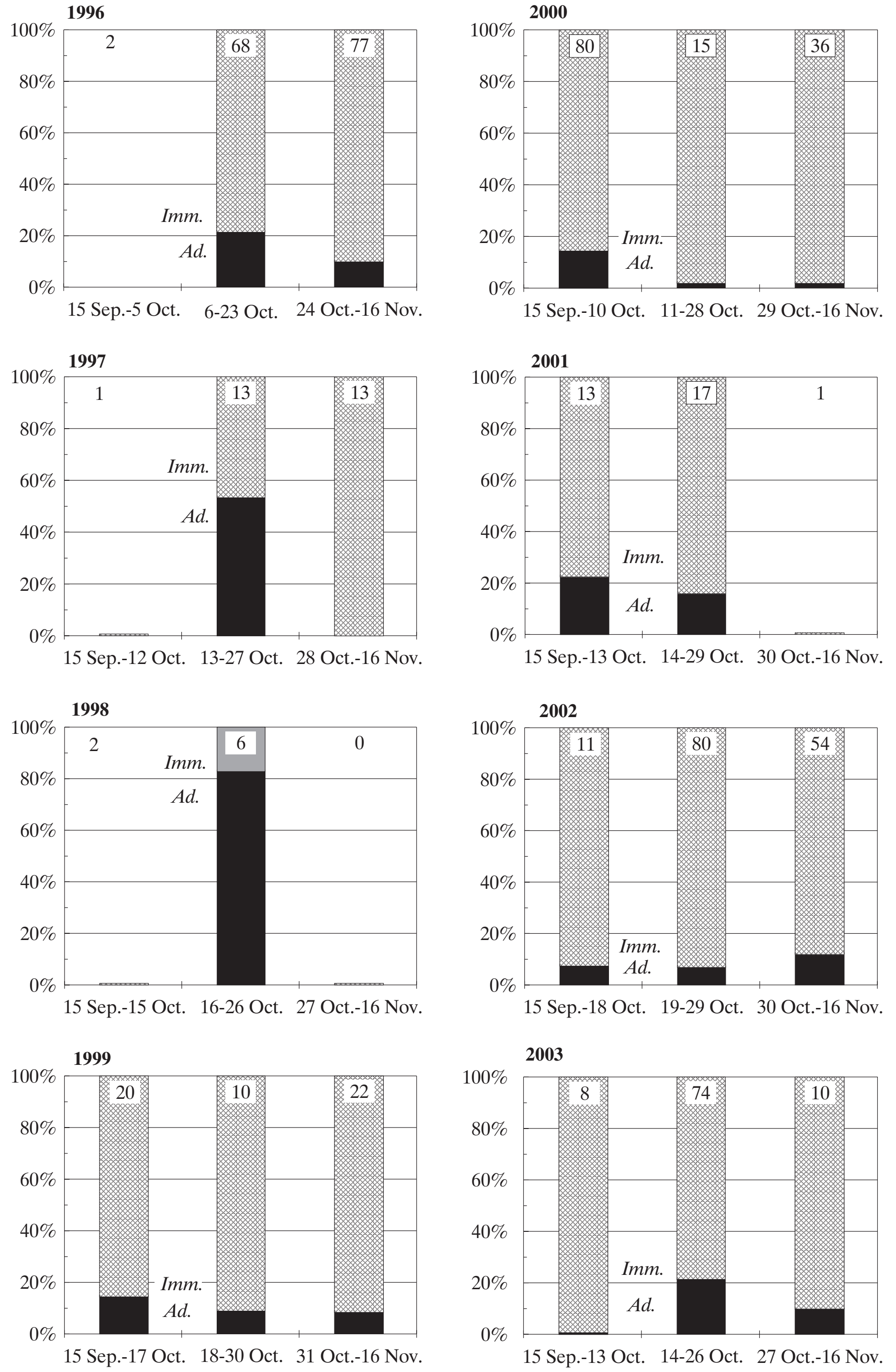

Fig. 4. Share of adult (*Ad.*) and young (*Imm.*) Long-eared Owls caught at Bukowo-Kopań station in autumns 1996-2003. Sample numbers are given.

groups. This could be due to too low number of individuals from one age category in analysed passage wave (first or third migration wave). But when we calculated χ^2-test for all seasons together, the value was high and differences were statistically significant ($\chi^2 = 10.96$, $p < 0.01$). To make sure that two most numerous years did not dominate the results, we excluded them from calculations but differences between passage waves were still significant ($\chi^2 = 9.01$, $p < 0.02$). These discrepancies suggest that the pattern of the owl migration is unusually variable and it must be studied in more detail.

The same, average passage dates showed that migration time varied between seasons very much but, as a rule, adult birds migrated earlier (from 1 to 16 days) or in the same time as young did (in 2001 and 2002) – see Table 5. Also median dates calculated for standard period in each season were in adults generally earlier or the same as in young owls. It is of interest to note very late median date in 2002 (8 days later than in young owls), while mean date calculation did not show the same. It was the year when extremely high number of owls was caught at Bukowo-Kopań station.

Table 5
Average passage dates and median passage dates of adult (*Ad.*) and immature (*Imm.*) Long-eared Owls at Bukowo-Kopań station; *N* – number of all birds in the year, Diff. – difference in days

	Total	Average			Median		
	N	*Ad.*	*Imm.*	Diff.	*Ad.*	*Imm.*	Diff.
1996	147	17/18 Oct.	19/20 Oct.	**+ 2**	14 Oct.	26 Oct.	**+12**
1997	27	10/11 Oct.	27/28 Oct.	**+17**	18 Oct.	1 Nov.	**+14**
1998	8	11/12 Oct.	5 Oct.				
1999	147	15/16 Oct.	17/18 Oct.	**+2**	22 Oct.	22 Oct.	**0**
2000	601	10/11 Oct.	19/20 Oct.	**+9**	6 Oct.	21 Oct.	**+15**
2001	188	19/20 Oct.	19/20 Oct.	**0**	24 Oct.	22 Oct.	**-2**
2002	736	15/16 Oct.	15 Oct.	**0**	22 Oct.	14 Oct.	**-8**
2003	190	21/22 Oct.	22/23 Oct.	**+1**	21 Oct.	21 Oct.	**0**
All years	**2036**	**15/16 Oct.**	**18/19 Oct.**	**+3**	**20 Oct.**	**21 Oct.**	**+1**

DISCUSSION

The share of immature birds was generally higher than of the adults, with the exception of 1998 year, but the number of caught birds was extremely low in this year. The highest percentage of immature owls occurred especially in years when the highest numbers of birds were caught (autumns 2000 and 2002). In general most of immature birds migrated in the third passage wave that was well pronounced in most numerous years (Michalonek *et al.* 2004). Only in years 1996, 2002 and 2003 the share of young owls was the highest in the first passage wave but still their number was the highest in the last wave. In these seasons migration pattern was a very special one – 100% of adult and over 90% of immature birds were caught in the second and third passage wave. Exceptionally high percentage of adult Long-eared Owls in third wave in 2002 could probably result from low food abundance at the breeding site after very successful breeding season in that year. In that year at Bukowo-Kopań station the highest number of the Long-eared Owl for the whole studied period was caught (*N* = 736). It is possible that adults, which show stronger breeding site fidelity than young ones (Cramp and Simmons 1985, Glue and Nilsson 1997), migrate in higher numbers only when food resources are too scarce to survive. Number of late adult migrants could be correlated with sex structure of migrating birds – males have stronger site fidelity (Harvey and Riddiford 1990) so probably they leave breeding territory only in extremely bad conditions.

The Long-eared Owl has on average 3.02 young per pair in successful nests (failed nests not counted) so the real breeding success is unknown (Scott 1997). If we assume that 3 young per pair survive and all birds migrate we should observe 40% of adults during migration as in passerine birds (Payevsky 1998). At Bukowo-Kopań station adults were on average 14.5% what means that they should bring up almost twelve young each season – that is impossible. Some other factors influencing such low number of adult birds must exist. First of all, second-year birds which are treated as young ones, should be probably analysed separately. Such analysis was not possible in this study due to the fact that birds were aged so precisely starting only from year 2000. It is possible that these individuals should be treated as adults, because second-year birds can breed (Cramp and Simmons 1985). Taking this into account: first – the proportion of adults would be higher and second – if they have their own nestlings then this would change age ratio as well. Further studies are necessary. Another factor, which can influence number of young birds, is that the Long-eared Owl can have second brood in years when food abundance is good (Cramp and Simmons 1985). We also cannot say that this owl represents typical migratory species because it is known that especially adult males show tendency to breeding site fidelity. So if adult males do not leave breeding grounds as was shown in Norway (Harvey and Riddiford 1990) then adults should make only a 25% of birds caught during autumn migration. From our experiences we know that some adult males do migrate as we caught them several times at the Polish coast of the Baltic Sea. Further studies on sex structure of migrating birds are necessary. If we assume that adult males are sedentary and only half of adult females migrate, then we should have 14.3% of adults out of all caught birds. As we can see in years 2001 and in 1996, when the highest proportion of adult birds was observed: 16.5% and 15.6%, respectively, these numbers exceed the assumed one, but not too much. This could mean that a little bit more than a quarter of adults take part in autumn migration. In year 1997 adult birds comprised 29.6% but in this year really low number of owls were caught (*N* = 27). Moreover, there is possibility that low number of adult birds can be a result not only of breeding site fidelity but additionally of a tendency to have shorter migration routes, like *e.g.* in the Rook *Corvus frugilegus* (Busse 1969), in the Grey Plover *Pluvialis squatarola* (Gromadzka and Serra 1998), or in large number of medium- and short-distance migrants – gulls, raptors (Berthold 1993). It is known that the further south, the more adult birds stay in territories (Mikkola 1983, Cramp and Simmons 1985, Glue and Nilsson 1997, Scott 1997, Kjellen 1999) so probably adult birds caught at Bukowo-Kopań are only long-distance migrants from the North and local birds are sedentary, in the case of local young ones we catch individuals on post fledging dispersal. It is possible that this is the main reason of low proportion of adult birds.

Constant high proportion of immatures of raptor species caught at the ringing stations can result from the fact that adults are resident as in such species like Red Kite (*Milvus milvus*) – 80% *imm.*, and Goshawk (*Accipiter gentilis*) – 96% *imm.*, or adults can show less tendency to follow guiding lines, they migrate in a wide front like *e.g.* Marsh Harrier (*Circus aeruginosus*) – 78% *imm.*, Hobby (*Falco subbuteo*) – 87% *imm.*, or Merlin (*Falco columbarius*) – 87% *imm.* (Kjellen 1998). But number of owls caught fluctuated between seasons distinctly from 27 in 1997 to 610 in 2002. When such big difference is observed, we can suspect that there is another reason of such high proportion of young birds during autumn migration. Probably mechanism is the same as in the case of the Hen Harrier (on average 58% of immatures migrate, this number varies from 40 to 70% in different seasons) and the Rough-legged Buzzard (*Buteo lagopus*) (resp. 23%: 5-35%). These species are extra dependent on voles cycles in tundra – breeding success is closely interrelated with small mammals abundance and this is the reason of high percentage of young birds and various number of autumn migrants each year (Kjellen 1998). In northern Finland the relation between the breeding success and vole cycles is so strong that nomadism is promoted – birds, like the Short-eared Owl (*Asio flammeus*) and others are forced to look for places where food is abundant in a given season. They could breed on average only twice in whole life if they stay in one place and wait for high vole density (Virkkala 1992).

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