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DAYTIME ACTIVITY OF REED PASSERINE BIRDS BASED ON MIST-NETTING

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Capture rates of eight reed passerine birds in relation to time of day were studied in the late breeding periods of 1999–2004 in National Nature Reserve Parížske močiare marsh (SW Slovakia). Based on 3700 captures, significant differences in mean capture times were found among species in both morning and evening. Capture rates of birds differed significantly also between the first and last 5 hours of daylight. Moustached Warbler, Sedge Warbler and Bearded Tit were most active in the morning, and Marsh and Reed Warblers in the evening. Adult daily activity differed considerably from that of juvenile in Bearded Tit, Reed and Moustached Warblers. We suggest that only morning sampling alone does not give an accurate estimate of relative abundance and age structure of reed passerines in mist-netting studies. A recommended regime would be to begin netting four hours before sunset and continue four hours after sunrise the next day on each visit.

Key words: capture efficiency, bird activity, Savi's Warbler, Reed Bunting

INTRODUCTION

Mist-netting is commonly used as a valuable tool for monitoring bird population (DUNN & RALPH 2004). However, this method is strongly limited by potential bias in sampling. The type of nets, e.g. mesh size and colour (HEIMERDINGER & LEBERMAN 1966, PARDIECK & WAIDE 1992), visibility and weather conditions (JENNI *et al.* 1996), species and habitat (JENNI *et al.* 1996, LÖVEI *et al.* 2001) all influence capture rates. Bird activity is generally greatest in the morning and late afternoon/early evening and significant variations in diurnal activity exist among species (DESLAURIES & FRANCIS 1991). While these patterns are well known in forest or grassland birds (for references see above), there are only a few studies that investigated the effect of time of day on capture efficiency of mist-nets in reedbed passerine birds. ORMEROD (1990) found almost identical capture times for Reed Warbler *Acrocephalus scirpaceus* and Sedge Warbler *Acrocephalus schoenobaenus*, indicating peaks of activity immediately after dawn and GYURÁCZ *et al.* (2004) found significant differences in the diurnal activity of adult and juvenile Sedge Warblers.

The aim of this study was to examine the influence of time of day on the capture rates of eight reedbed passerine birds at the end of breeding period and determine whether significant inter- or intraspecific differences in diurnal activity patterns exist.

METHODS

The study was conducted in the National Nature Reserve Parížske močiare marsh located in the Danube Lowlands in south-western Slovakia (47°52'N, 18°30'E). This area is one of the largest wetlands in Slovakia, and is located in a shallow depression of the brook Paríž. The vegetation is dominated by stands of common reed *Phragmites australis* and reedmace *Typha* spp. and willows *Salix* spp. The total area of the reserve is 184 ha, of which 144 ha is marshland and the rest consists of other habitat types. The elevation ranges from 120 to 125 meters above sea level.

Data were collected in the late breeding periods of 1999–2004. Over this time, 180–250 m of nets were set daily in SE part of the reserve from 24 June (in 2001) until 11 July (in 2004), giving a total of 9907 net-hours. To eliminate the effect of weather, nets were operated only under dry, windless and low cloud or cloudless conditions. The nets were opened before daylight and closed after dusk every day, and checked at regular 30–60 minutes intervals depending on number of mist netted birds (the first control was done before sunrise and the last after sunset). To standardise our data we used capture rates calculated as absolute number of birds/length of nets (m) × number of hours they were open (number of birds captured m^{-1} h^{-1}). All captured birds were identified to species, aged, sexed if possible, ringed and released about 400 m from the nets immediately thereafter. Time of capture was recorded after every net control. For comparison of morning and evening activities, the times of captures were standardised as 5 h after sunrise and 5 h before sunset. Pearson correlations did not show differences in the daily activity of birds between years and data from all years were pooled.

Statistical analyses of data were conducted using standard tests in Statistica (StatStof, Inc. 2001) and SPSS 11.0 programmes. Data were compared with ANOVA and subsequent post-hoc Scheffé test, nonparametric data with traditional χ^2-square test or Fisher exact test for smaller sample size and Mann-Whitney U test.

RESULTS

In 1999–2004, a total of 3 700 birds were caught between the end of June and early of July. Capture rates showed two activity peaks, one in the morning and one in the evening (Fig. 1). The highest number of birds was caught between first and second hours after sunrise (i.e. about 06:00 and 07:00 CET of daylight savings time) and a smaller one between the third and fourth hour before sunset (19:00 and 20:00 CET). There were significant differences among species in both morning and evening mean capture times (ANOVA, $F_{7, 1375} = 5.551$, $P < 0.001$ and $F_{7, 476} = 2.422$, $P = 0.019$, respectively, Fig. 2). Bearded Tit *Panurus biarmicus* was active later than other reed passerines except for Moustached Warblers *Acrocephalus melanopo-*

Table 1. χ^2 comparison of morning vs. evening activities between individual reedbed passerine species in National Nature Reserve Parížske močiare marsh in the late breeding periods of 1999–2004. Statistical significance of each model: * – P < 0.05, ** – P < 0.01, *** – P < 0.001, ns – non significant.

	A. melanopogon	*A. schoenobaenus*	*A. palustris*	*A. scirpaceus*	*A. arundinaceus*	*P. biarmicus*	*E. schoeniclus*
L. luscinioides	ns	*	ns	ns	ns	ns	ns
A. melanopogon		ns	**	**	ns	ns	ns
A. schoenobaenus			**	***	ns	ns	**
A.palustris				ns	*	*	ns
A. scirpaceus					**	**	ns
A. arundinaceus						ns	ns
P. biarmicus							*

gon and Marsh Warblers *Acrocephalus palustris* (post-hoc Scheffé test). Capture rates of birds differed significantly also between the first and last 5 hours of day (Table 1). (Though not all of these results reached statistical significance if Bonferroni corrections were applied, we propose that marked differences between species have serious biological relevance even after lower statistical power.) The most active in the morning were Moustached Warblers (74.4% of all daily captures), Sedge Warblers *Acrocephalus schoenobaenus* and Bearded Tits (69.2 and 68.7% respectively), least of them Marsh Warbler (57.1%). During the day, between the activity peaks, the activity of all species was low and stable.

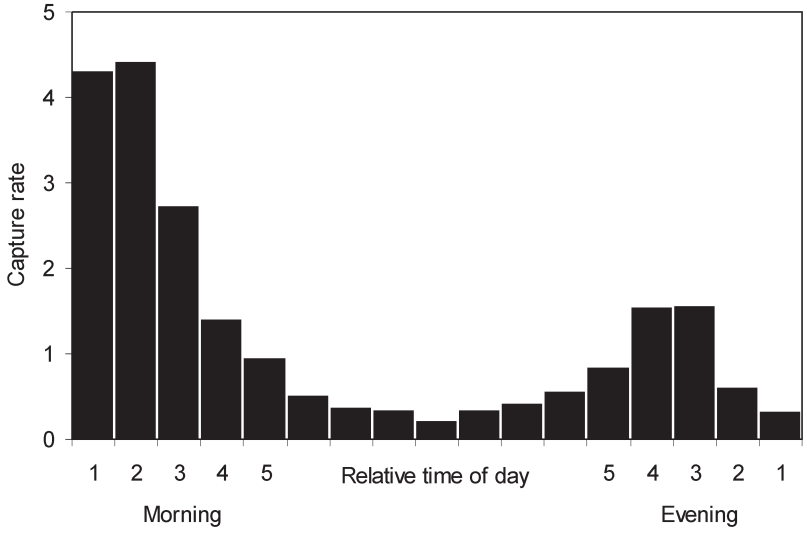

Fig. 1. Capture rates of reedbed passerines mist netted in National Nature Reserve Parížske močiare marsh in the late breeding periods of 1999–2004

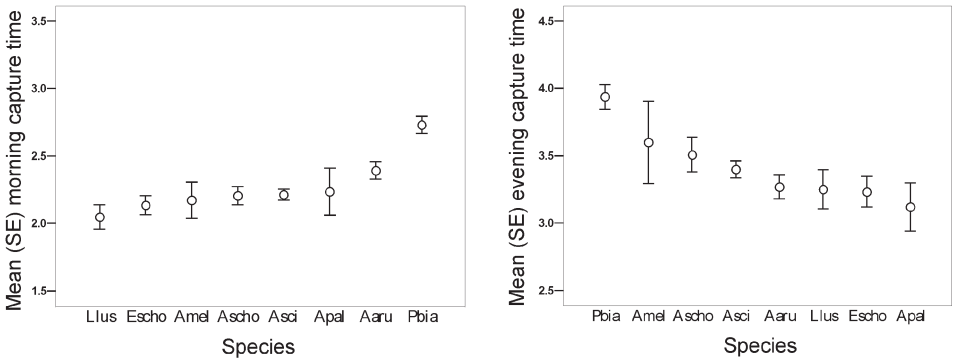

Fig. 2. The morning (left) and evening (right) mean capture times (±SE) of reedbed passerines in National Nature Reserve Parížske močiare marsh in the late breeding periods of 1999–2004. (Llus: *Locustella luscinioides* (n = 293), Amel: *Acrocephalus melanopogon* (n = 78), Asch: *A. schoenobaenus* (n = 445), Apal: *A. palustris* (n = 112), Asci: *A. scirpaceus* (n = 1270), Aaru: *A. arundinaceus* (n = 588), Pbia: *Panurus biarmicus* (n = 498), Esch: *Emberiza schoeniclus* (n = 416))

Considerable differences between the daily activities of the different age classes were found in the Bearded Tit, Reed Warbler *Acrocephalus scirpaceus* and Moustached Warbler (Fig. 4). While the juveniles activity of Reed Warblers and Bearded Tits was concentrated in the early morning (morning vs. evening: 69% vs. 18.9% and 71.3% vs. 16.6%, n = 888 and 428, respectively), adults were almost identical between morning and evening (44.8% vs. 42.2% and 52.9% vs. 35.7%,

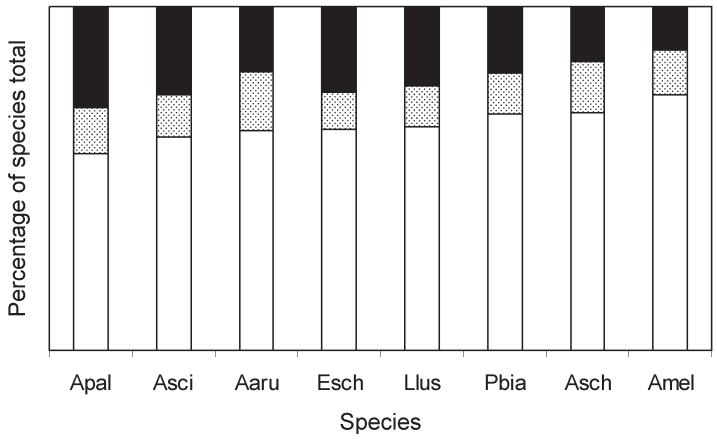

Fig. 3. Morning (white), daily (dotted) and evening (black) activity of reedbed passerines in National Nature Reserve Parížske močiare marsh in the late breeding periods of 1999–2004. (Llus: *Locustella luscinioides*, Amel: *Acrocephalus melanopogon*, Asch: *A. schoenobaenus*, Apal: *A. palustris*, Asci: *A. scirpaceus*, Aaru: *A. arundinaceus*, Pbia: *Panurus biarmicus*, Esch: *Emberiza schoeniclus*)

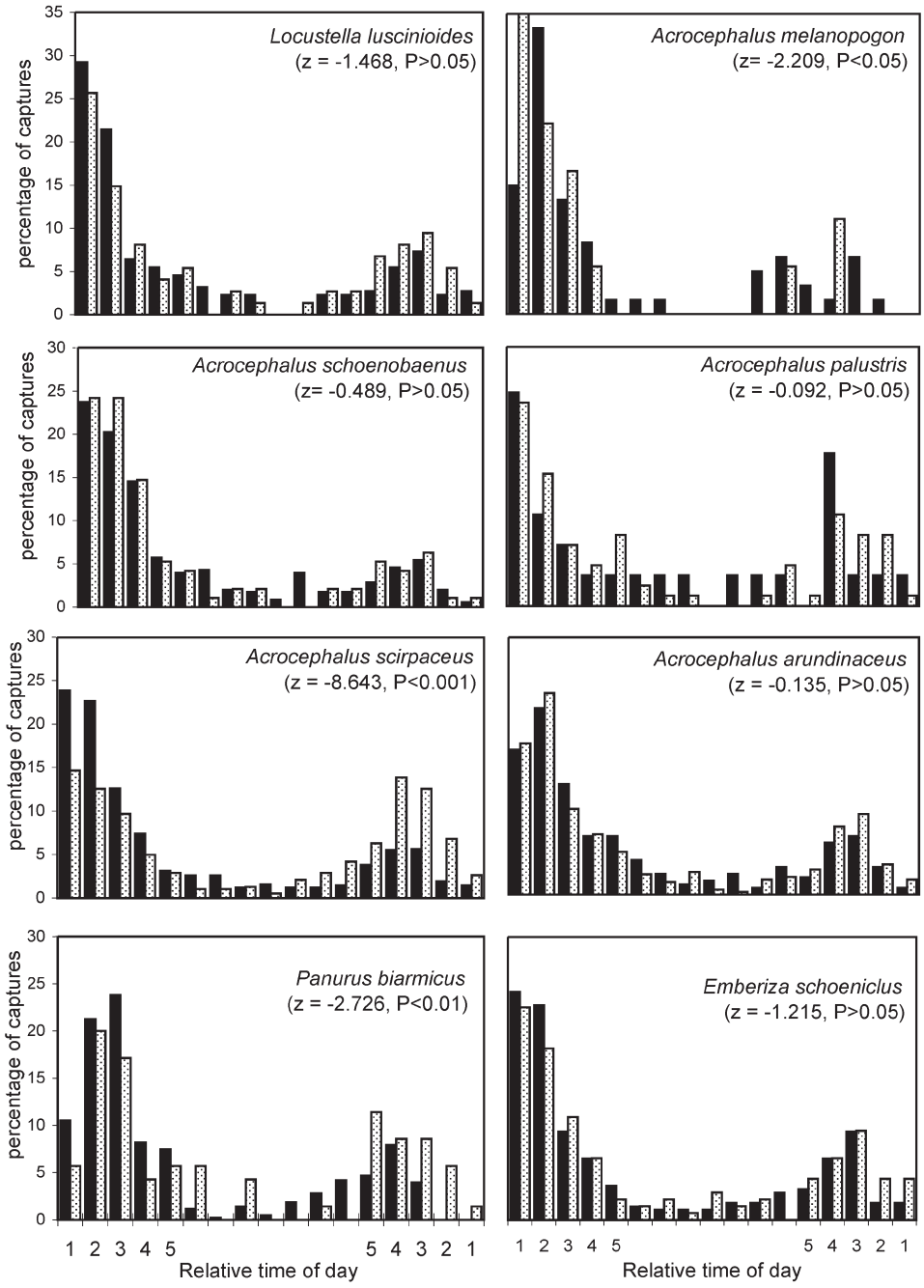

Fig. 4. Daily activity of juvenile (black columns) and adult (dotted columns) reedbed passerines in National Nature Reserve Parížske močiare marsh in the late breeding periods of 1999–2004

n = 382 and 70, respectively), being significantly different from that of juveniles ($\chi^2 = 86.39$ and 14.49, respectively, df = 1, $P < 0.001$). Adult Moustached Warbler (n = 18), on the contrary, showed an intensive activity in the morning (83.3% vs. 11.1%) but no differences were found between adults and juveniles activity (Fisher exact test, P = 0.52).

DISCUSSION

In our study we found a large effect of time of day on mist net captures of reed passerine birds in the end of breeding period. Bird activity and thereby mist-netting success may be affected also by weather and net visibility (KAYES & GRUE 1982, JENNI *et al.* 1996). According to QUINLAN and BOYD (1976) the number of birds captured was associated significantly with temperature, air pressure and cloud cover. While the capture success was positively correlated with barometric pressure and cloud cover, temperature indicated a strong negative correlation. JENNI *et al.* (1996) found that the capture efficiency of mist-nets affected by the degree of shading by vegetation or clouds. Wind and visibility of celestial cues are also important for the decision to initiate migration in nocturnal migrants such as *Acrocephalus* warblers (ÅKESSON *et al.* 2001, 2002, ERNI *et al.* 2002) and their intensive activity in the evening. In our study, however, the nets were operated only under stable weather conditions, and, based on analyses of recaptures, the captured birds were breeding in the study area (TRNKA *et al.* 2003). Therefore, we excluded weather as a factor which influenced capture rates of birds in our study.

Bird activity can depend evidently also on other factors, such as habitat type, species-specific capture efficiencies as well as duration of mist-netting (LÖVEI *et al.* 2001) when activity levels apparently decrease during mist-netting seasons. To minimize this, birds were mist-netted during 6–7 successive days in the same sites every year.

We assume therefore that capture times of reed passerines differ above all as a consequence of their different foraging behaviour patterns within the study area. Thus, similarly to the findings of DESLAURIES and FRANCIS (1991), differences in diurnal activity among species are closely related to foraging guilds, due to variations in the timing of prey activity. While Reed Warbler forages on more active insects (BIBBY & GREEN 1981, GRIM & HONZA 1996), Sedge Warbler and Great Reed Warbler *Acrocephalus arundinaceus* feed mainly on aphids or prefer slow-flying insects, respectively (BIBBY & GREEN 1981, TRNKA 1995). Unlike them, the Bearded Tit forages, in breeding season, almost exclusive on slow-flying invertebrates, mainly Chironomidae from near the water's edge, beetles, spiders and

caterpillars (CRAMP & PERRINS 1993). Therefore the early activity of Savi's Warbler *Locustella luscinioides* and most of *Acrocephalus* species could be because this is when their prey is least active due to lower ambient temperatures, whereas Bearded Tits, for example, are more indifferent to this factor.

Interspecific differences in the capture rates of reed passerines between morning and evening have not been demonstrated before. Only GYURÁCZ *et al*. (2004) at Sumony (Hungary) found dependence of daily activity on the stopover period in Sedge Warbler, where the recaptured birds showed intensive activity in the afternoon. We suspect that differences found in our study reflect interspecific variations in breeding as well as foraging behaviour patterns among species. There are also little known intraspecific differences concerning diurnal activity of different age classes in reed passerine birds. Variations in capture rates of adult and juvenile Sedge Warblers were found by GYURÁCZ *et al.* (2004). Our results confirm the existence of such patterns in further species: Bearded Tits, Reed and Moustached Warblers. The reasons for this are not quite clear, though it could be related to post-fledging dispersal and parental care in these species, which still continues in the study period (TRNKA *et al.* 2003). Young birds are less experienced and efficient than the adults in gathering food (KOSKIMIES & SAUROLA 1985) and thereby more active in the early morning when their prey is least agile. Differences in the daily activity between juvenile and adult birds and subsequently in the efficiency of mist netting can be influenced also by different responses of birds to predators (TRNKA & PROKOP 2006). In addition, it could be relate to evening premigratory activity of adult Reed Warblers, migration of which peaks during study period (TRNKA *et al.* 2003).

Without regard to reasons of these findings, it is evident from our study that only morning sampling distort the relative abundance and age structure of reedbed passerines in mist-netting studies and monitoring programs, such as CES (Constant Effort Sites) Scheme (PEACH *et al.* 1996). The species more active later in the morning, such as Bearded Tit, and species active also in the evening (Marsh Warbler and Reed Warbler) would be underestimated in this way. In Bearded Tit, Reed Warbler and Moustached Warbler morning sampling alone would distort results concerning their age ratio as well. Taking into consideration these facts we recommend that a typical regime for bird monitoring should be to begin netting four hours before sunset and continue four hours after sunrise in the next day on each visit. However, keeping the daily trapping schedule is a fundamental prerequisite for monitoring with mist nets.

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