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INDIVIDUAL RECOGNITION OF SCOPS OWLS (*OTUS SCOPS*) BY SPECTROGRAPHIC ANALYSIS OF THEIR CALLS: A PRELIMINARY STUDY

INDIVIDUALNO PREPOZNAVANJE VELIKIH SKOVIKOV (*OTUS SCOPS*) S SPEKTOGRAFSKO NANALIZO NJIHOVIH KLICEV: PREDHODNA RAZISKAVA

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ABSTRACT

Individual recognition of Scops Owls (*Otus scops*) by spectrographic analysis of their calls: A preliminary study

Numerous studies have confirmed that males of several species can be individually identified by spectrographic analysis of their vocalizations. Spectrographic analysis of 12 recordings of Scops Owl (*Otus scops*) males made on Ljubljansko barje (central Slovenia) and in Istria (NW Croatia) revealed that this method is suitable for individual recognition of males. Average values for the following three parametres of calls were calculated (±SE): lenght of call 278.3±3.69 ms (min 228-max 371 ms), time interval between calls 2.72±0.05 s (min 2.08-max 3.39 s) and fundamental frequency of call 1.32±0.01 kHz (min 1.17-max 1.50 kHz). Discriminant function analysis successfully separated recordings of differents males on the basis of above mentioned parametres (Wilkins'λ=0.0027, P<0.001). Variables considered in the model were length of call and time interval between calls, whereas fundamental frequency was omitted as its variance between individuals was too low. Both discriminant functions were statistically significant (p<0.001), the first one accounting for 90% of variance, and both together for 100% of variance.

Considering the fact that Scops Owls may form larger calling groups and may breed in loose colonies where conditions are favourable, this method represents a very important tool for accurate determination of the number of calling males. Recordings of Scops Owl are relatively easy to obtain as the species is highly vocal and males respond well to playback of another male. The method is also less time-consuming for the surveyor and less disturbing for the bird, compared to capturing and banding.

Key words: Scops Owl, *Otus scops*, individual recognition, spectrographic analysis of male calls.

IZVLEČEK

Individualno prepoznavanje velikih skovikov (*Otus scops*) s spektografsko nanalizo njihovih klicev: predhodna raziskava

S številnimi raziskavami je bilo ugotovljeno, da je mogoče samce nekaterih vrst individualno prepoznati s spektrografsko analizo njihovih klicev. S spektrografsko analizo 12 posnetkov klicev samcev velikega skovika (*Otus scops*) posnetih na Ljubljanskem barju (osrednja Slovenija) in v Istri (SZ Hrvaška), smo ugotovili, da je metoda primerna za individualno prepoznavanje samcev. Povprečne vrednosti parametrov klica so bile naslednje (±SE): dolžina klica 278,3±3,69 ms (min 228-max 371 ms), interval med klici 2,72±0,05 s (min 2,08-max 3,39 s) in osnovna frekvenca klica 1,32±0,01 kHz (min 1,17-max 1,50 kHz). Z diskriminančno analizo smo uspešno ločili posnetke različnih samcev na osnovi zgoraj opisanih parametrov (Wilkinsova λ=0,0027, P<0,001). Spremenljivki, upoštevani v modelu, sta bili dolžina klica in interval med klici. Osnovna frekvenca je bila izpuščena, saj je bila njena varianca med osebki prenizka. Obe diskriminančni funkciji sta bili statistično značilni (p<0,001), prva je pojasnila 90 % variance, obe skupaj pa 100 % variance.

Samci velikega skovika lahko oblikujejo velike klicalne skupine, pari pa v ugodnih pogojih gnezdijo v ohlapnih kolonijah, zato je spektrografska analiza klicev pomembno orodje pri določanju točnega števila kličočih samcev. Samci se dobro odzivajo na predvajani posnetek drugega samca in so tudi spontano zelo zvočno aktivni, zato je mogoče v relativno kratkem času kvalitetno posneti veliko njihovih klicev. Ta metoda individualnega prepoznavanja je za raziskovalca časovno manj zahtevna, za ptice pa manj stresna v primerjavi z lovom in obročkanjem.

Ključne besede: veliki skovik, *Otus scops*, individualno prepoznavanje, spektrografska analiza klicev samca.

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INTRODUCTION

Male vocalization in birds serves at least two purposes; attracts and/or stimulates potential partners, and discourages rivals from competing for limited resources (GALEOTTI 1998). Vocalization carries information about male's qualities that influence female's choice. It also influences male's competition to rivals and transfers information about the quality of male's territory (GALEOTTI 1998). Numerous studies have confirmed that males of several species can be individually identified by spectrographic analysis of the recordings of their vocalizations; e.g. Emperor Penguin (*Aptenodytes forsteri*), King Penguin (*A. patagonicus*) (AUBIN & JOUVENTIN 1998, AUBIN et al. 2000, LENGAGNE et al. 2001, LENGAGNE et al. 2004), Black-throated Diver (*Gavia arctica*) (GILBERT et al. 1994) Guillemot (*Uria aalge*) (LENGAGNE et al. 2004), Great Bittern (*Botaurus stellaris*) (GILBERT et al. 1994, PUGLISI & ADAMO 2004), Ruffed Grouse (*Bonasa umbellus*) (SAMUEL et al. 1974), Corncrake (*Crex crex*) (PEAKE et al. 1998, PEAKE & MCGREGOR 2001, TERRY & MCGREGOR 2002), White-tailed Hawk (*Buteo albicaudatus*) (FARQUHAR 1993), Little Tern (*Sterna albifrons*) (MOSELEY 1979), Black-headed Gull (*Larus ridibundus*), Slender-billed Gull (*L. genei*) (MATHEVON et al. 2003), Scops Owl (*Otus scops*) (GALEOTTI & SACCHI 2001), Tawny Owl (*Strix aluco*) (GALEOTTI & PAVAN 1991), Eagle Owl (*Bubo bubo*) (LENGAGNE 2001), African Wood Owl (*Strix woodfordii*) (DELPORT et al. 2002), Nightjar (*Caprimulgus europaeus*) (REBBECK et al. 2001), Bee-eater (*Merops apiaster*) (LESSELLS et al. 1995), Great Tit (*Parus major*) (LIND et al. 1996), Long-tailed Tit (*Aegithalos caudatus*) (HATCHWELL et al. 2001), and Silvereye (*Zosterops lateralis*) (ROBERTSON 1996). Individual variability is a prerequisite for individual recognition. An ideal signal for individual recognition is stereotypical for an individual but highly variable among different individuals (FALLS 1982). For individual recognition of males through several consecutive breeding seasons, used vocalization parameters should be stable over a longer period of time (GALEOTTI & SACCHI 2001).

Recording and later individual recognition of males by analysing their calls is a very suitable method of survey for species that are sensitive to disturbances (such as capture and banding, radio-tagging), active by night or visually harder to detect (GALEOTTI & PAVAN 1991, GILBERT et al. 1994). Spectrographic analysis thus enables (1) an accurate determination of the number of calling males (GILBERT et al. 1994, PEAKE & MCGREGOR 2001), (2) the determination of territorial borders for each calling male (GALEOTTI & PAVAN 1991, GILBERT et al. 1994, DELPORT et al. 2002), (3) the detection of territorial movements of individual males within a breeding season (PEAKE et al. 1998, REBBECK et al. 2001), (4) the determination of individually specific behaviour (PEAKE & MCGREGOR 2001). If males can be recognized between different breeding seasons, it is also possible to (5) calculate the turnover rate between years (GALEOTTI & PAVAN 1991, DELPORT et al. 2002), (6) determine territorial movements between years (GALEOTTI & SACCHI 2001), (7) calculate survival rate (GILBERT et al. 1994), (8) determine nest-site fidelity (GILBERT et al. 1994, GALEOTTI & SACCHI 2001), and (9) demographic structure and development of population (PEAKE & MCGREGOR 2001, LENGAGNE 2001).

Individually specific vocalization in birds is important for several reasons: 1) recognition and constant communication between partners ensures a more successful mating and breeding as it strenghtens pair bond (MOSELEY 1979, FALLS 1982, GALEOTTI & PAVAN 1991, GALEOTTI 1998) – the latter is especially important in long-lived monogamous species with constant partners and in colonial birds (FALLS 1982, GALEOTTI & PAVAN 1991, LENGAGNE 2001); 2) in colonial breeders it is important that the young recognize their parents among many adults returning to colony with food (AUBIN & JOUVENTIN 1998, AUBIN et al. 2000, LENGAGNE et al. 2001, MATHEVON et al. 2003); 3) in species where non-breeding individuals (helpers) help in feeding the young (e.g. Bee-eater, Long-tailed Tit) it is common that helpers are in some kind of family relation to the breeding pairs. Their mutual recognition is based primarily on vocal signals and is learned in youth, as they are usually siblings from the same nest (LESSELLS et al. 1995, HATCHWELL et al. 2001); 4) recognition of rivals by their calls can reduce the number of physical conflicts between males and thus saves a lot of energy and time (FALLS 1982, GALEOTTI & PAVAN 1991).

The Scops Owl is a migratory species returning to Europe from wintering sites at the end of March or in the beginning of April. Immediately upon their return males begin to advertise their territory and to attract females by gentle monosyllabilic hooting »tjü« that is repeated 22-26 times per minute during the night. Males call intensively until the beginning of egg-laying (end of May – beginning of June) – after that their vocal activity is reduced or even ceases. (GLUTZ VON BLOTZHEIM & BAUER 1980) By spectrographically analysing 12 recordings of male hooting we established whether this method is appropriate for individual recognition of males. We intend to use this method in future studies of population dynamics of Scops Owl on Ljubljansko barje (central Slovenia) with a population size estimated at 40-50 calling males (DENAC 2003).

MATERIAL AND METHODS

The 12 recordings used in this pilot study were made at Ljubljansko barje (central Slovenia, 10 recordings) and in Istria (NW Croatia, 2 recordings). Six of them were made before 2004 at Ljubljansko barje and in Istria (Slovenian Museum of Natural History, Ljubljana audio archive) and six of them in May and June 2004 at Ljubljansko barje. The two recordings from Istria were used to increase the sample size and to compare the intraindividual variability of call parametres in birds that are undoubtedly different individuals. The study area of Ljubljansko barje is located in the southern part of the Ljubljana basin at an average height of 290 m a.s.l. The total surface area is 140 km^2. Certain parts remained raised above the surrounding plain due to slower rates of geological sinking that began two million years ago and are now isolated hills (e.g. Blatna Brezovica, Bevke). The climate is continental. The average annual precipitation is over 1400 mm with a peak in autumn. Vrhnika, at the western part of Ljubljansko barje, receives most precipitation (1601 mm on average) while the village Lipe in the central part receives only 1374 mm of rainfall on average. The highest average temperatures are recorded in July (approx. 19°C) and the lowest in January (approx. -2°C). According to data from 1994, land use on Ljubljansko barje is following: 51% meadows, 24% wood, 15% fields and 10% rest (settlements, orchards, pastures) (Lovrenčak & Orožen Adamič 1998).

The recordings were made in the field using a Telinga PRO V parabolic microphone (parabola diameter 57 cm) connected to Sony DAT recorder TCD-D10 (sampling rate 48 kHz, 16 Bit dynamic range). In the laboratory, DAT recordings were transferred to the Hard disk of Power Macintosh G4 computer through Audiomedia III sound card. We used Digidesign Protools 5 and Canary 1.2.4 (Cornell University, New York – USA) as the software for viewing, editing and analysing the calls. Sonagrams (spectrograms) and spectra were produced with the software Canary using the following settings: filter bandwidth – 349.70 Hz, frame length 512 points, FFT size 4096 points, Hamming window, logarithmic amplitude scale, smooth display. The parametres measured on calls were 1) the lenght of the call (ms), 2) time interval between calls (s) and 3) fundamental frequency of the call (kHz). Data were analysed using discriminant function analysis (Galeotti & Sacchi, 2001) to determine identification efficiency of individual Scops Owl males.

RESULTS AND DISCUSSION

Among the three measured call parameters in Scops Owls the length of call appeared to be the most variable one (Table 1).

In Italy, call parametres were similar (mean is reported±SE with maximum and minimum values in parentheses): length of call 250.4±1.8 ms (185.5-342.1 ms), interval between calls 2.86±0.02 s (2.48-4.15 s) and fundamental frequency 1.28±0.001 kHz (1.13-1.50 kHz) (Galeotti & Sacchi 2001).

Discriminant function analysis successfully separated recordings of differents Scops Owl males on the basis of measured parametres (Wilkins'λ=0.0027, P<0.001; Fig. 1). Variables considered in the model were the length of call and time interval between calls (Table 2), whereas fundamental frequency was omitted as its variance between individuals was too low, probably due to small sample size. Both discriminant functions were statistically significant (p<0.001), the first one accounting for 90% of differences, and both together for 100%. Similarly, time components of calls, especially length of the call, were more important in the Italian study, too (Galeotti & Sacchi 2001).

The squared Mahalanobis' distances between centroids of recordings (D^2) differed significantly among themselves (p<0.001), with the exception of D^2 values for pairs of recordings no. 1-2 (p=0.69), no. 5-6 (p=0.69), no. 7-8 (p=0.21) and no. 10-11 (p=0.92) (Table 3). With the exception of recordings no. 7 and 8 it was previously known that each of these pairs of recordings belonged to the same individual. Those pairs of recordings were made immediately one after another from the same position which leaves little doubt about the identity of males.

Intraindividual variability of call parametres was was very low, particularly for fundamental frequency (Table 4). As from discriminant function analysis, it is also evident from Table 4 that pairs of recordings belonging to the same male have virtually identical mean values of call parametres (pair of recordings 1-2, 5-6, 7-8 and 10-11).

Spectrographic analysis helped reveal that recordings no. 7 and 8 belong to the same individual that would otherwise have been double-counted in survey if this method had not been used. In another case, (recordings no. 10, 11 and 12) this method revealed that we are dealing with two different males, whereas we originally thought that only one male was calling from different borders of its territory. One drawback of our preliminary study is a small sample size of 12 recordings that was greatly enlarged in 2004 and 2005 but the data are still in raw form.

Considering the fact that Scops Owls may form larger calling groups (several males can be heard calling from one survey point but not necessarily at the same time) (Štumberger 2000, Kljun 2002, Denac 2003) and breed in loose colonies where conditions are favourable (Glutz von Blotzheim & Bauer 1980), this method represents a very important tool for determination of the accurate number of calling males. Therefore, the conclusion of our pilot study is that spectrographic analysis of calls is a suitable method for individual recognition of Scops Owl males. Recordings of Scops Owl are relatively easy to obtain as the species is highly vocal and males respond well to playback of another male. The method is also less time-consuming for the surveyor and less disturbing for the bird, compared to capturing and banding. The use of spectrographic analysis of male calls also allows the calculation of turnover rate and mortality of males in sequential years (Galeotti & Sacchi 2001) because it is a form of mark-recapture method (with individual vocalization being equal to individual marking). But in this case, in addition to recording them, it would be advisable to mark individual males in a more old-fashioned manner, e.g. with alluminium rings, in order to separate them with certainty the following year. In this way, we could also gather important information about whether males change their call parametres with age or not. Galeotti & Sacchi (2001) discovered that male calls remain stable in one breeding season and also in subsequent years.

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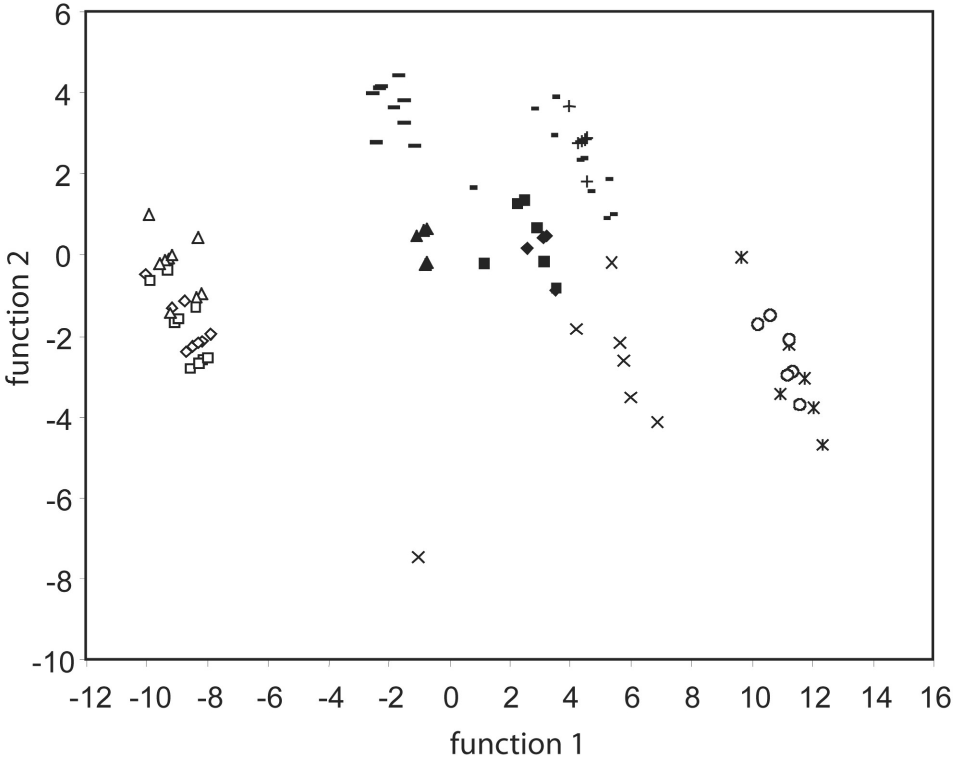

Figure 1: Separation of Scops Owl (*Otus scops*) male calls by discriminant functions 1 and 2. In the case of recordings no. 1-2, 5-6, 7-8 and 10-11 these pairs of recordings belong to the same individual.

Table 1: Average values of call parametres of Scops Owl (*Otus scops*) recorded on Ljubljansko barje (Slovenia) and in Istria (Croatia), measured on spectrograms.

Parametre	No. of calls	Average	Min	Max	SE
Fundamental frequency (kHz)	95	1.32	1.17	1.50	0.008
Length of call (ms)	95	278.3	228.0	371.0	3.69
Interval between calls (s)	95	2.72	2.077	3.388	0.047

Table 2: Variables in the model of discriminant function analysis and their contribution to both discriminant functions.

Variable	Partial Wilk's λ	F	P	Func. 1	Func. 2
Length of call	0.111	59.33	<0.001	0.518	-0.859
Interval betw. calls	0.044	163.52	<0.001	-0.899	-0.445
Cumulative proportion		-		0.8997	1.000

Table 3: Squared Mahalanobis' distances between centroids of recordings (D^2), ns - non significant p levels, all other p levels are<0.01.

Recording	1	2	3	4	5	6	7	8	9	10	11	12
1	0,00	0,34 ^{ns}	17,40	15,03	89,28	80,87	10,86	6,26	44,06	157,40	162,20	167,72
2	0,34 ^{ns}	0,00	13,52	19,27	100,30	91,28	10,81	6,02	36,71	146,90	151,49	155,65
3	17,40	13,52	0,00	48,94	182,30	170,90	39,33	30,19	15,08	72,54	75,70	77,46
4	15,03	19,27	48,94	0,00	50,65	46,46	40,75	34,02	105,28	203,19	208,82	226,69
5	89,28	100,30	182,30	50,65	0,00	0,31 ^{ns}	92,17	93,99	253,47	454,73	463,14	485,27
6	80,87	91,28	170,90	46,46	0,31 ^{ns}	0,00	82,16	84,13	238,03	439,80	448,05	468,54
7	10,86	10,81	39,33	40,75	92,17	82,16	0,00	0,71 ^{ns}	47,79	216,89	222,15	219,31
8	6,26	6,02	30,19	34,02	93,99	84,13	0,71 ^{ns}	0,00	41,80	195,56	200,61	199,32
9	44,06	36,71	15,08	105,28	253,47	238,03	47,79	41,80	0,00	84,51	87,05	76,07
10	157,40	146,90	72,54	203,19	454,73	439,80	216,89	195,56	84,51	0,00	0,04 ^{ns}	2,96
11	162,20	151,49	75,70	208,82	463,14	448,05	222,15	200,61	87,05	0,04 ^{ns}	0,00	2,71
12	167,72	155,65	77,46	226,69	485,27	468,54	219,31	199,32	76,07	2,96	2,71	0,00

Table 4: Mean values±SE of call parametres for individual recordings of Scops Owl (*Otus scops*) males.

Recording	**Fundamental frequency (kHz)**	**Length of call (ms)**	**Interval between calls (s)**
1	1.31±0.00	290.6±5.8	2.52±0.02
2	1.31±0.00	286.2±9.0	2.54±0.06
3	1.27±0.00	272.3±3.6	2.77±0.01
4	1.46±0.02	325.1±14.4	2.54±0.24
5	1.18±0.02	351.0±17.5	2.10±0.03
6	1.17±0.00	346.2±9.2	2.10±0.02
7	1.34±0.03	273.0±4.2	2.33±0.01
8	1.31±0.00	275.6±12.4	2.38±0.09
9	1.31±0.00	238.1±6.2	2.70±0.03
10	1.36±0.00	257.6±7.7	3.34±0.03
11	1.39±0.03	256.7±10.0	3.36±0.02
12	1.36±0.00	242.4±7.6	3.32±0.04