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Bats (Mammalia, Chiroptera) of the Burgas Wetlands, Bulgarian Black Sea Coast

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Abstract: The dominant composition of the bat community in the region of the Burgas wetlands (Bulgarian Black Sea Coast) is established, using the methods of detection and analysis of ultrasonics. The study was carried out during the reproductive period (June 2003) and the period of autumn migration (September and October 2002). Ultrasonic emissions of *Pipistrellus pipistrellus* (SCHREBER, 1774) and *Pipistrellus nathusii* (KEYSERLING, BLASIUS, 1839) dominated, showing that these two species form the principal part of the bat community. The zones with the highest feeding activity have been determined and the importance of the studied lake areas for abundant populations of bats, mainly in the late autumn period of migration, has been established. Principal conservation measures that should be implemented are proposed.

Key words: Chiroptera, wetlands, echolocation calls, Bulgaria

Introduction

Until 2002 the bats of the Burgas wetlands did not seem to be a subject of special study. Only a few isolated reports about specimens of *Pipistrellus pipistrellus* (SCHREBER, 1774) and *Eptesicus serotinus* (SCHREBER, 1774), found dead in the region of the lakes, had been reported. Evidence of *Pipistrellus nathusii* (KEYSERLING, BLASIUS, 1839) was found in bird pellets in the area of the Bulgarian South Black Sea Coast (POPOV, personal communication).

The main objectives of this study were to establish the dominant composition of the bat communities in the region of the Burgas wetlands, to establish their territorial activity, to show the role of the wetlands in the nourishment of abundant bat populations, and to propose measures for their conservation.

Material and Methods

The fieldwork was carried out during the periods of 6-9.09.2002, 18-22.10.2002, and 26-27.06. 2003 in the regions of the lakes of Vaya (Burgas Lake), Pomoriisko and Atanassovsko, and the low parts of the valleys of the Aitos and Aheloi rivers. The studied area is situated close to the sea coast and includes not only the coastal zone of the lakes and sectors of their free water surface, but also the adjacent towns and villages (Burgas, Pomorie, Dolno Ezerovo and Aheloi).

Vaya is the biggest natural freshwater lake in Bulgaria with a surface area of 27,5 km^2. It is polymictic and fort eutrofic. The mean depth is only about 1 m. The lake is situated to the west of Burgas and the industrial zone of the town on the northern lakeshore. The salt-water lakes of Pomorie and Atanassovsko are situated close to the seashore. Small dams, used for the extraction of salt, separate large parts of their surfaces. The Burgas wetlands are situated on the migration path of birds Via Pontica, offering a rich feeding base for more than 250 bird species. They play an important role in the conservation of the biodiversity and the ecological equilibrium of the Bulgarian Black Sea Coast.

The detection of ultrasonics emitted by bats, using a Pettersson D 240 detector and Sony audio-tape recorder, was the principal method of investigation. The recordings in time expansion were transformed in computer files by BatSound sound analysis software. The obtained spectrograms permitted us to determine the dominant composition of the bat community. The manual of BARATAUD (1996) was used.

The recordings were made from the following fixed observation points:

- the region of the Pomoriisko Lake: six points (Fig. 1);
- Aheloi River;
- the region of the Atanassovsko Lake: six points (Fig. 2);
- the region of the Vaya Lake: three coastal points and transects were made in western and central parts of the lake (Fig. 3);
- Aitos River, close to the Vaya Lake; and
- the town of Burgas: three points (the central town zone and the residential districts of Slaveikov and Izgrev).

The recordings were made at every point of observation for at least an hour during the first half of the night. We consider that this interval is representative for evaluating the relative bat activity and dominant species composition.

The number of echolocation calls may be used as an additional variable to assess bat activity (FURMANKIEWICZ 2003). The occurrence (pF) of each species has been calculated as a percentage of detected ultrasonics of the species from the total number of recordings in each studied region. Although very approximate, this assessment can be considered giving a comparison at different points of monitoring.

In total, 1032 recordings of bat ultrasounds have been analyzed (Table 1).

Species Composition and Remarks

In total, eight bat species were established.

Family Vespertilionidae

Myotis daubentonii (KUHL, 1819) - Daubenton's bat

Although widely distributed in Europe, this species is relatively rare in Bulgaria. High foraging activity has been observed during the reproductive period over some large wetlands along the south Black Sea Coast of Bulgaria, the Strandzha Mountain, and the Veleka River valley, where the populations of the species are large (PANDOURSKI, WHITCHER in press). The presence of the species was confirmed by mist netting in the studied area (WHITCHER, personal communication). In the region of the Burgas lakes the Daubenton's bat is rare with a relatively high foraging the activity in the southern part of the Atanassovsko Lake, which is rich in aquatic vegetation. The echolocation calls of this species have a maximum frequency of about 45 KHz (Fig. 4).

Nyctalus noctula (SCHREBER, 1774) - Noctule

In Bulgaria the Noctule bat is mainly dendrophilous, but frequently its daily roosts are associated with human agglomerations. For example, it shelters in crevices between

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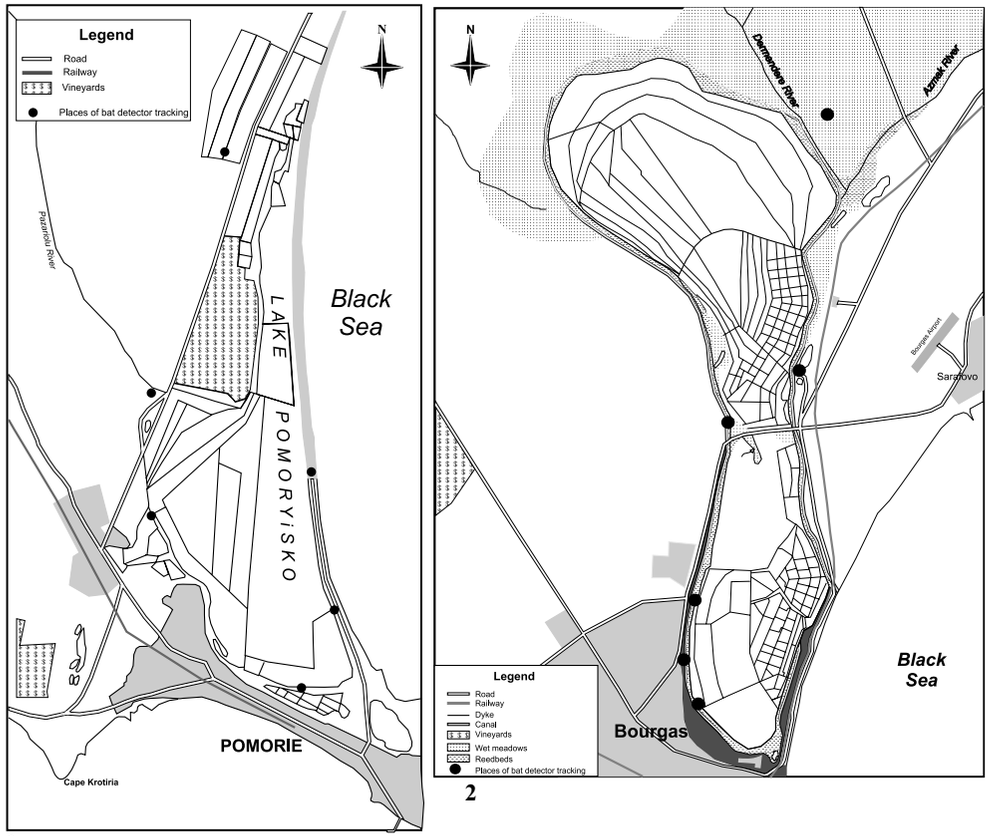

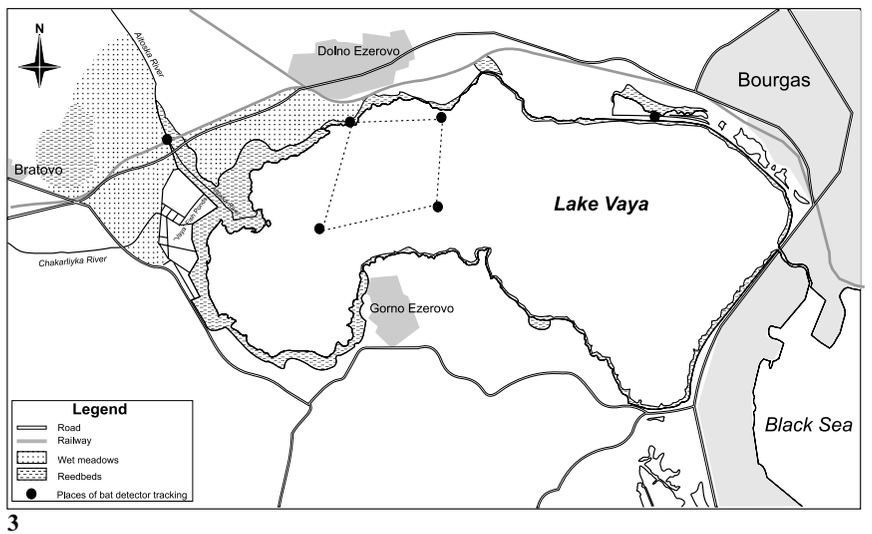

Fig. 1-3. Maps of Pomoryisko Lake (1), Atanassovsko Lake(2) and Vaya Lake (3)

Table 1. Total number of ultrasonic bat recordings made in the Burgas wetlands.

Studied region	Number of recordings	Period of monitoring
Pomoriisko Lake	362	6-9.09.2002; 18-22.10.2002; 26-27.06.2003
Aheloi River	27	6-9.09.2002; 18-22.10.2002
Atanassovsko Lake	69	6-9.09.2002; 26-27.06.2003
Vaya Lake	402	6-9.09.2002; 18-22.10.2002; 26-27.06.2003
Aitos River	29	6-9.09.2002;
Burgas: the town zone	143	6-9.09.2002; 18-22.10.2002; 26-27.06.2003
Total number of recordings	1032	

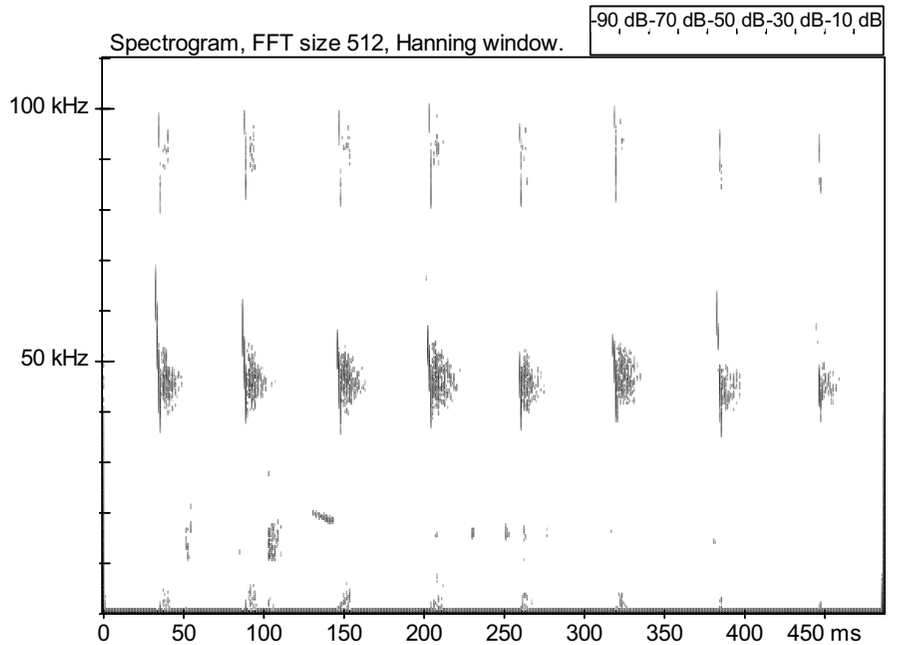

Fig. 4. Echolocation calls of *Myotis daubentonii*, Pomoriisko Lake.

concrete walls. It migrates over long distances. The highest feeding activity was registered at dusk at a height of 10-30 m above the lake surface. It had an even distribution in all studied areas. The echolocation calls of this species have a maximum frequency of about 17-18 KHz (Fig. 5).

Nyctalus leisleri (KUHL, 1818) - Leisler's bat

The Leisler's bat is relatively rare in Bulgaria and prefers forest habitats.

Rarely, it occurs in crevices of buildings and hibernates in similar roosts. Migratory distances of more than 800 km are known in Europe (SCHROBER, GRIMMBERGER 1991). The territory of South Bulgaria may represent the target area of immigrants from the north (BENDA *et al.* 2003).

The feeding activity was higher around the streetlights of Burgas than above the lakes. The echolocation calls of this species have a maximum frequency of about 22 KHz (Fig. 6).

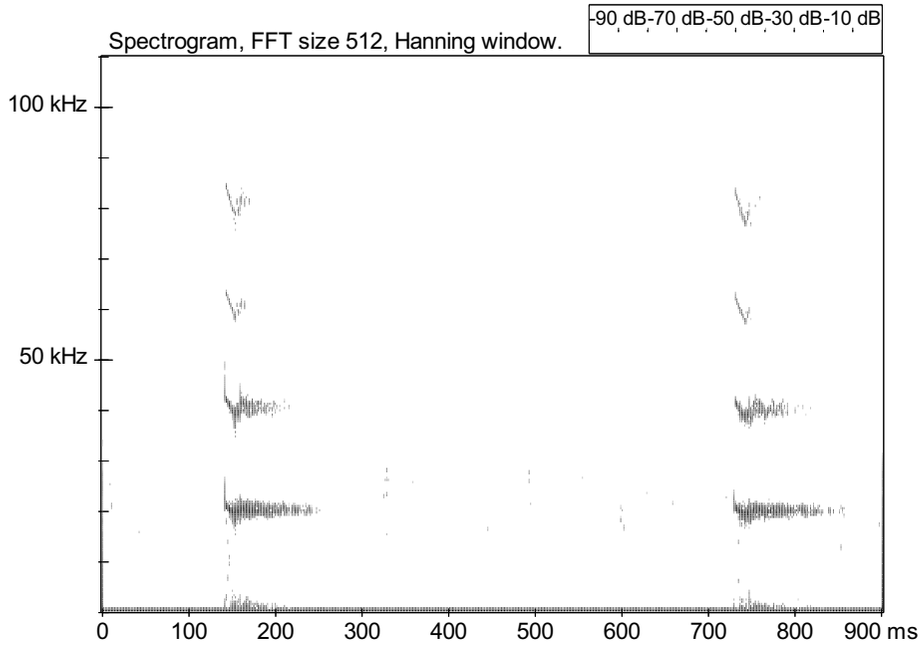

Fig. 5. Echolocation calls of *Nictalus noctula*, Vaya Lake.

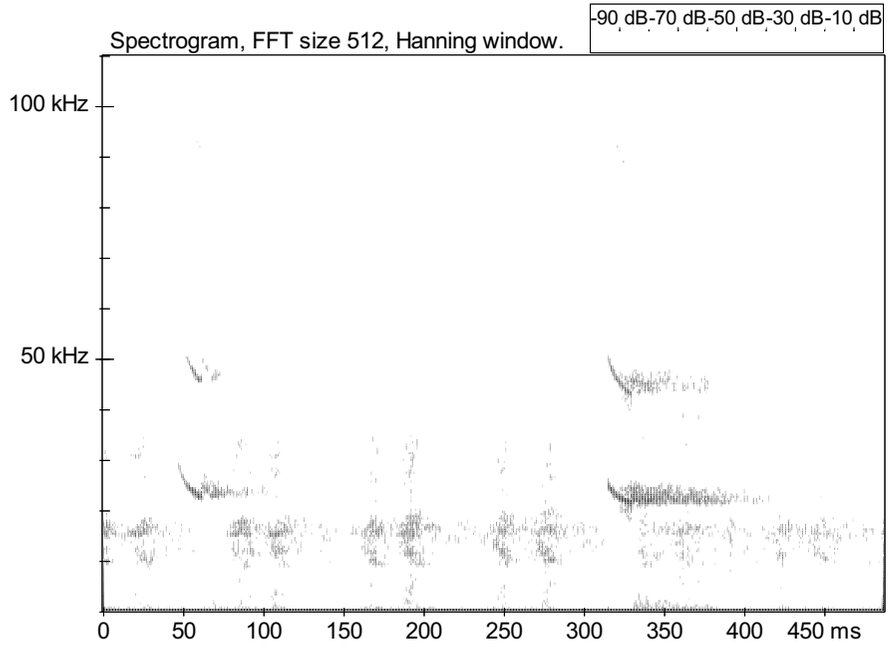

Fig. 6. Echolocation calls of *Nyctalus leisleri*, Burgas.

Eptesicus serotinus (SCHREBER, 1774) - Serotine

The Serotine bat has a large distribution over the plain areas of Bulgaria. Frequently it inhabits the crevices in buildings (POPOV, SEDEPHCHEV 2003), but its main feeding habitat in the studied region is the lake zone. It hunts at a height of 6-10 m. High activity was observed at dusk, together with *N. noctula*. The study of JENSEN, MILLER (1999) shows a strict correlation for Serotine bats between the mean frequency of echolocation calls and the height of flight. For bats flying above 8 m the mean frequency range is between 17 and 27 KHz. The mean terminal frequency decreases gradually from around 30,5 KHz to around 25,5 KHz for bats flying at a 9 m altitude or higher. The frequency of echolocation calls, detected in the region of the Burgas wetlands, varies from 23 KHz to 29 KHz (Fig. 7).

Pipistrellus pipistrellus (SCHREBER, 1774) - Common pipistrelle

The species is widely distributed in Bulgaria and is frequently found together with other species of the genus *Pipistrellus*. The Common pipistrelle forms colonies, mainly in lowlands, up to 600 m a.s.l., and they hunt close to their daily roosts. The echolocation calls, detected in the studied region, have a maximum frequency of about 45-49 KHz. The bats emitted typical social calls (Fig. 7), detected frequently during October 2002 in the central town zone of Burgas and the adjacent villages. Together with *P. nathusii*, this is the most frequent species in the Burgas wetlands (Fig. 8).

Pipistrellus nathusii (KEYSERLING, BLASIUS, 1839) - Nathusius's pipistrelle

This species is considered to be rare in Bulgaria. Long distances between winter roosts in Western Europe and maternity colonies in Eastern Europe confirm the seasonal migration of this species (JARZEMBOWSKI 2003). According to BENDA *et al*. (2003) there is no evidence of a permanent occurrence and reproduction of *P. nathusii* on the

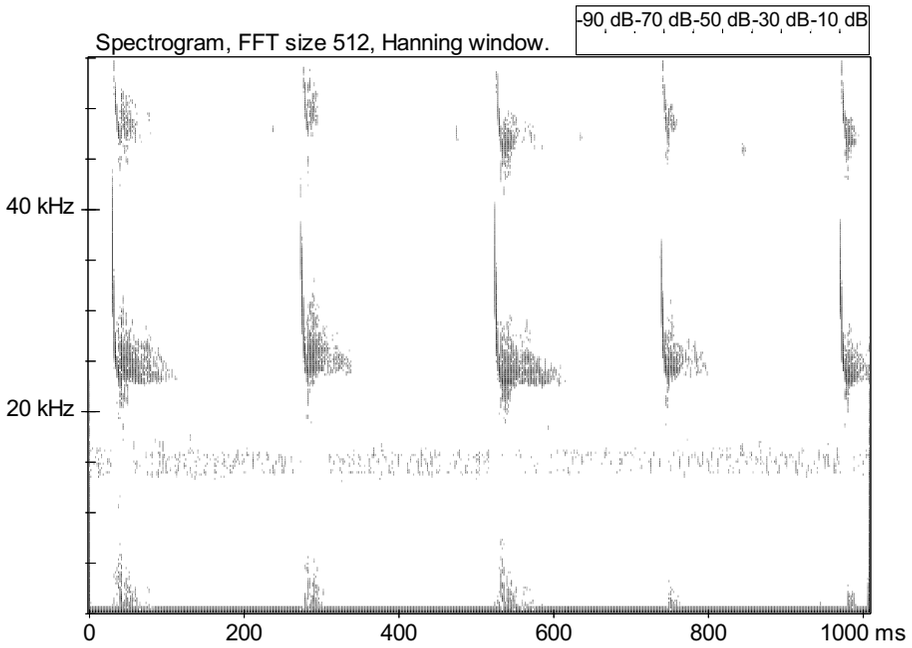

Fig. 7. Echolocation call of *Eptesicus serotinus*, Pomoriisko Lake.

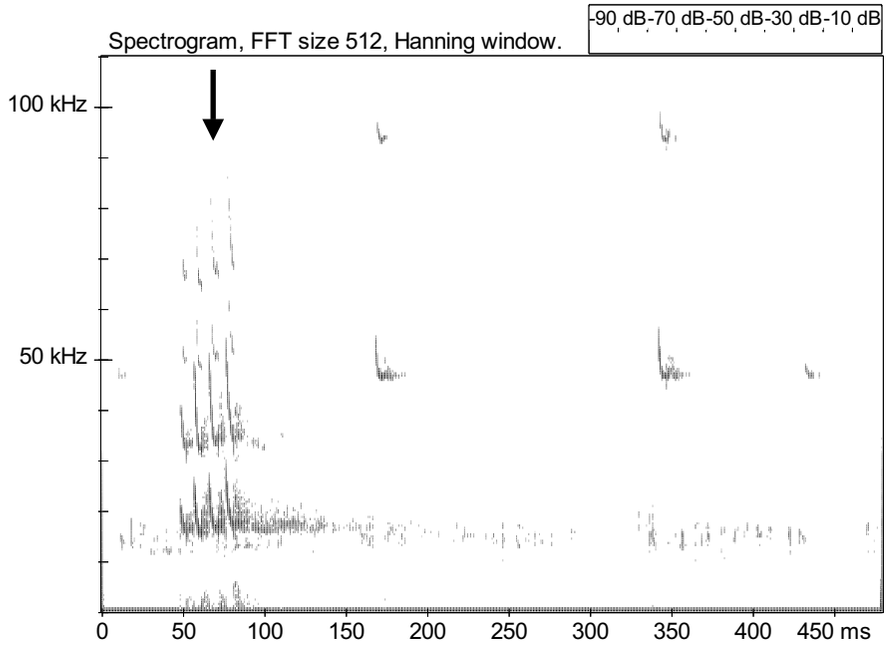

Fig. 8. Social (see the arrow) and echolocation calls of *Pipistrellus pipistrellus*, Burgas.

territory of Bulgaria and theoretically, a resident population could exist in certain floodplain region. The registered low activity of the species during the reproductive period in the region of the Burgas wetlands confirms this hypothesis. Nathusius's pipistrelle hunts frequently above the water surface. Their echolocation calls have a mean frequency of about 38-41 KHz. The social calls, emitted during the mating period to attract females for harem formation, are population dependent (AHLÉN 1991). The calls of *P. nathusii* emitted outside the mating period may also play another social function. These calls modulate between 14 and 45 KHz (FURMANKIEWICZ 2003). During the late autumn period of 2002, social calls were frequently detected from bats feeding above the water surface of the Pomoriisko Lake (Figs. 9 and 10).

Pipistrellus pygmaeus (LEACH, 1825) - Soprano pipistrelle

The Soprano pipistrelle was only recently established in Bulgaria (DIETZ *et al*. 2002). Our studies with ultrasonic detectors demonstrate that the species is widely distributed in great numbers over some wet zones along the south Bulgarian Black Sea coast. In the region of the Burgas wetlands it is a relatively rare bat species: only a few specimens, together with *P. pipistrellus*, have been observed above the lake surfaces. This species is easily distinguished by echolocation calls with a mean frequency of over 50 KHz (Fig. 11).

Hypsugo savii (BONAPARTE, 1837) - Savi's pipistrelle

The Savi's pipistrelle is a very rare species in the studied region. Only isolated specimens were detected above the water surface in the early hours of the morning. It has not been detected in any human agglomerations within the studied area. Echolocation calls have a maximum frequency of about 34 KHz (Fig. 12). Social calls have not been detected in the Burgas wetlands.

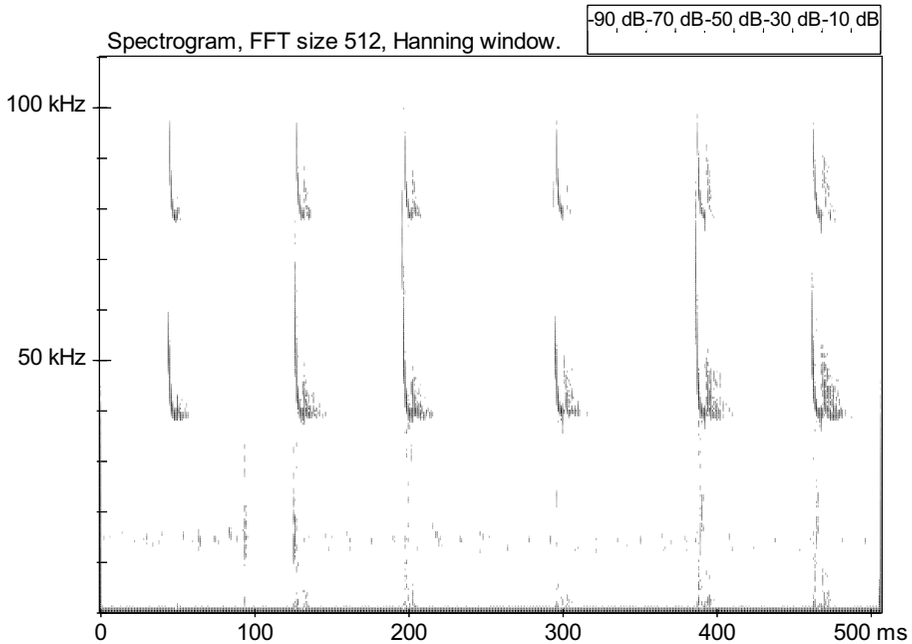

Fig. 9. Echolocation calls of *Pipistrellus nathusii*, Vaya Lake.

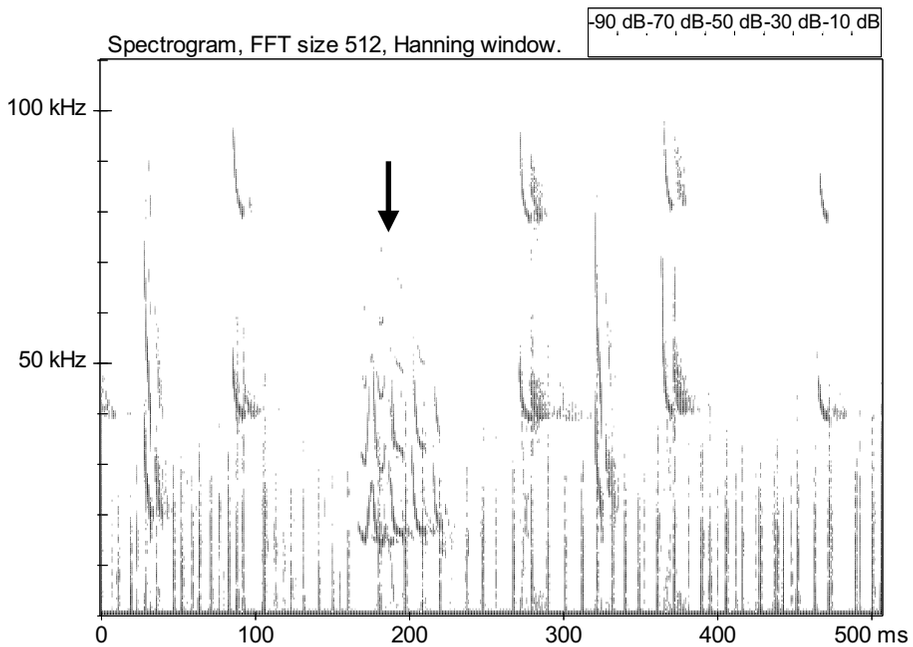

Fig. 10. Echolocation and social (see the arrow} calls of *Pipistrellus nathusii*, Pomorie Lake.

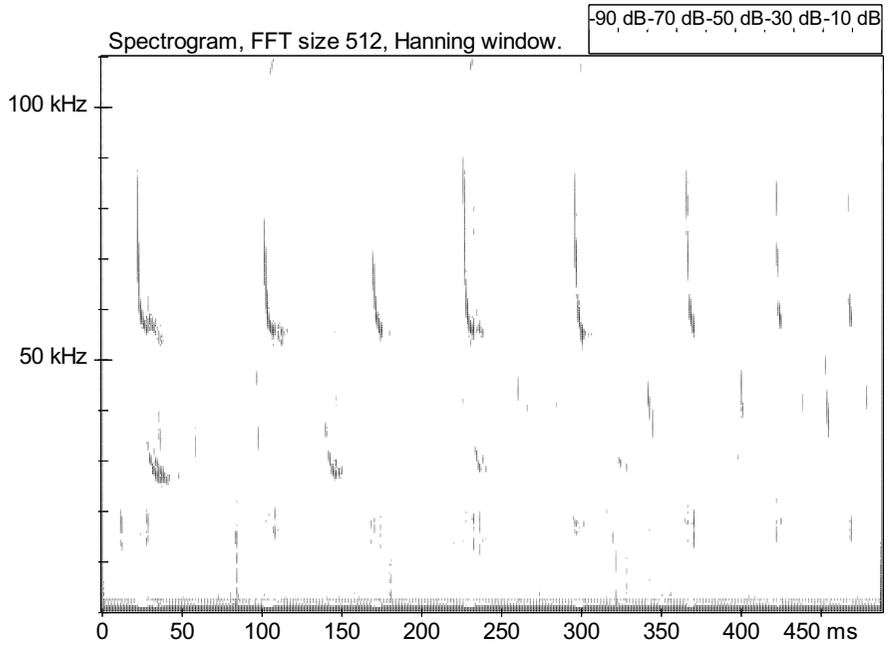

Fig. 11. Echolocation calls of *Pipistrellus pygmaeus*, Burgas.

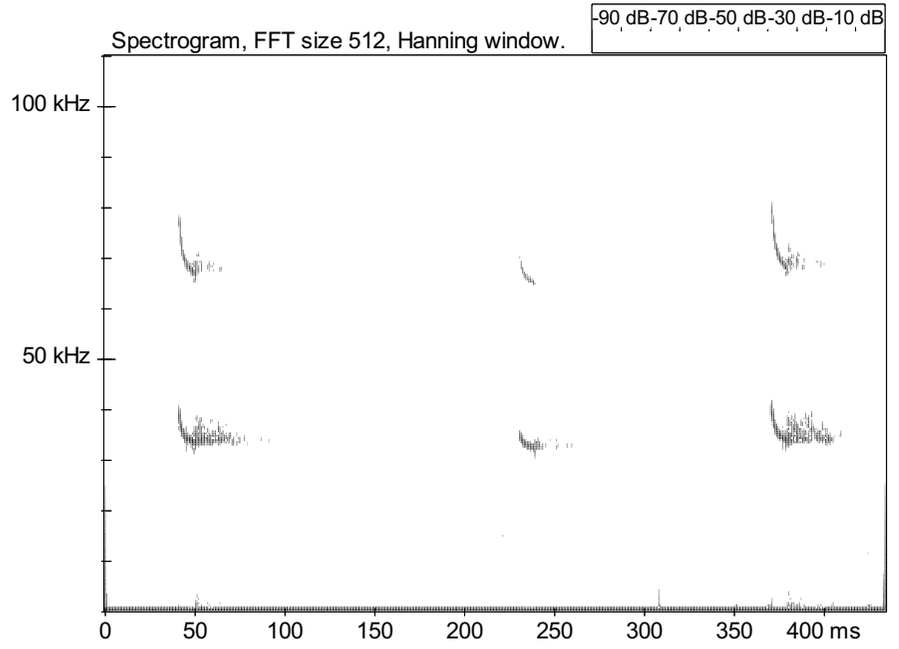

Fig. 12. Echolocation calls of *Hypsugo savii*, Pomorie Lake.

Analysis of bat assemblages

Territorial distribution and activity are shown on Table 2.

Table 2. Species composition of the bat community in the Burgas wetlands.

Species / Localities	M. daubentonii	N. noctula	N. leisleri	E. serotinus	P. pipistrellus	P. nathusii	P. pygmaeus	H. savii	Total number of species
Pomoriisko Lake	+	+	+	+	+	+	+	+	8
Aheloi River	+				+	+			3
Atanassovsko Lake	+	+	+	+	+	+	+	+	8
Vaya Lake	+	+	+	+	+	+	+	+	8
Dolno Ezerovo		+		+	+	+			4
Aitos River		+		+	+	+	+		5
Burgas, central town zone		+	+	+	+	+	+		6

Short remarks about the bat activity in each of the studied regions during the period of reproduction and the period of autumn migration are given below.

Pomoriisko Lake (Fig. 1, Table 3)

Table 3. Species composition and frequency of bats in the region of the Pomoriisko Lake.

Species	6-9.09.2002		18-22.10.2002		26-27.06.2003	
	Number of recordings	pF (%)	Number of recordings	pF (%)	Number of recordings	pF (%)
P. pipstrellus	61	20,9	33	31,1	2	40,0
P. nathusii	160	54,8	70	66,0	3	60,0
P. pygmaeus	1	0,4	-		-	
Pipistrellus sp.	5	1,7	-		-	
H. savii	8	2,7	1	0,9	-	
M. daubentonii	5	1,7	2	2,0	-	
E. serotinus	3	1,0	-		-	
N. noctula	30	10,3	-		-	
N. leisleri	10	3,4	-		-	
Indeterm.	9	3,1	-		-	
Total number of recordings	292	100	106	100	5	100

Observations Made During the Autumn Period of Migration

The highest feeding activity was observed near the town of Pomorie (the Museum of Salt, the Sanatorium and the Dam). *Pipistrellus nathusii* (pF=54,8 %), *P. pipistrellus* (pF=20,9 %) and *N. noctula* (pF=10,3 %) are dominant there. High activity of *Pipistrellus nathusii* and *P. pipistrellus* was observed in October 2002 near the new dams used for the extraction of salt. The activity was constant during the studied nights, but lower in the western part of the lake.

The exclusively rich nutritive base represented by adult forms of Chironomidae (*Chironomus aprilinus* Meigen, 1830 and *Chironomus salinarius* Kiefer, 1915) is the main reason for the high feeding activity of bats in late autumn, in spite of the strong wind during this period. During this period we observed directly the foraging of the bat communty on adults of Chironomidae. The number of bats in the studied community probably reaches some thousand individuals.

Observations During the Reproductive Period

In June 2003 we observed very low bat activity in the region of the lake. Only isolated specimens of *P. nathusii* and *P. pipisrellus* above the lake and around the streetlights in Pomorie were detected. This can be explained by the very poor development of adult Chironomid insects in the saltwater of the Pomoriisko Lake.

Aheloi River: Period of Autumn Migration

We observed a moderate degree of activity of *Pipistrellus nathusii*, *P. pipistrellus* and, rarely, *Myotis daubentonii*, flying above the river.

Atanassovsko Lake (Fig. 13, Table 4)

Observations During the Autumn Migration

Two lake zones were identified in relation to the degree of activity of bats. The highest activity was detected in the southern part of the lake, close to the settlement of Izgrev, and the channel with freshwater inflow. Seven species were established there, including *N. leisleri* (pF=13 %) and *Myotis daubentonii* (pF=4,8 %).

Relatively low activity was observed in the central ultrahalinne part of the lake,

Table. 4. Species composition and frequency (in %) in the region of the Atanassovsko Lake.

Species	6-9.09.2002		26-27.06.2003	
	Number of recordings	pF (%)	Number of recordings	pF (%)
P. pipistrellus	7	11,3	13	72,0
P. nathusii	19	30,0	5	28,0
P. pygmaeus	1 –%	1,6	-	
M. daubentonii	3 –%	4,8	-	
E. serotinus	2 –%	3,2	-	
N. noctula	16 –%	25,0	-	
N. leisleri	8 –%	13,0	-	
Indeterm.	4 –%	11,1		
Total number of recordings	62	100	18	100

separated by small dams used for the extraction of salt. *N. noctula* was the dominant species.

Observations During the Reproductive Period

The number of bat species tended to decrease during this period. Only two species (*P. pipistrellus* with pF=72 % and *P. nathusii* pF=28 %) were detected.

Vaya Lake (Fig. 14, Table. 5)

Table. 5. Species composition and frequency of bats in the region of the Vaya Lake.

Species	6-9.09.2002		18-22.10.2002		26-27.06.2003	
	Number of recordings	pF (%)	Number of recordings	pF (%)	Number of recordings	pF (%)
P. pipistrellus	39	13,6	27	27,8	29	37,2
P. nathusii	123	42,8	66	68,0	15	19,2
P. pygmaeus	2	0,7	-		2	2,6
H. savii	3	1,0	-		-	
M. daubentonii	8	2,8	-		-	
E. serotinus	4	1,4	2	2,1	16	20,5
N. noctula	73	25,4	2	2,1	15	19,2
N. leisleri	1	0,3	-		-	
Indeterm.	34	12,0	-	0	-	1,3
Total number of recordings	287	100	97	100	78	100

Observations During the Autumn Migration

Ten species form the bat community. Their activity was high and constant, not only on the lakeshore near the village of Dolno Ezerovo, but also on the studied transect in the central part of the lake. In October 2002 the species decreases considerably after 20:00 h, because of the low air temperature and low abundance of insects: in fact only two species were dominant in this late autumn period (*P. nathusii* with pF=68,04 % and *P. pipistrellus* with pF=27,83 %).

Observations During the Reproductive Period

Six species were established. *P. pipistrellus* dominates with an abundance of 37,18 %. In this period *P. nathusii* had a relatively low frequency of 20 %. *P. pygmaeus* is extremely rare: only two recordings of its echolocation calls were made.

Aitos River - under the bridge near the Dolno Ezerovo Village: period of autumn migration (Table. 6)

P. nathusii was the dominant species. The other four species were detected by isolated specimens.

Dolno Ezerovo Village

The species composition here was very similar to that established along the Aitos River, but *P. pygmaeus* was not detected. The activity was concentrated around the streetlights.

Table. 6. Species composition of bats along the Aitos River.

Species	Date: 7.09.2002	
	Number of recordings	pF (%)
N. noctula	2	6,1
E. serotinus	1	3,0
P. pipistrellus	4	12,1
P. nathusii	24	72,7
P. pygmaeus	2	6,1
Total number of recordings	33	100

Town of Burgas (Table. 7)

Table. 7. Species composition and frequency of bats in the city of Burgas.

Species	6-9.09.2002		18-22.10.2002		26-27.06.2003	
	Number of recordings	pF (%)	Number of recordings and frequency in %	pF (%)	Number of recordings and frequency in %	pF (%)
N. noctula	1	12,5	6	13,3	10	10,7
N. leisleri	1	12,5	1	2,2	2	2,1
E. serotinus	-		1	2,2	-	
P. pipistrellus	5	62,5	32	71,2	37	43,2
P. nathusii	-		4	8,9	36	38,7
P. pygmaeus	1	12,5	1 –%	2,2	2	2,1
Pipistrellus sp.	-		-		3	3,2
Total number of recordings	8	100	45	100	93	100

Observations During the Autumn Migration

Many specimens of *Pipistrellus pipistrellus* were observed at dusk in the central town zone. This was the dominant species during the whole period of monitoring, with a very high abundance in autumn. Groups of individuals of Common pipistrelles around the streetlights in the Slaveikov settlement were observed in the early hours of the night during October. The males frequently emitted social calls (Fig. 8) and demonstrated "display behaviour" (SCHOBER, GRIMMBERGER 1991).

Observations During the Reproductive Period

The structure of the bat community did not change. *P. nathusii* and *P. pipistrellus* had an almost equal frequency of occurrence of about 39 %.

Conclusions and Conservation Measures Proposed

The studies of bats in the wetlands of Bulgaria are still in their initial stages. Previously acquired data were collected sporadically using classical methods of field observations (e.g. capturing bats by mistnets in some potential foraging sites). The application of more advanced methods for recording and analysis of bat sounds in different landscapes allowed us to study the structure of bat communities and their foraging activity in detail (PANDOURSKI, WHITCHER, in press). The present study shows the first results on the dominant species composition, the activity and the territorial distribution of bats in the Burgas wetlands.

The Burgas lakes are very important foraging sites for large populations of several different bat species. The very rich food supply, represented by adult forms of Chironomidae (*Chironomus aprilinus* MEIGEN, 1830 and *Chironomus salinarius* KIEFER, 1915 in the Atanassovsko and Pomoriisko lakes, and *Chironomus balatonicus* DEVAI, WULKE, SHOLL (KRASTANOV, personal communication) in the Vaya Lake) attracts many bats. PANDOURSKI (2001) established that the number of benthic juvenile forms of Chironomidae in the Vaya Lake can reach 842 specimens/m^2. Thus, even in late autumn periods, the bat population is very big.

The bat community during the studied period is composed of eight species. The two species of the family Vespertilionidae (*Pipistrellus pipistrellus* and *P. nathusii*) dominate. The latter was considered to be rare in Bulgaria due to the small number of known roosts. In our study we confirmed that it was very common in the studied area, as we detected very high foraging activity above all studied lakes near Burgas. We have established that *Pipistrellus pygmaeus* is not a common species, but does forage above the Vaya Lake.

Another two comparatively common bat species here are *N. noctula* and *E. serotinus*. We can refer them to the antropophilous complex, as in the region near the studied lakes the settlements are well presented and supply suitable day roosts for bats. These two species were detected not only in the city of Burgas, but also in the surrounding wetlands.

Some bat species, which typically inhabit forests or rocky and karst terrains, are comparatively rare in the studied region of the Burgas lakes. Isolated individuals of *Hypsugo savii* and *Pipistrellus pygmaeus* were detected foraging above the water surface of the lakes at and after midnight.

During the autumn period of migration, the Burgas lakes play an important role for the feeding of numerous populations of Nathusius's pipistrelle, considered to be a rare species in Europe.

Bats are a very important element of the general biological diversity of the Burgas wetlands, which, having a very rich fauna, represent a very valuable site for the conservation of the ecological equilibrium along the Bulgarian South Black Sea coast.

We consider the following conservation measures for the bats of the Burgas wetlands of utmost importance:

- Protection and amelioration of the quality of lake waters. This measure will ensure a good nutritive base for bats: adult forms of aquatic insects, mainly from the Chironomidae family.
- Protection of riparian forests around the wetlands, focusing on the preservation of old tree holes that are suitable for the roosting of many bat species of the genera *Pipistrellus* and *Nyctalus*.
- To create a positive attitude within local people towards the conservation of bats inhabiting the agglomeration in the region of the Burgas lakes. This can be achieved by the production and dispersal of educational materials.
- Control of toxic gas emissions from the petrol refinery in Burgas and the local industry.
- Control of the application of pesticides and insecticides in agricultural practices in the area of the Burgas wetlands.

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