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A PRELIMINARY ASSESSMENT OF THE ORNITHOLOGICAL IMPORTANCE OF KARST POLJES AT BOSANSKO GRAHOVO (WESTERN BOSNIA AND HERZEGOVINA)-RESULTS OF A LARGE-SCALE SURVEY IN PERIOD 1974 TO 2020

SUMMARY

This paper presents the results of long periods of research on the bird fauna of municipality of the Bosansko Grahovo, and these systematic surveys of the ornithofauna of this area have been running continuously since 1974. This contribution contains a full list of the noted bird species. Birds were recorded at times of nesting, spring and autumn migrations as well as in winter. Twenty years ago, the avifauna of the municipality of Bosansko Grahovo was poorly known. To date, or to this paper, about 50 bird species have been noted on the municipality of Bosansko Grahovo (Livanjsko polje not included). Birds were recorded at times of nesting, spring and autumn migrations as well as in winter. During large number of field excursions, which were performed in all seasons, 165 bird species were registered in B. Grahovos area, and today it can safely be said that 105 bird species nest on this area (Livanjsko polje not included). Because of the diversity of its flora and fauna, the area of the municipality of Bosansko Grahovo harbors favorable bird habitats during the whole year.

Key words: Birds, distribution, biodiversity, the municipality of Bosansko Grahovo, karst poljes, types of habitat.

INTRODUCTION

The birds of karst poljes of Bosansko Grahovo (except the part belonging to Livanjsko polje) are poorly researched. Data on the presence of multiple species from Bosansko Grahovo municipality are indicated by Reiser (1939), while data on individual species are available from different authors, such as Fernbach (1963) and Lukač *et al.* (1992). During last few decades, the ornithofauna of karst poljes is intensively researched (Kotrošan *et al.* 2013, 2018; Sackl *et al.* 2014), particularly part of Livanjsko polje (Obratil, 2006; Milanović and Kotrošan, 2012; Stumberger & Sackl 2009), although some poljes are investigated in detail in the past (Puzović *et al.* 2019; Obratil, 1984., 1987.,

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1992). Generally, the area of the municipality of Bosansko Grahovo (=B. Grahovo) is poorly investigated, and in last two decades, smaller and partial researches were conducted on Grahovo's karst poljes (Kotrošan *et al.* 2013 and 2018; Sackl *et al.* 2014) and surrounding mountains (Fernbach, 1963; Hadžiabdić, 2008; Grubešić *et al.* 2011). It is renowned that karst poljes have a great importance for many water-bound bird species, both nesting and migratory (Stumberger and Sackl 2009; Sackl *et al.* 2014; Topić *et al.* 2019). Moreover, it is known that karst poljes represent an important corridor for many European species, particularly during autumn migration (Schneider-Jacoby, 2008; Stumberger & Schneider-Jacoby 2010; Denac *et al.* 2010).

The karst poljes, as well as the complete Dinaric karst are characterized by a diverse, rare and endemic flora and fauna. In particular, the subterranean fauna of the Dinaric Karst is the richest and the most diverse in the world. Grahovo poljes and the whole area of municipality are inhabited by different endemic species (karst endemics), but only the ichthyofauna has been intermittently researched (Marić, 1980, 1983, 1990; Delić *et al.* 2006, etc.).

This paper is aimed to provide a more detailed information on the diversity of birds in this area and its importance for breeding, migratory and wintering birds.

MATERIAL AND METHODS

Study area

Geographical position of Bosansko Grahovo municipality

The study area, the municipality of Bosansko Grahovo, is situated in west part of Bosnia and Herzegovina (B & H) (Fig.1) and it covers 780 km². It is situated between 16° 21' 00" and 16° 27' 00" of eastern geographical longitude and 44° 09' 00" and 44° 11' 00" of northern geographical latitude. The municipality of Bosansko Grahovo situated in hilly terrain B&H (Fig. 2) area and surrounded with mountains Uilica (1602 m), Jadovnik (1650 m), Šator (1872 m) and mountain Dinara with its peak Veliki bat (1851 m). There are 4 karst poljes among or between those mountains: Grahovo poljes (3 poljes) are 790-850 m a.s.l., 29 km length and width 2 - 4 km (80 km²) and Livanjsko polje which is 700-800 m a.s.l. The Livnjsko polje, part of it which belongs to the municipality of Bosansko Grahovo has surface of around 10.000 ha (average width 8 km, 13 km length). The massif of the Dinara and Uilica Mountain separates the Karst poljes from the Adriatic, which is only 50/60 km away.

In the languages of the Dinaric Karst's countries the term "polje" has different meanings and wide uses. In its broadest way, it "polje" means: flat and open land, often in the sense of living space and the source of goods. However, for the people who live in the Dinaric Karst their most common and peculiar meanings are related to karst poljes (Lučić, 2014).

Different poljes within the area the municipality of Bosansko Grahovo are often inaccurately named in the literature (e.g. Scwarz, 2013; Kotrošan *et al.* 2018; Topić *et al.* 2019; Rubinić *et al.* 2019 etc.).

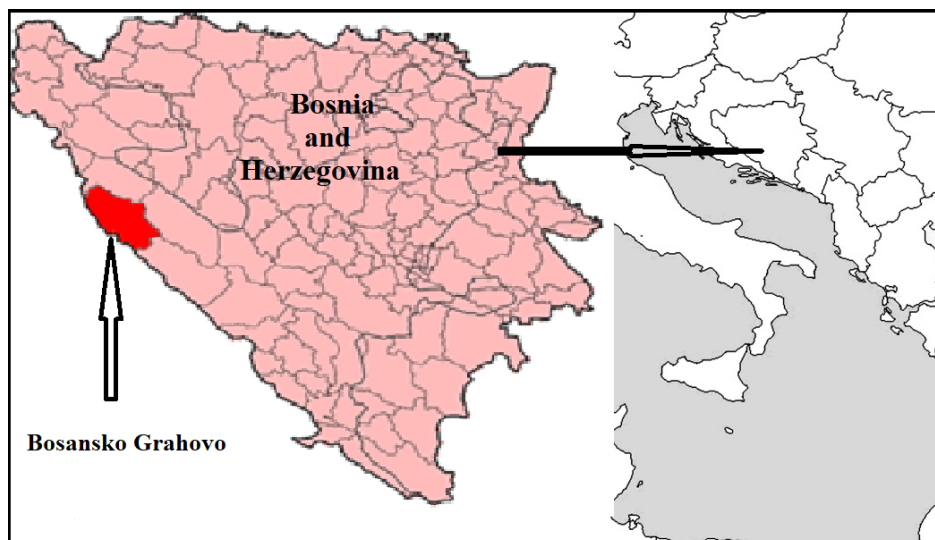


Figure 1. Geographical position the municipality of Bosansko Grahovo

Mostly, all of them are put under name of Grahovo poljes, except the part of Livanjsko polje, as stated in Stumberger et al. (2014). Local people use term “Pašića polje” for flat ground around the town of B. Grahovo and east to Korita village (in length of about 6 - 7 km) as well as the rocky area with many sinkholes on both sides of the road to Livno town. The length of Pašića polje is around 12 km, and its surface area is about 25 km². Another polje, situated north-west of the B. Grahovo town towards Drvar is dubbed “Resenovačko polje”, by the similar Resnovci village. Parts of this polje are sometimes named after the nearest village. Besides wrong toponyms, the catchment basins that these poljes belong to are also mis stated (e.g. Stumberger et al. 2014). The waters of Pašića polje, which contain sinking River Korana flow to the Krka River (Adriatic basin), and waters of Resenovačko polje with the sinking River Struga flow to the Unac River, then the Una river, which belongs to the Black Sea basin (Marić, 1980; Bonacci and Ljubenkovic 2005; Bonacci *et al.* 2006).

Typical karst poljes shows complex hydrogeological characteristics such as exsurgences, estavelles, swallow holes, and losing rivers. Within the 42 km long valley of B. Grahovo, besides the two mentioned larger poljes (Pašića and Resenovačko polje) there are also smaller polje near villages of Marinkovci and Maleševci at higher altitudes of 790 - 830m. Resenovačko and Pašića poljes are connected through a narrow valley containing numerous karst hollows and depressions.

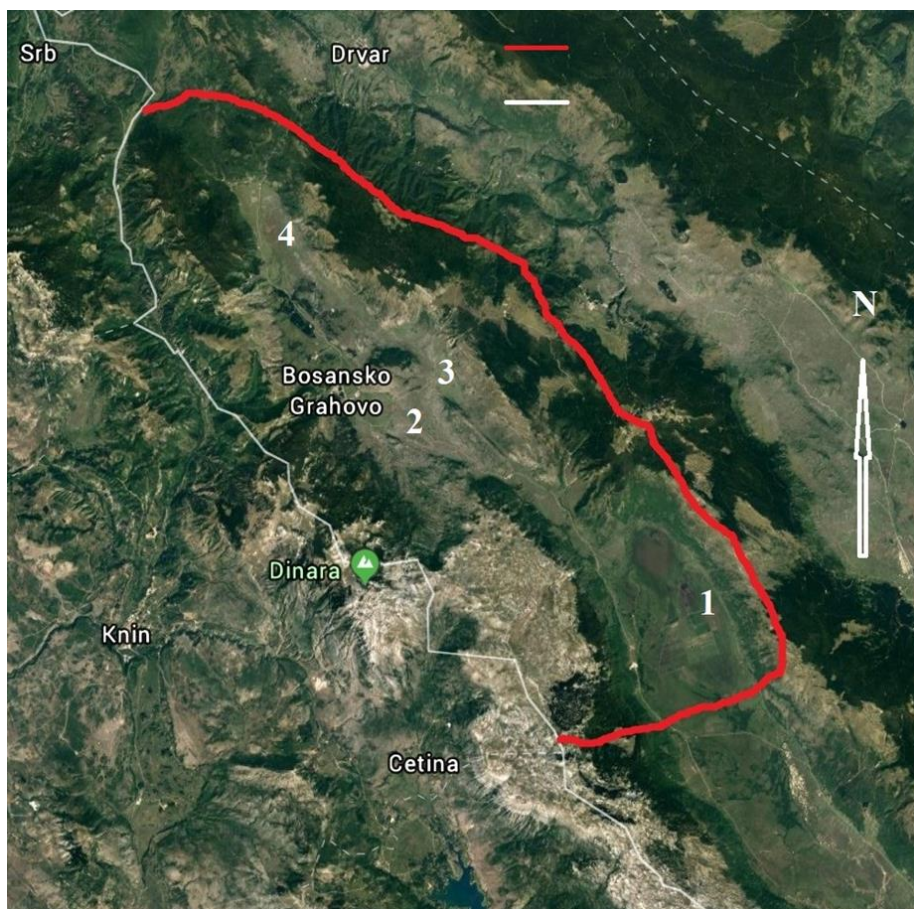


Figure 2. The area of the municipality of Bosansko Grahovo, red line border between the municipalities and white line borders between the states. 1) Livanjsko polje, 2) Pašića polje, 3) Marinkovci polje, 4) Resenovačko polje

Climate at Bosansko Grahovo municipality area

The municipality of Bosansko Grahovo, even though by its position is very close to Adriatic sea, has continental climate with long and sharp winters and short and dry warm summers. Due to its position this area has very big number of sunny days in a year. Mean annual temperature is 5.6 °C and the average annual precipitation is 1,990 millimeters (Federal Hydrometeorological Institute of Bosnia and Herzegovina).

Demographic Data

At the area of the municipality there are presently 32 settlements (in the past 35) from 550 m a.s.l. up to 1200 m a.s.l. According to the 1991 census, the municipality of Bosansko Grahovo had 35 settlements and 8.311 inhabitants, while today's municipal administration estimates less than 1.000 inhabitants, which shows almost 90% decline in comparison to 1991 census.

Landscapes and biota in the municipality of B. Grahovo

Region of the municipality of B. Grahovo contains all types of karst landforms and features including karren (lapies), dolines, jamas (pits), ponors (swallow holes, sinks), dry and blind valleys, caves and caverns as single forms, and uvalas, poljes and karst plains as larger complex forms.

Characteristic of this area is that poljes are encircled by high hills and mountains (Fig. 2), overgrown with forests on the north side, while southern expositions are barren (pastures) or covered with low forest and bush vegetation. The tallest parts of mountains (above 1500 - 1600 m a.s.l.) are barren pastures, with scarce shrub vegetation (see vegetation types below).

In general, typical karst poljes are elongated and closed depressions with bottoms that have been leveled and covered with arable soils which are surrounded by gentle or, more rarely, by steep mountain slopes. Poljes exhibit complex hydrological and hydrogeological features and characteristics, such as permanent and temporary springs and rivers, losing and sinking rivers (Fig. 3), and swallow holes and estavelles.

Karst poljes are characterized by unique landscape: central parts are flat and usually arable land, and the lower parts, which contain sinking rivers, are swampy and flooded in winter. Situated at the edge of each karst polje there is a small village (Fig. 4), usually by the main roads.

The settlements are surrounded by either small hills or rugged flat land, usually without trees. Those areas are used for grazing (Fig. 5) and they are much larger than arable land.



Figure 3. Sinking River Korana in Pašića polje (photo D. Marić)



Figure 4. Karst polje – the central part of Pašića polje, at the edge of polje there are small villages (photo D. Marić)

Within these pastures, larger dolinas and rock-free patches were also plowed and mowed (Fig. 6). This is the area where flocks of sheep, goats, cows and horses were extensively and seasonally grazed by 60.000 animals in the past. About 50.000 sheep were grazing in the study area year-round, keeping the vegetation here short and succession limited in the past, now about 3.000 (10.000) (personal observation).

The grazing period in the municipality of B. Grahovo typically lasted from mid-March to early July on grasslands and from end-July to early November on hay meadows.

The municipality of Bosansko Grahovo presents a typical livestock region, where arable land (plough-land, gardens, settlements and orchards) covers 4.6%, while forests cover 38.19% of the total area (780 km²).



Figure 5. Pastures in Pašića polje (photo D. Marić)



Figure 6. A typical *dolina* in arid parts of polje (photo D. Marić)

Permanent pastures and hay meadows cover 57.21% of the total area. Individual ploughs are small, and do not exceed 1 ha. Settlements are either small villages with up to 250 inhabitants or single farms, located between arable land and pastures. Near the settlements, typical land use consists of orchards, a combination of crops and vegetables (autumn and spring-sown cereals, legumes, maize, potatoes, cabbage, beets, parsley, carrots, etc.), hay and silage for winter forage, and small grazing pastures for cattle, sheep and horses. Cereals are sown from October to November and harvested in August, but potatoes are sown in April and harvested in September or the first week of October. Potato is currently the most extensively cultivated crop but it covers only about 10% of arable land. After harvesting, the fallow is not ploughed until April. Plough margins are dominated by *Heracleum* spp., *Artemisia* spp., *Achillea* spp., *Cirsium* spp., *Centaurea* spp., and scattered bushes, mostly *Rosa canina* and *Crataegus monogyna*. The meadows are covered by diverse vegetation dominated by *Deschampsia* sp., *Bromus erectus*, *Brachypodium pinnatum*, *Calamagrostis villosa*, *Agrostis schraderiana*, *Poa* spp., *Molinia* spp., *Iris* spp., *Ranunculus* spp., *Filipendula* spp., *Hieracium* spp., *Ononis spinosa*, with presence of single or small trees or shrubs (mostly *R. canina*, *C. monogyna*). Hay is usually mowed before the end of July. Mowing in the B. Grahovo poljes always strongly depended on weather conditions and took place only on days

without precipitation. Over the whole observation period, mowing of hay meadows occurred on 30 days.

Natural grazing pastures are an integral part of traditional farmland landscape in karst polje area, where continuous grazing regime sometimes is maintained for centuries. Pasture vegetation is dominated by *B. pinnatum*, *Nardus stricta*, *B. erectus*, *Festuca* spp., *Danthonia* spp., *Stipa* spp. and *Scorzonera villosa*, *Thimus* spp., *Trifolium* spp., *Teucrium* spp., *Eryngium* spp., *Potentilla* spp., *Sanguisorba* spp., *Lotus* spp. The high species diversity of native grasses and herbs is probably a result of specific climatic/weather conditions, geological structures, specific soil nutrient levels etc.

The small height of grasses and herbs was the result from the continuous biomass removal through grazing and no use of artificial fertilizers in the past. Boulders occur frequently within the pastures, which makes the ground unsuitable for plowing and this natural pasture is usually a fine-scaled mosaic of open ground, shrubs, trees, and boulders. The pastures are not privately owned and no boundary hedges exist. According to ecological and vegetation classification of Bosnia and Herzegovina (Stefanović *et al.* 1983), this area belongs to both Mediterranean-Dinaric and Sub-Mediterranean-alpine regions. Following sources are used for all descriptions of habitat types: *Interpretation manual of European Union habitats-EUR 28-NATURA 2000*, Brussels: European Commission-DG Environment, http://ec.europa.eu/environment/nature/legislation/habitats_directive/index_en.htm#interpretation. (2013), Field guide to Natura 2000 habitat types in Bosnia and Herzegovina (Milanović *et al.* 2015).

11 macro habitat types were defined and according to NATURA 2000 twenty-nine habitats types were defined in the municipality of B. Grahovo (not included Livanjsko polje):

- 1.ASG** = Alpine and subalpine grasslands or Alpine pastures and stony grasslands (over 1200 meters a.s.l.) and screes (8120, 8140). Four habitat types of pastures were defined (NATURA 2000 code): 6110, 6170, 6230, 62D0.
- 2.AB** = Alpine bushes: Bushes with *Pinus mugo* and *Rhododendron hirsutum*., *Pinion mugo* Pawlowski 1928. Three habitat types were defined (NATURA 2000 code): 4060, 4070, 4080.
- 3.For** = forest (woods)., deciduous and evergreen, This forest in the municipality of B. Grahovo is represented by several phytocoenoses. Seven habitat types were defined (NATURA 2000 code): 9110, 9130, 9140, 91K0, 91R0, 9410, 9530. There are few relatively preserved forests, more frequent are degraded and sprout-forests in different development stages.
- 4.ForW** = Forests along the banks of creeks and rivers, habitat types is probably 91E0 (NATURA 2000 code), these forests (host forests of alder, willows and poplar forests) are along the banks of sinking rivers

(the Struga and the Korana), it is now reduced to fragments and a narrow coastal strip (key species: *Alnus glutinosa*, *A. incana*, *Salix alba*, *S. fragilis*, *S. purpurea*, *Populus nigra*, *P. alba*).

- 5.HSCH** = high shrub deciduous and evergreen bushes (up to 7-10m) or forests with large clearings, degraded forests in different degradation stages (cover 20-40%) (key species: *Fagus sylvatica*, *Acer obtusatum*, *Sorbus aria*, *Fraxinus ornus*, *Carpinus betulus*, *Betula pendula*, *Populus tremula*, *Sesleria autumnalis*.). Two habitat types were defined (NATURA 2000 code): 9140 (*Aceri-Fagetum*-degraded stages), 91K0 (*Ostryo-Fagenion*-degraded stages).
- 6.SCH** = deciduous bushes: bushes, shrubs of low trees and shrubs (mostly up to 3m high) with large clearings (20-70%), Bushes with: *Rossa spp.*, *Crategus spp.*, *Amelanchier ovalis*, *Corilus avellana*, *Cornus mas*, *Cornus sanguinea*, *Ostrya carpinifolia* (key species) etc, are the common forms of succession, which in the progradation line comes as a developmental stage between pasture and permanent forest stages.
- 7.DCG** = Dry calcareous grasslands, From karst poljes to the montane zone, several types of calcareous grasslands exist. Some of them are on sparse rocky or shingle soils. Three habitat types were defined (NATURA 2000 code): 6110, 6210, 6230.
- 8.M & AI** = Meadow & Agricultural land (arable fields, grasslands and wet meadows of karst poljes). Five habitat types (meadows mowing) were defined (NATURA 2000 code): 62A0, 6410, 6510, 6520, 6540 and arable land. The agricultural soils are mostly sown with wheat, ray, oat, barley, maize, legumes and potatoes.
- 9.R & C** = Rocks and caves, rocky habitats and caves (NATURA 2000 code):8240, 8310.
- 10.Sett & O** = Settlements (villages and town) with Orchards.
- 11.W** (water) = Freshwater habitats: springs, brooks, sinking river, short rivers, pools, lakes, wetlands. There is extremely little aquatic vegetation (wetlands) along the water bodies (20-25 ha). mostly by the Lake Pečenci and at the helocrine spring and the Zvijezda stream (both in Pašića polje).

Collection of Field Material

Studies of the ornithofauna of the municipality of Bosansko Grahovo have been running continuously since 1974 to 2020, with the exception of the period 1991 - 2000, when the research was not possible due to civil war and post-war instability. Regular field work was conducted during the whole year, and birds were recorded at times of nesting, spring and autumn migrations as well as in winter. About 2000 days was spent in the field. The used methods were line transect, point counts, “free” method, playback method and capturing and

marking method. For *Crex crex* and Strigiformes, night surveys of calling birds were conducted.

The representatives of all species were visually identified using binoculars (8 x 30, 10 x 40 or 9 x 60) and determined using handbooks: Martino and Matvejev (1947) and Peterson *et al.*, (1968).

The bird species were classified into three categories based on the species' status as a breeder (nesting N), regular winter visitor (W), or a passage migrant (M) (Table 1.). The order of habitats in the table follows the elevation in the vertical profile.

RESULTS AND DISCUSSION

The results of species' observations in period 1974 - 1991 and 2001 - 2020 from the municipality of Bosansko Grahovo (except Livanjsko polje) are shown in Table 1. During our sampling (all methods), we counted over 100.000 individuals of 163 bird species (Table 1), distributed among the orders of Passeriformes (94), Accipitriformes (9), Piciformes (8), Charadriiformes (7), Galliformes and Pelecaniformes (5), and etc. There are few data about the birds of karst poljes of B. Grahovo municipality, except the belonging part of Livanjsko polje. The best description of the ornithological and natural values of Livanjsko polje is found in the great materials of Ornithologia Balcanica (Reiser, 1939). Besides data for Livanjsko polje, Reiser (1939) indicates only 34 bird species for the area of the municipality of B. Grahovo, which are not bound to wetlands of Livanjsko polje.

Later, Fernbach (1963), Lukač *et al.* (1992) and few ornithologists in 21 century indicate only a few more bird species for this area. This paper presents the list of 163 species, which is more than 100 species more than mentioned in the available literature (all cited authors). Only two species cited in the literature (Kotrošan *et al.* 2018) were not registered within this research: Spanish Sparrow (*Passer hispaniolensis*) and Glossy Ibis (*Plegadis falcinellus*). Together with 28 species observed by Obratil (2006) at belonging part of Livanjsko polje (Ždralovac), and three more species-Ferruginous Duck (*Aythya nyroca*), Milanović and Kotrošan (2012), Great White Egret (*Ardea alba*), Kotrošan (2018) and Yellow-legged Gull (*Larus michahellis*), Topić (2018), the total number of species recorded in the area of Bosansko Grahovo municipality is 196.

Within the area of B. Grahovo municipality, we registered 105 species that are certain breeders (nests observed) and four species that occur during the breeding season (May or June) but whose nests were not observed. Seven species were occasionally registered during breeding season, and for some, e.g. Collared Flycatcher (*Ficedula albicollis*) or Turtle Dove (*Streptopelia turtur*) there is a suitable breeding habitat. Kotrošan *et al.* (2018) and Rubinić (2019) do not mention European Turtle Dove for Grahovo poljes. Six species were found only on few days in nesting period.

Table 1. Check list of bird species observed in period 1974-1990 and 2001-2020.

| Scientific name | Status of species | Habitats |
|-------------------------------|-------------------|------------------------------------|
| Species | N-W-M | |
| <i>Anas crecca</i> | M sep. | W |
| <i>Anas platyrhynchos</i> | N | W |
| <i>Aythya ferina</i> | M | W |
| <i>Spatula querquedula</i> | M | W |
| <i>Alectoris graeca</i> | N | ASG, AB |
| <i>Coturnix coturnix</i> | N | M & AI |
| <i>Perdix perdix</i> | N | SCH, DCG, M & AI |
| <i>Tetrao urogallus</i> | N | For |
| <i>Tetrastes bonasia</i> | N | For, HSCH, |
| <i>Columba livia</i> (#) | N | R & C |
| <i>Columba palumbus</i> (#) | N | For |
| <i>Streptopelia decaocto</i> | M? | Sett & O |
| <i>Streptopelia turtur</i> | M? | Sett & O |
| <i>Cuculus canorus</i> | N | AB, For, HSCH, SCH, Sett & O, ForW |
| <i>Apus apus</i> (#) | N | R & C |
| <i>Grus grus</i> | M | M & AL |
| <i>Podiceps cristatus</i> | M | W |
| <i>Podiceps nigricollis</i> | N? | W |
| <i>Tachybaptus ruficollis</i> | N | W |
| <i>Crex crex</i> | N | M & AL |
| <i>Gallinula chloropus</i> | N | W |
| <i>Fulica atra</i> | N | W |
| <i>Porzana porzana</i> | In May | W |
| <i>Rallus aquaticus</i> | In May | W |
| <i>Ciconia ciconia</i> | M | M & AL |
| <i>Ardea cinerea</i> | ? | W |
| <i>Ardea purpurea</i> | M | W |
| <i>Ardeola ralloides</i> | M | W |
| <i>Botaurus stellaris</i> | N? | W |
| <i>Nycticorax nycticorax</i> | In May | W |
| <i>Vanellus vanellus</i> | ? | W |
| <i>Scolopax rusticola</i> | N | HSCH, SCH, ForW |
| <i>Actitis hypoleucos</i> | N | W |
| <i>Gallinago gallinago</i> | ? | W |
| <i>Tringa glareola</i> | ? | W |
| <i>Tringa nebularia</i> | M sep | W |
| <i>Tringa ochropus</i> | N? | W |
| <i>Gyps fulvus</i> # | EX | / |
| <i>Accipiter gentilis</i> (#) | N | For |
| <i>Accipiter nisus</i> (#) | N | For |
| <i>Aquila chrysaetos</i> (#) | N | R & C, For |
| <i>Clanga pomarina</i> | M (1) | N.N. |
| <i>Buteo buteo</i> (#) | N | For |
| <i>Buteo lagopus</i> | Octob. | DCG |
| <i>Circus aeruginosus</i> (#) | ? | M & AL |
| <i>Circus pygargus</i> | N? | DCG, M & AL |
| <i>Circaetus gallicus</i> (#) | N | N.N. |
| <i>Athene noctua</i> (#) | N | R & C |
| <i>Asio otus</i> (#) | N | For |
| <i>Bubo bubo</i> | N | For |
| <i>Otus scops</i> (#) | N | Sett & O, ForW |
| <i>Strix aluco</i> | N | For |
| <i>Upupa epops</i> | N | R & C, DCG, Sett & O, ForW |

| | | |
|----------------------------------|-----------|--|
| <i>Merops apiaster</i> | In June | DCG |
| <i>Alcedo atthis</i> | N | ForW, W |
| <i>Jynx torquilla</i> | N | For, HSCH, Sett & O, ForW |
| <i>Dendrocopos leucotos</i> | N | For, HSCH, Sett & O |
| <i>Dendrocopos major</i> | N | For, Sett & O, ForW |
| <i>Dryobates minor</i> | N | For, HSCH, |
| <i>Dryocopus martius</i> | N | For |
| <i>Dendrocoptes medius</i> | N | For, HSCH, |
| <i>Picus canus</i> | N | For |
| <i>Picus viridis</i> | N | For, Sett & O |
| <i>Falco biarmicus</i> | M/May | M & AL |
| <i>Falco naumanni</i> | M/Sep | DCG, M & AL |
| <i>Falco subbuteo</i> (#) | N | For |
| <i>Falco tinnunculus</i> (#) | N | R & C, For, Sett & O |
| <i>Falco vespertinus</i> | M/Sep-Okt | M & AL |
| <i>Oriolus oriolus</i> | N | For, HSCH, Sett & O, ForW |
| <i>Corvus corax</i> (#) | N | R & C, For |
| <i>Corvus cornix</i> (#) | N | For, Sett & O, ForW |
| <i>Corvus frugilegus</i> | M | M & AL |
| <i>Coloeus monedula</i> | W | M & AL |
| <i>Garrulus glandarius</i> | N | For, HSCH, Sett & O |
| <i>Nucifraga caryocatactes</i> | N | For, Sett & O |
| <i>Pica pica</i> (#) | N | Sett & O, ForW |
| <i>Pyrrhocorax graculus</i> | N | ASG, R & C |
| <i>Lanius collurio</i> | N | HSCH, SCH, DCG, M & Al, Sett & O, ForW |
| <i>Lanius excubitor</i> | W | Sett & O, M & Al, ForW |
| <i>Lanius minor</i> | N | Sett & O, M & Al, ForW |
| <i>Lanius senator</i> | M/May | SCH |
| <i>Parus major</i> | N | For, HSCH, Sett & O, ForW |
| <i>Poecile montanus</i> | N | For |
| <i>Poecile palustris</i> | N | For, HSCH |
| <i>Periparus ater</i> | N | For |
| <i>Cyanistes caeruleus</i> | N | For, HSCH, |
| <i>Alauda arvensis</i> | N | ASG, DCG, M & Al |
| <i>Galerida cristata</i> | W | DCG, M & Al |
| <i>Eremophila alpestris</i> | N | ASG |
| <i>Lullula arborea</i> | N | SCH, DCG, Sett & O |
| <i>Aegithalos caudatus</i> | N | For, HSCH, ForW |
| <i>Delichon urbicum</i> (#) | N | Sett & O |
| <i>Hirundo rustica</i> (#) | N | Sett & O |
| <i>Acrocephalus arundinaceus</i> | N | W |
| <i>Acrocephalus paludicola</i> | M | W |
| <i>Acrocephalus scirpaceus</i> | N | For, W |
| <i>Hippolais icterina</i> | M | Sett & O |
| <i>Hippolais olivetorum</i> | M | Sett & O |
| <i>Phylloscopus collybita</i> | N | AB, For, HSCH |
| <i>Phylloscopus sibilatrix</i> | N | For, HSCH |
| <i>Phylloscopus trochilus</i> | M | For, HSCH, Sett & O, ForW |
| <i>Sylvia atricapilla</i> | N | For, HSCH, SCH, Sett & O, ForW |
| <i>Sylvia borin</i> | M | Sett & O |
| <i>Curruca communis</i> | N | HSCH, SCH, Sett & O |
| <i>Curruca curruca</i> | M | HSCH, SCH, Sett & O |
| <i>Curruca hortensis</i> | M | HSCH, SCH, Sett & O |
| <i>Curruca nisoria</i> | N | HSCH, SCH, Sett & O |
| <i>Regulus ignicapillus</i> | M | For, HSCH, Sett & O |
| <i>Regulus regulus</i> | N | AB, For |
| <i>Bombycilla garrulus</i> | W | SCH, Sett & O, M & Al, ForW, |

| | | |
|--------------------------------------|----------|--------------------------------|
| <i>Sitta europaea</i> | N | For, HSCH, Sett & O, |
| <i>Sitta neumayer</i> | N | ASG, R & C |
| <i>Certhia brachydactyla</i> | ? | Sett & O |
| <i>Certhia familiaris</i> | N | For |
| <i>Troglodytes troglodytes</i> | N | For, HSCH, Sett & O |
| <i>Sturnus vulgaris</i> (#) | N | Sett & O, ForW |
| <i>Cinclus cinclus</i> | N | W |
| <i>Turdus iliacus</i> | M (Oct.) | Sett & O |
| <i>Turdus merula</i> | N | For, HSCH, SCH, Sett & O, ForW |
| <i>Turdus philomelos</i> | N | For |
| <i>Turdus pilaris</i> | W | SCH, M & AI, Sett & O, ForW |
| <i>Turdus viscivorus</i> | N | For, HSCH, SCH, Sett & O, ForW |
| <i>Muscicapa striata</i> | N | HSCH, SCH |
| <i>Ficedula albicollis</i> | M? | HSCH, SCH, Sett & O |
| <i>Ficedula hypoleuca</i> | M | Sett & O, ForW |
| <i>Erithacus rubecula</i> | N | For, HSCH, SCH, Sett & O |
| <i>Luscinia luscinia</i> | M | Sett & O |
| <i>Luscinia megarhynchos</i> | N | Sett & O, ForW |
| <i>Monticola saxatilis</i> | N | ASG, R & C, DCG |
| <i>Oenanthe hispanica</i> | M | DCG |
| <i>Oenanthe oenanthe</i> | N | ASG, DCG |
| <i>Saxicola rubetra</i> | N | DCG, M & AI |
| <i>Saxicola rubicola</i> | M | M & AI |
| <i>Phoenicurus phoenicurus</i> | In June | HSCH, SCH, Sett & O |
| <i>Phoenicurus ochruros</i> | N | ASG, R & C, Sett & O |
| <i>Petronia petronia</i> | M Sep. | SCH, DCG |
| <i>Prunella collaris</i> | N | ASG, AB |
| <i>Prunella modularis</i> | N | ASG, For |
| <i>Passer domesticus</i> (#) | N | Sett & O |
| <i>Passer montanus</i> | W | Sett & O, ForW |
| <i>Anthus campestris</i> | N | DCG |
| <i>Anthus pratensis</i> | M/Okt. | M & AI |
| <i>Anthus spinoletta</i> | N | ASG |
| <i>Anthus trivialis</i> | N | HSCH |
| <i>Motacilla alba</i> (#) | N | R & C, Sett & O |
| <i>Motacilla cinerea</i> | N | W or ASG |
| <i>Motacilla flava</i> | N | M & AI |
| <i>Linaria cannabina</i> (#) | N | AB, SCH, DCG |
| <i>Carduelis carduelis</i> (#) | N | For, HSCH, Sett & O, ForW |
| <i>Spinus spinus</i> | N | For |
| <i>Chloris chloris</i> | N | For, HSCH, Sett & O, ForW |
| <i>Coccothraustes coccothraustes</i> | N | For, HSCH, Sett & O, ForW |
| <i>Fringilla coelebs</i> | N | For, HSCH, Sett & O, ForW |
| <i>Fringilla montifringilla</i> | W | Sett & O, M & AI |
| <i>Loxia curvirostra</i> (#) | N | For |
| <i>Pyrrhula pyrrhula</i> (#) | N | For |
| <i>Serinus serinus</i> | N | For, Sett & O |
| <i>Emberiza cia</i> | N | HSCH, SCH |
| <i>Emberiza citrinella</i> | N | For, HSCH, SCH, Sett & O, ForW |
| <i>Emberiza hortulana</i> | N | SCH |
| <i>Emberiza melanocephala</i> | N | SCH, Sett & O |
| <i>Emberiza schoeniclus</i> | M | ForW |
| <i>Miliaria calandra</i> | N | DCG, Sett & O, M & AI, ForW |

(period/season: W=wintering, M=migration, N=nesting-breeding., habitats: ASG, AB, For, ForW, SCH, DCG, M & AI, R & C, Sett & O, W, see above in methods., (1) = species observed at least once).

(#)Species detected during the breeding period outside of breeding habitat (mostly while feeding).

On the Dinara Mountain, Griffon Vulture (*Gyps fulvus*) used to breed until 1968. One poisoned individual was brought by hunters to Luka village in May 1969 (personally witnessed). It is generally known that this species has disappeared from the municipality of B. Grahovo 50 years ago. Single individuals of *A. chrysaetos* and *A. gentilis* can be regularly observed during the all season and one individual of *C. pomarina* was observed once near the Korana Rivr (May 20, 1982). Single individuals or pairs of *C. aeruginosus* and *C. pygargus* can be seen in the nesting season (April, May, July and August) but these individuals do not nest here, they are vagrants. According to Rubinić *et al.* (2019) *C. pygargus* breeds in Grahovo poljes. Also, on the Dinara Mountains, in the municipality of Bosansko Grahovo, the threatened shore lark (*E. alpestris*) was found in only 3 breeding pairs. This threatened species is also rare in the neighboring mountains (Lukač *et al.* 2017).

Due to limited wetland area, breeding water birds are rare, e.g. Moorhen (*G. chloropus*) and Coot (*F. atra*), with 1 or 2 pairs in Pečenačko Lake. Common Sandpiper (*A. hypoleucos*) breeds irregularly in this area.

Dendrogram shows that diversity of breeding birds in the habitat Set & O is similar to forest habitats including shrub lands, and the similarity is the greatest with habitat ForW (see Fig. 7). The most similar habitats by breeding birds' diversity are pastures and arable fields (M & Al).

During migration period, 33 species of non-breeding birds were registered, mostly at autumn migration (September). Multiple species, like warblers *Hippolais* spp., *S. borin* or *C. curruca*, were registered over a longer period, especially species that feed on fruits and berries and some species were registered over only few days in both periods, e.g. Common Crane (*G. grus*), Night Heron (*N. nycticorax*), White Stork (*C. ciconia*), *etc.* Rubinić (2019) and Rubinić *et al.* (2019) do not indicate Common Crane in this area during migration, although this species is sometimes present in larger numbers (about 50 individuals). Topić and Topić (2017) mention only one individual at Pašića polje. The falcons, *F. naumanni* and *F. vespertinus*, were sporadic autumn migrant (very rare) while *F. biarmicus* was sporadic spring migrant (in May). Rubinić (2019) and Rubinić *et al.* (2019) indicate the presence of *F. naumanni* in larger numbers, and *F. vespertinus* as scarce. The Rough-legged Buzzard (*B. lagopus*) was registered only in two years: three specimen in 2011 and four specimen in 2020 on Pašića polje. Water birds (W) are generally scarce during migration. During autumn migration, mass flocks are formed by Starlings, and Meadow Pipits occur with few hundred individuals in October. In the past, large flocks were formed by seed-eating species, including *F. montifringila* which is present also during the winter in this area. Regular and numerous wintering species (WV – winter visitor) are Brambling (*F. montifringilla*) and Fildfare (*T. pilaris*), and in much smaller numbers also Great Grey Shrike (*L. excubitor*) and Crested Lark (*G. cristata*). Occasionally, during strong winters, this area is attended by Waxwing (*Bombycilla garrulus*) where it feeds on *Crataegus* spp. and *Rosa* spp.

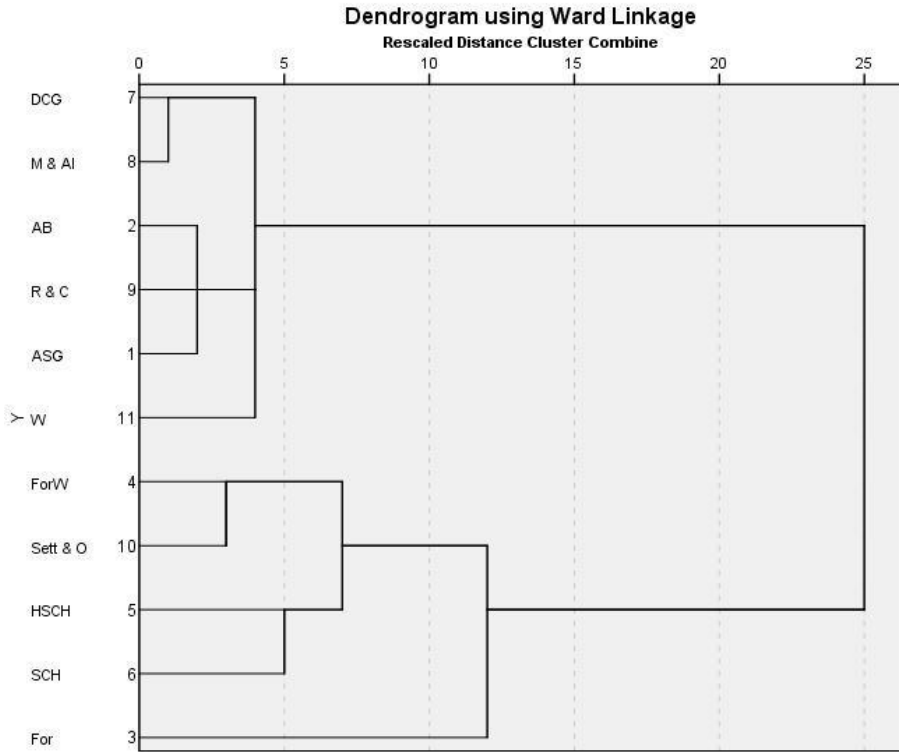


Figure 7. Dendrogram of breeding birds' diversity in 11 habitat types

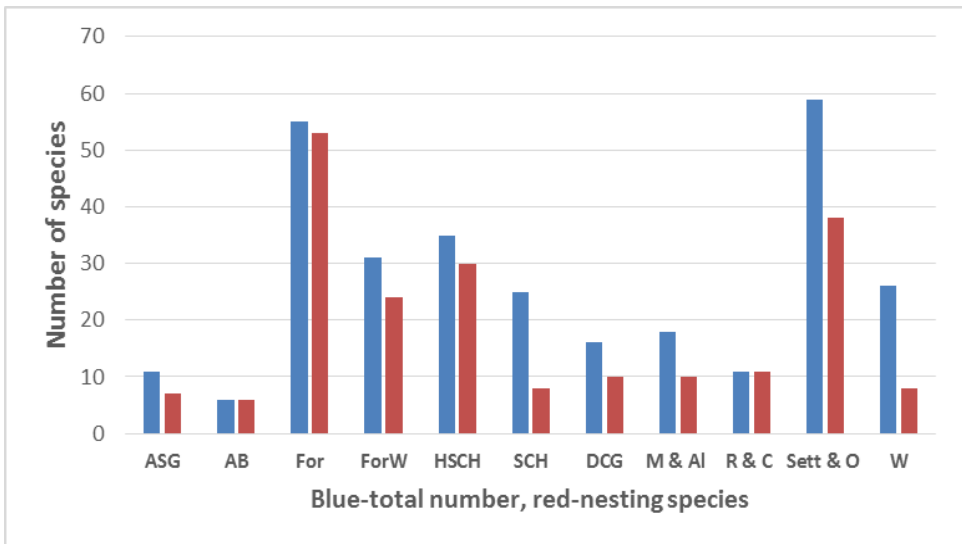


Figure 8. Number of species in 11 types of habitats in the area of Bosansko Grahovo municipality

Of all wintering visitors, the earliest one is *L. excubitor*, which arrives in the first half of October, after the first substantial cold (in Europe), and other species mostly arrive much later.

The majority of breeding species was registered in forest habitats (For), although the greatest number of species is found in settlements and orchards (Sett & O). Total number of species and number of breeders by habitat type is presented on Figure 8.

Alpine and subalpine ecosystems had the fewest bird species. The graph 8 shows that wetlands, settlements and orchards, and then progradation stadium of shrub lands (SCH) have the greatest importance for migratory species. Since the wetland habitats (W) are small, they provide suitable resources only for smaller flocks or just few individuals. The orchards, besides being important for many migratory species, attract many species during the breeding season, especially during cherry ripening, even if they are not characteristic for such habitat. Similar observations are brought by Holmes and Robinson (1981). In general, a small number of bird species e.g. Rock partridge (*A. graeca*), Capercaillie (*T. urogallus*), Hazel Grouse (*T. bonasia*) and some others, do not depend on karst poljes habitats (ForW, DCG, M & Al, Sett & O, W), including settlements with orchards.

Karst poljes in the municipality of Bosansko Grahovo are important centers of biodiversity in Bosnia and Herzegovina and they are of great importance for bird fauna. For certain species, such as Corncrake (*Crex crex*), Lesser Grey Shrike (*L. minor*), and others, karst poljes are important nesting sites. On the other hand, for a big number of species Grahovo poljes are of great importance during migration periods. More than 100 species migrate through this area.

In the spring, particularly numerous are flycatchers (Muscicapidae). The last species that leave this area in larger flocks (over 50 individuals) in late October are *P. ochruros*, *S. torquata* and *A. pratensis* usually with more than 100 individuals. This conclusion is supported by the recently identified bird migration path called the "Adriatic Flyway".

CONCLUSIONS

The paper corrects incorrect names for the studied karst poljes (fields). This paper to provide a more detailed information on the diversity of birds in this area and its importance for breeding, migratory and wintering birds. 165 bird species were registered in B. Grahovos area, and today it can safely be said that 105 bird species nest on this area (Livanjsko polje included). We have registered several endangered bird species that nest or migrate in this area. Because of the diversity of its flora and fauna, the area of the municipality Bosansko Grahovo harbors favorable bird habitats during the whole year.

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