A new genus and new species of grebe (Podicipediformes, Aves) from the Early Miocene lake deposits of Valjevo Basin (Serbia)

by
Vesna DIMITRIJEVICH, Erika GÁL & Eugen KESSLER

Abstract — *Miodytes serbicus*, a new genus and species of grebe from the Early Miocene lake deposits of Bela Stena series (Valjevo Basin, West Serbia) is introduced. The fossil bird bones of an almost complete wing skeleton are found in anatomical connection in a thin layer slate. The representatives of Podicipedidae are rare in Central European deposits of any age, and indicate the vicinity of a seacoast environment, i. e. Paratethys Sea. Among rare bird remains in the Neogene of Serbia, the find from Valjevo Basin is the very first to enable species identification.

Key words — Aves, Podicipediformes, Podicipedidae, *Miodytes*, Early Miocene, Valjevo Basin, Serbia.

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Introduction

The bird remains were found in the village Šušeoke in the Valjevo Basin (Figure 1). Situated in West Serbia, the Valjevo Basin is filled with Early and Middle Miocene lake deposits and subsequently, in the north and northeast, also with Late Miocene brackish sediments (DOLICH, 1995). The occasional occurrences of laminated sediments with organic matter (kerogen), which are found from the river Toplica on the east to Klinci near Valjevo on the west and exposed in the village Suseoke are called "Bela Stena series". They contain plant remains (PANTICH, 1956) and fish bones (ANDJELKOVICH, 1970). Remains of insects and bird feathers are also registered (STEVANOVICH, 1977).

"Bela Stena series" probably belong to the oldest lake formation in the Valjevo Basin assigned to the Early Miocene (JOVANOVICH et al., 1994). In earlier literature its age was differently treated as "freshwater Tortonian", "freshwater Sarmatian", "freshwater Sarmatian–Early Pannonian", "freshwater Pannonian" and "brackish Sarmatian and Pannonian" (PANTICH, 1956; STEVANOVICH, 1977; PANTICH et al., 1980 and DOLICH, 1984).

Bird remains are rare in Neogene of Serbia, and the find from "Bela Stena series" in Šušeoke village is the first to enable species identification. A single bird bone is recorded from the Miocene deposits of Arandjelovac (LASKAREV, 1936), and fossil eggs in Miocene of Brajkovac near Ljig (STEVANOVICH, 1959). Recently, a bone of "the song bird" (Passeriformes) is found in the core of a bore hole drilled in the Late Miocene deposits near Negotin in eastern Serbia (KRSTICH et al., 1995). Abundant bird remains are appearing not until Pleistocene, when they are preserved in cave sediments (MALEZ & DIMITRIJEVICH, 1990).

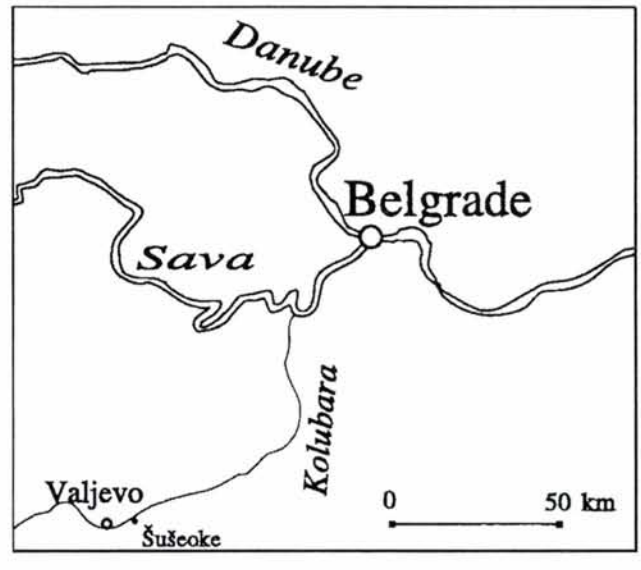

Figure 1 — Site position.

Material and methods

Acronyms used — IPH: Regalia Collection in the Human Palaeontology Institution, Paris. *LAC*: Laboratory of Comparative Anatomy, National Museum of Natural History, Paris. *UCBL*: Department of Geology, Claude Bernard University, Lyon. *MTM*: Geological and Palaeontological Department, Hungarian Natural History Museum. *BBU*: Department of Zoology, Babeş-Bolyai University, Cluj. *USNM*: National Museum of Natural History,

Smithsonian Institution. *RGF*: Fossil bone collection in the Institute of Regional Geology and Palaeontology

Comparative material available — Recent bones of the wing (humeri, ulnae, radii and carpometacarpi and phalanges alae 1 digiti 2) of the next taxa were studied:

1 — Podicipediformes: *Aechmophorus occidentalis* (LAWRENCE), 1858 [male: USNM 560546, 560548, 561115, 561116; female: USNM 560550, 561113, 561117], *Aechmophorus clarkii* (LAWRENCE), 1858 [male: USNM 560534, 560535; female: USNM 560531, 560537], *Podiceps cristatus* (LINNAEUS), 1758 [UBB], *Podiceps auritus* (LINNAEUS), 1758 [BBU], *Podiceps nigricollis* BREHM, 1831 [BBU], *Podiceps griseigena* (BODDAERT), 1783 [BBU], *Tachybaptus ruficollis* (PALLAS), 1764 [BBU].

2 — Procellariformes: *Fulmarus glacialis* (LINNAEUS), 1761 [IPH 1154, MTM 561172, UCBL], *Daption capense* (LINNAEUS), 1758 [LAC 1997–134], *Pagodroma nivea* (FORSTER), 1777 [LAC 1997–1141], *Pterodroma nigripennis* (ROTHSCHILD), 1893 [MTM 614813], *Pterodroma phaeopygia* (SALVIN), 1876 [LAC 1997–148], *Pterodroma baraui* (JOUANIN), 1964 [UCBL], *Pterodroma macroptera* (SMITH), 1840 [LAC 1997–144], *Pachyptila vittata* (FORSTER), 1777 [LAC 1997–140], *Pachyptila desolata* (GMELIN), 1789 [LAC 1997–813], *Bulweria* sp. [IPH 1073], *Procellaria cinerea* GMELIN, 1789 [LAC 1910–299, MTM 33516, 502128], *Calonectis diomedea* SCOPOLI, 1769 [IPH 1035, LAC 1992–24, BBU, UCBL], *Puffinus pacificus* (GMELIN), 1789 [USNM 289180, UCBL], *Puffinus gravis* (O'REILLY), 1818 [IPH 1419], *Puffinus griseus* (GMELIN), 1789 [IPH 1418, UCBL], *Puffinus puffinus* (BRÜNNICH), 1764 [IPH 1152, MTM 556056, UCBL], *Puffinus lherminieri* LESSON, 1839 [UCBL], *Oceanites oceanicus* KUHL, 1820 [IPH 581], *Hydrobates pelagicus* (LINNAEUS), 1758 [IPH 1252], *Oceanodroma leucorhoa* (VIEILLOT), 1817 [IPH 1268, USNM 428056, UCBL], *Pelecanoides urinatrix* (GMELIN), 1789 [LAC 1997–127, USNM 18771], *Priofinus* sp. [IPH 1352].

3 — Charadriiformes: *Stercorarius pomarinus* (TEMMINCK), 1815 [USMN 620722], *Stercorarius longicaudus* VIEILLOT, 1819 [USNM 491644], *Stercorarius parasiticus* (LINNAEUS), 1758 [USNM 13648], *Stercorarius maccormicki* SAUNDERS, 1893 [USNM 488321], *Sterna caspia* PALLAS, 1770 [USNM 501244], *Gelochelidon nilotica* GMELIN, 1789 [USNM 289676], *Recurvirostra avosetta* LINNAEUS, 1758 [USNM 610452].

Anatomical terminology follows BAUMEL et al. (1979), GILBERT et al. (1981) and BOCHENSKI (1994).

Measurements were taken with mechanical and digital callipers to 0.1 mm and 0.01 mm, respectively.

Systematics

Order: Podicipediformes FÜRBRINGER, 1888
Family: Podicipedidae BONAPARTE, 1831
Genus *Miodytes* n. gen.

Type species — *Miodytes serbicus*, new species.
Included species — type species only.
Type locality — Bela Stena, Suseoke village, Valjevo Basin, west Serbia.
Type stratum — "Bela Stena series", Early Miocene
Name derivation — Miocene and *Dytes*, from the Greek δυτικοω (diving).
Diagnosis — as for the holotype.

Miodytes serbicus n. sp.
(Figure 2–3)

Type locality — Bela Stena, Suseoke village, Valjevo Basin, west Serbia.
Holotype — A slab with an almost complete right wing skeleton (RGF 97/3): distal fragment of humerus, ulna, radius, carpometacarpus and phalanx alae 1 digiti 2 (Figure 2).
Name derivation — The species name was derived after Serbia, the country where the fossil material was found.
Diagnosis — Small grebe, morphologically and dimensionally differing from all the known recent and fossil species. On the humerus, sulcus musculi brachialis is very deep and long, epicondylus ventralis is well developed and processus supracondylaris dorsalis is lacking. The edge between trochlea carpalis and the point of processus extensorius is hollow on the carpometacarpus.

Measurements — (in mm):
humerus, width of diaphysis above the distal epiphysis: 4.60,
width of the distal epiphysis: 7.31;
ulna: total length: 56.27,
estimated length of the proximal epiphysis: 6.80,
width of the diaphysis: 3.05,
thickness of the distal epiphysis: 4.70; radius:
total length: 53.42,
width of the diaphysis: 2.73,
thickness of the distal epiphysis: 2.72;
carpometacarpus: total length: 26.52,
width of the proximal epiphysis: 5.70,
length of the processus metacarpi I: 3.38,
width in the middle of the bone: 3.32,
width of the distal epiphysis: 4.04;
phalanx alae 1 digiti 2: total length: 12.19;
phalanx alae 2 digiti 2: total length: 8.02.

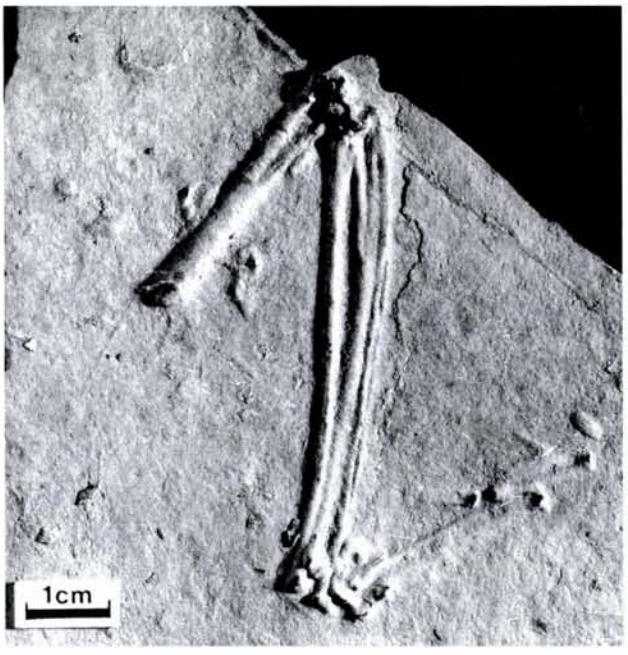

Figure 2 — Slab with the right wing skeleton of *Miodytes serbicus* n. gen & n. sp.

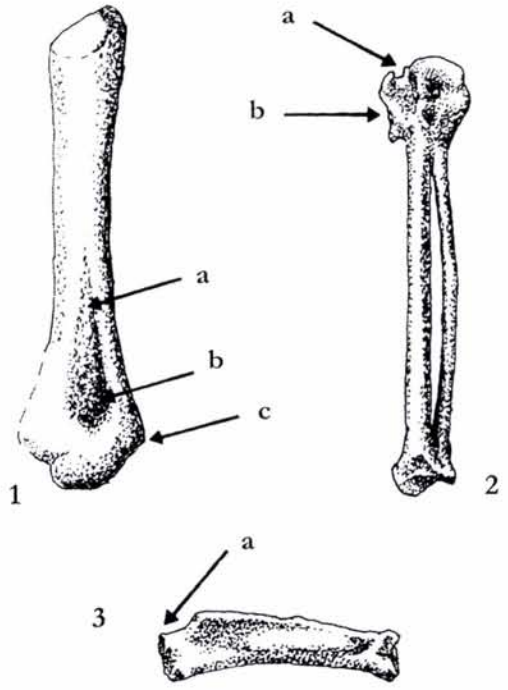

Figure 3 — **Humerus** (1). - **a:** sulcus musculi brachialis; **b:** fossa musculi brachialis; **c:** epicondylus ventralis. — **Carpometacarpus** (2). - **a:** edge between trochlea carpalis and the point of processus extensorius; **b:** edge of processus extensorius. — **Phalanx alae** (3). - **a:** apophysis of crista on the distal part.

Comparison — Comparison with some fossil and modern genera of Podicipediformes, Procellariformes and Charadriiformes were done (see in the description).

Description — As the bones can not be extracted from the slab without risk of damage, direct comparisons were possible only on the distal end of humerus and proximal part of carpometacarpus.

On the humerus, sulcus musculi brachialis forms a deep depression, having an inversed V-shape (Figure 3: 1a). This appears only in *Fulmarus* and *Oceanodroma* genera of Procellariformes, and *Gelochelidon*, *Hydroprogne* and *Stercorarius* (Laridae), *Recurvirostra* and *Himantopus* (Recurvirostridae) of Charadriiformes, but not as deep and long as in the Šušeoke specimen. Fossa m. brachialis (Figure 3: 1b) is round and deep. Epicondylus ventralis (Figure: 3: 1c) is well developed. Contrary to Procellariformes and Charadriiformes, processus supracondylaris dorsalis is lacking.

The shape of the forearm and the phalanx alae 1 digiti 2 is similar to grebes. First of all, ulna is arched that excludes Procellariformes. The shape of the proximal epiphysis of ulna and depressio musculi brachialis on the cranial face corresponds to grebes. Radius is not showing any indicative morphological feature.

Concerning the carpometacarpus, the edge between trochlea carpalis and the point of processus extensorius is hollow (Figure 3: 2a). The edge of processus extensorius (Figure 3: 2b) of the carpometacarpus presents similarities with some Procellaridae and Laridae species, but it is much closer to Podicipedidae. The form of spatium intermetacarpalis and distal epiphysis and the height of synostosis metacarpalis distalis also refer to the grebes.

The shape of phalanx alae 1 digiti 2 differs from Charadriiformes. Procellariformes phalanx has the same shape, but the apophysis of crista on the distal part (Figure 3: 3a) projects, contrary to the Šušeoke specimen.

Discussion

The remains are in a slab and belong to the right wing of a bird. The bones are in anatomical connection. The total length of the humerus may be only estimated, because it lacks the proximal end. Among the phalanges only phalanx alae 1 digiti 2 and phalanx alae 2 digiti 2 are distinct, moved away from the carpometacarpus. For a detailed description of the bones see above.

Regarding its sizes, the fossil wing skeleton belongs to a smaller specimen then the fossil Podicipedidae species (Table 1). By reason of the own measurements and bibliographical data, the ratio of the main bones of the wing also ranks among the fossil grebes.

Considering the ratios of the humerus, ulna, carpometacarpus and phalanx alae 1 digiti 2, we calculated the next values:

- the humerus/ulna proportion of *Pterodroma*, *Procellaria*, *Frigadafons*, *Bulweria*, *Calonectis* and *Hydrobates* is less then 1.00 (0.92–0.99). The same

proportion range between 1.00–1.05 in *Pachyptila, Daption, Oceanodroma* genera, while it is bigger (1.07–1.28 in *Fulmarus, Pagodroma, Oceanites, Puffinus* and *Pelecanoides* genera's. The grebes present 1.08–1.14.

– in the case of ulna/carpometacarpus proportion, this value is less than 1.50 in *Pelecanoides* and *Oceanites*, it ranges between 1.50–2.00 in *Pachyptila, Puffinus, Frigadafons, Pagodroma* and *Oceanodroma* genera and reaches 2.23 in *Pterodroma, Procellaria, Fulmarus, Daption, Calonectis* and *Bulweria*. This proportion is 1.86–2.15 within grebes, while the fossil specimen presents 2.12.

– the ratio of carpometacarpus/phalanx alae 1 digiti 2 give the same arrangements as the ulna/carpometacarpus for all the studied genera excepting the grebes, where it ranges between 2.25–2.57. This proportion in the fossil specimen is only 2.18.

The fossil specimen osteometrically also differs from the recent species: the shaft of humerus is stouter but the ratio of carpometacarpus/phalanx alae 1 digiti 2 shows smaller values.

Summarising the morphological characteristics of the bones, the comparisons of the sizes and the proportions of the bones with other genera, we may conclude that there is no doubt that the fossil wing belongs to a new fossil genus and thus, a new species of grebe.

Table 1 — Measurements (mm) of humeri, ulnae, radii, carpometacarpi and phalangaes alae of the compared recent and fossil Podicipediformes species. — Abbreviations: 1 = total length, **2** = width of the shaft, **3** = width of the distal epiphysis, **Cmcp** = carpometacarpus, **Ph. alae** = phalanga alae 1 digiti 2, * = bibliographical data.

Species	Humerus			Ulna	Radius	Cmcp	Ph. alae	Ulna/	Cmcp/
	1	2	3	1	1	1	1	Cmcp	Ph. alae
Aechmophorus clarkii									
Male: n=2 (USNM 560534, 560535)	115.8–119.6	4.1–4.5	10.3–10.9	104.1–107.3	103.9–107.3	51.3–51.5	20.7–21.9	2.03–2.08	2.35–2.48
Female: n=3 (USNM 560531, 560537, 560542)	103.5–107.5	3.4–4.4	9.7–9.9	89.6–96.4	87.8–93.7	44.7–46.1	19.4–19.6	1.96–2.09	2.30–2.35
Aechmophorus occidentalis									
Male: n=4 (USNM 560546, 560548, 561115, 561116)	114.1–122.3	4.5–6.0	10.9–11.7	102.4–110.1	99.7–106.7	50.6–55.2	21.5–23.0	1.98–2.00	2.35–2.57
Female: n=3 (USNM 560550, 561113, 561117)	109.1–114.7	4.6–4.9	9.6–9.8	97.1–103.3	94.8–101.0	46.6–49.8	20.1–21.5	2.07–2.08	2.31–2.32
Podiceps cristatus									
Male: n= 34 (BBU + *)	103.6–114.9	5.4	10.1–11.6	94.7–109.2	90.9–106.3	44.6–50.9	18.8–21.5	2.12–2.15	2.32–2.37
Female: n=37*	100.2–117.5		9.9–11.6	91.5–106.6	89.5–104.0	42.6–50.3	18.4–21.9	2.13–2.15	2.29–2.32
Podiceps griseigena									
n=48 (BBU+*)	84.9–104.9	4.0	9.1–11.4	77.0–99.0	74.8–94.9	36.1–48.3	16.0–21.2	2.05–2.13	2.25–2.27
Podiceps auritus									
n=13 (BBU+*)	67.2–78.4	4.16	7.1–8.3	59.6–69.6	57.4–67.5	30.1–34.8	13.0–14.6	1.86– 2.00	2.38–2.56
Podiceps nigricollis									
n=28 (BBU+*)	61.5–75.3	3.4	6.8–8.2	60.3–69.2	58.6–67.0	29.0–33.6	12.5–14.8	2.06–2.08	2.27–2.32
Tachybaptus ruficollis									
n=47 (BBU+*)	48.8–57.5	2.9	5.2–6.2	43.6–51.3	42.7–49.8	21.6–25.5	9.3–11.3	2.01–2.02	2.25–2.40
Podiceps pisanus (PORTIS)	ap. 73.0		7.9						
Podiceps sociatus (NAVAS)	70.0			73.0	73.0				
Podiceps miocenicus KESSLER	ap. 113.0	6.0	11.2						
Miodytes serbicus sp. nov.	ap. 62.0–65.0	4.60	7.31	56.27	53.42	26.52	12.19	2.12	2.18

Conclusions

The number of Tertiary grebes is very few in Europe. Two genera, *Podiceps* and *Miobaptus*, belong to the Podicipedidae. According to MLIKOVSKY (1995) and BOCHENSKI (1997), recent genus *Podiceps* includes the following fossil species: *Podiceps pisanus* (PORTIS), 1889 from the Middle Pliocene of Italy, *Podiceps sociatus* (NAVAS), 1922 from the Upper Miocene of Spain and *Podiceps miocenicus* KESSLER, 1984 from the Upper Miocene of Moldavia. *Miobaptus walteri* SVEČ, 1982 from the Lower Miocene Czech Republic belong to the fossil genus *Miobaptus*.

Miobaptus walteri description is based on the proximal part of humerus, a nearly complete coracoideum and three fragments of tarsometatarsus (two proximal and one distal) (SVEC, 1982). *Podiceps pisanus* was described on a humerus (REGALIA, 1902), while *P. sociatus* is based on a nearly complete skeleton (humerus, ulna, radius, femur, tibiotarsus and tarsometatarsus) in a slab (LAMBRECHT, 1933). A humerus of *Podiceps miocenicus* was described by KESSLER (1984, 1992). *Miodytes serbicus* differs morphologically and by its dimensions from all the mentioned species.

Fossil grebes are also known from the Miocene, Pliocene and Pleistocene of North America: *Podiceps parvus* (SHUFELDT), 1913, *Podiceps oligoceanus* (SHUFELDT), 1915, *Podiceps subparvus* (L. MILLER & BOWMANN), 1958, *Podiceps dixi* BRODKORB, 1963 and *Pliodytes languisti* BRODKORB, 1953 (BRODKORB 1963, LAMBRECHT 1933).

As majority of the species were described from other type of bones then presented in Suseoke specimen, their comparison was more difficult. *Podiceps parvus* description is based on tarsometatarsus, a distal part of femur is described of *P. oligocaenus* and *P. subparvus*. *P. dixi* was described from the proximal part of carpometacarpus, but it's sizes differ from our species', while *Pliodytes languisti* description is based on coracoideum. All these birds were much larger than *Miodytes serbicus*.

Modern grebes live almost exclusively on the water. They are found on the backwaters, lakes and reeds, and avoid the vicinity of ice or snow or intensely cold water. All species are vulnerable to habitat changes and water pollution. As the ecological conditions of Suseoke in Miocene seem to have been convenient for our species, its presence is not considered surprising. We may

conclude that the ecological characters of Podicipedidae were the same as today.

Grebes are migratory species in the present. They are wintering mostly on the sea costs and estuaries. When migrating or wintering, tolerate more open waters (fresh or saline) where food ample. Some species like little grebe (*Tachybaptus ruficollis*), great crested grebe (*Podiceps cristatus*), and sometimes red-necked grebe (*P. griseigena*) nests in Serbia, while others (e.g. *P. nigricollis* and *P. griseigena*) are winter visitors (CRAMP 1998) We hardly can estimate since when grebes are migratory species.

Since the fossil wing appears in its anatomical connection, we may conclude that this bird was not caught by a predator. As a supposed migrating species, most probably it was a victim of an accident.

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The authors' addresses:

Dr. Vesna DIMITRIJEVICH
Institute of Regional Geology and Palaeontology
Faculty of Mining and Geology
Kamenicka 6, Beograd 11000, Yugoslavia
E-mail: vesnadim@beotel.yu

Dr. Erika GÁL
Babes-Bolyai University
Department of Zoology
Clinicilor 5–7, Cluj 3400, Romania
E-mail: gal_erika@yahoo.com

Dr. Eugen KESSLER
Babes-Bolyai University
Department of Zoology
Clinicilor 5–7, Cluj 3400, Romania
E-mail: jkessler@hasdeu.ubbcluj.ro