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New Data on Hesperornithids (Aves: Ornithurae) from the Campanian of the Lower Volga Region (Late Cretaceous, Russia)

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Abstract—Taxonomic diversity of Late Cretaceous hesperornithids (Aves: Hesperornithidae) of European Russia and Eastern Europe as a whole remain poorly understood, and the morphology of these large flightless birds is poorly known. New finds of Hesperornithidae in the Karyakino locality (Saratov oblast, Russia) confirm the coexistence of two forms of these flightless seabirds in the Campanian (mid-Late Cretaceous) of the Lower Volga region. A femur is described for the first time for *Hesperornis rossicus* Nessov et Yarkov, 1993, indicating that this large species is morphologically distinct from North American *H. regalis* Marsh, 1872.

Keywords: fossil birds, Hesperornithidae, Late Cretaceous, European Russia
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Hesperornithids (the family Hesperornithidae of the extinct order Hesperornithiformes) were very large flightless diving birds, which inhabited seas of the Northern Hemisphere in the second half of the Late Cretaceous. Hesperornithids are well known in the fossil record of North America, but their fossils are extremely rare in Eurasia. Consequently, taxonomic diversity and morphology of East European and West Asian Hesperornithidae are still poorly understood [1–3]. The status of all species described in Eurasia [3] remains unclear in view of a possible Holarctic distribution of particular species of Hesperornithiformes [4]. A very large *Hesperornis* of the Campanian Age (Late Cretaceous) of Eastern Europe is most often referred to as *Hesperornis rossicus* [5]. However, the species is known by only fragmentary finds, and its validity is questionable [1]. At least one more *Hesperornis* species is sometimes thought to exist in the Campanian of Eastern Europe [3, 6]. Up to ten Hesperornithiformes species have been described from the Campanian of North America [2].

Here we describe the new finds of bones of the *Hesperornis* postcranial skeleton from the Campanian locality Karyakino (Saratov oblast, Russia), where *H. rossicus* and, presumably, another, unnamed *Hesperornis* have been reported earlier [3, 5]. A fragmentary femur and a fragmentary tibiotarsus belonged to birds of two size classes and confirm the existence of two forms of Hesperornithidae in the Campanian of the Lower Volga region. The femur, which has a high diagnostic value in Hesperornithidae, is for the first time described for east European *Hesperornis* here.

The distal half of a femur (PIN, specimen no. 5027/8) belonged to a very large bird, somewhat larger than North American *Hesperornis regalis*. The dimensions of PIN, specimen no. 5027/8 are as follows: the maximum width of the distal end, 65.2 mm; the shaft width at the level of the proximal margin of the condylus lateralis, ~41.2 mm; the minimum craniocaudal height of the shaft, 17.8 mm; the craniocaudal height of the condylus medialis, 32.5 mm; and the minimum craniocaudal height of the sulcus intercondylaris, 18.4 mm. Features of the specimen are that the diaphysis shows a distinct craniocaudal flattening and a mediolateral widening, that the sulcus patellaris is very shallow and wide and does not extend distally to the sulcus intercondylaris, and that the condylus lateralis along with the trochlea fibularis protrude laterally to a substantial extent. By combination of the features, the specimen is similar to representatives of the genera *Hesperornis* and *Parahesperornis* and differs from other Hesperornithiformes [7]. The Karyakino femur is similar to femora of *Hesperornis* not only in having a large size, but also in that the trochlea fibularis protrudes laterally to a great extent, that the fossa poplitea

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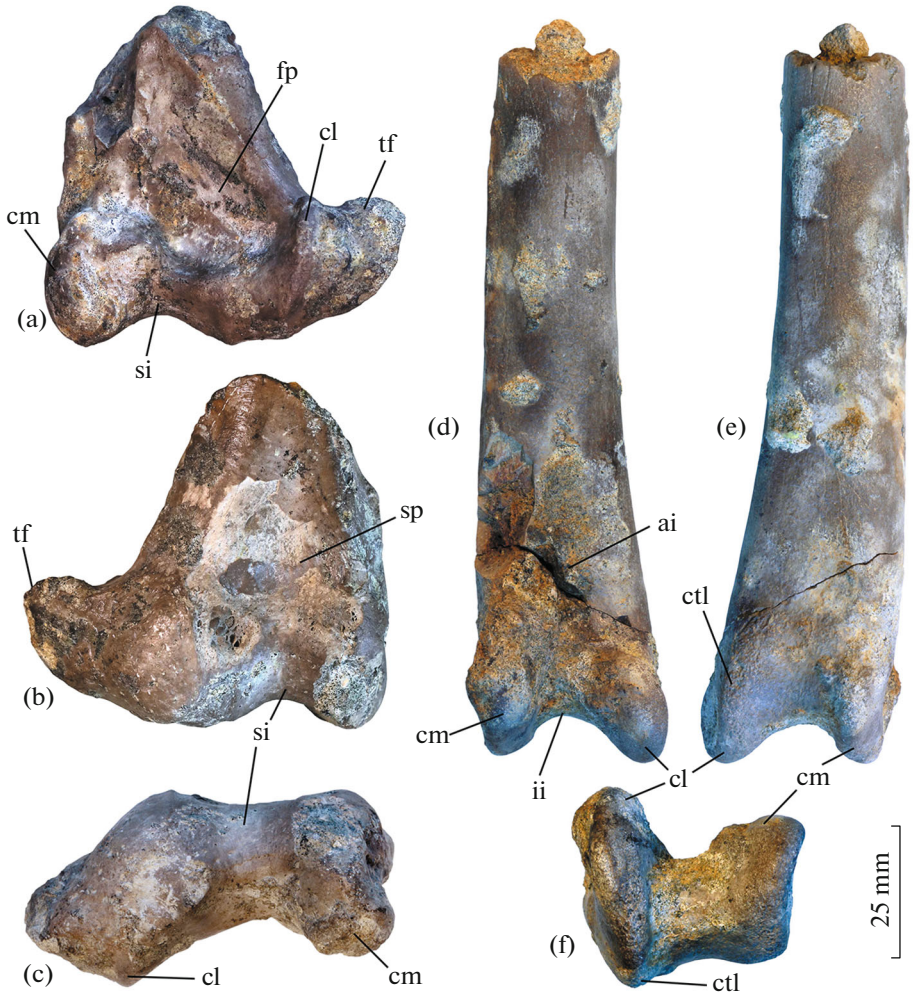

Fig. 1. New finds of *Hesperornis* (Aves: Hesperornithidae) from the Campanian of the Karyakino locality (Lower Volga region, Saratov oblast, Late Cretaceous). (a–c) *Hesperornis rossicus* Nessov et Yarkov, 1993, a fragmentary right femur, PIN item no. 5027/8: (a) caudal, (b) cranial, and (c) distal views. (d–f) *Hesperornis* sp., a fragmentary right tibiotarsus, PIN item no. 5027/9: (d) cranial, (e) caudal, and (f) distal views. Designations: ai, apophysis internum ligament obliqui; cm, condylus medialis; cl, condylus lateralis; ctl, crista trochlearis lateralis; fp, fossa poplitea; ii, incisura intercondylaris; si, sulcus intercondylaris; sp, sulcus patellaris; tf, trochlea fibularis.

is large (extending virtually to the lateral margin of the shaft), and that the condylae medialis et lateralis protrude equally in the distal direction. In members of the genus *Parahesperornis*, the condylus lateralis protrudes distally to a greater extent than the condylus medialis, and the trochlea fibularis protrudes laterally only to a moderate extent [7].

Generally, PIN, specimen no. 5027/8 is similar to the femur of *Hesperornis regalis* and differs in that it is somewhat larger in size and that the trochlea fibularis protrudes appreciably farther in the lateral direction and is narrower proximodistally, so that the distal end as a whole looks wider than that of the above North American species. The proximal apex of the condylus lateralis in PIN, specimen no. 5027/8 also protrudes laterally to a greater extent than in *H. regalis*. There is almost no inflection between the apex of condylus lateralis and trochlea fibularis in the distal margin of the bone. In the caudal view, the bone prominence that forms the distal margin of the fossa poplitea in the specimen under study is narrower and has a greater mediolateral length than in *H. regalis*. In the distal view, the dorsal part of the sulcus patellaris forms a slight incision, which is distinctly more concave in *H. regalis*. In the distal view again, the caudal margin of the condylus lateralis is appreciably less steep (at a lower angle to the transverse axis of the bone) than in *H. regalis*, whose condylus lateralis is more slant. Distinctive morphological features of the femur, along with its greater size, make it possible to identify it as belonging to *H. rossicus*. This confirms the validity of the species, which has earlier been established by the tarsometatarsus, which similarly differs from its *H. regalis* counterpart by being larger in size and hav-

ing morphological specifics. In view of the confirmed presence of *H. rossicus* in the fauna of the Karyakino locality, a very large fragmentary tibiotarsus (ZIN specimen, PO 6611) that has been described previously [3] and is somewhat larger than in *H. regalis* is also possible to assign to *H. rossicus*.

A distal half of the right tibiotarsus (PIN specimen, no. 5027/9) from Karyakino differs from the previously described tibiotarsus (ZIN specimen, no. 6611) from the same locality [3] in being appreciably smaller in size and having a deeper and proximally wider incisura intercondylaris. In the distal view, the specimen has a dorsoventrally wide bony wall between the condyles. The condyles are poorly preserved in the specimen ZIN, no. 6611, and the articular surface is therefore impossible to compare between the two specimens. The dimensions of specimen PIN, no. 5027/9 are as follows: the shaft width at the level of the tuberosity of the apophysis internum ligament obliqui (see [8]), 28.5 mm; the craniocaudal height of the shaft in its proximal half, ~13.8 mm; the transverse width of the distal end, 31.1 mm; the craniocaudal height through the condylus medialis, 21.2 mm; and the craniocaudal height through the condylus lateralis, 30.6 mm. Based on the differences in size and morphology, the specimen cannot be assigned to *H. rossicus*, but apparently belongs to another *Hesperornis* species. The specimen corresponds to North American *H. regalis* in dimensions, but slightly differs in distal profile. The condylus lateralis protrudes substantially greater in the cranial direction as compared with the condylus medialis in PIN specimen no. 5027/9, while a far lower difference in cranial protrusion is observed between the condyles in *H. regalis*. In contrast, the crista trochlearis lateralis of the condyle appreciably protrudes relative to the epiphysis in *H. regalis* and is far less prominent in PIN specimen no. 5027/9. Distal tibiotarsi have not been described for other North American *Hesperornis* species.

Thus, the new finds from the Karyakino locality confirm that at least two *Hesperornis* species coexisted in the Lower Volga Region in the Campanian. One was very large *H. rossicus*. The other was smaller, similar in size to *H. regalis*, but differed morphologically from this North American species. Apart from the above tibiotarsus (PIN specimen no. 5027/9), fragmentary tarsometatarsi described from Karyakino earlier [3, 5] can also be identified as belonging to the smaller form. The tarsometatarsi differ from those of *H. rossicus* by somewhat smaller dimensions and have morphological differences from the large North American species *H. regalis* and *H. chowi* as well. Sexual dimorphism, which cannot be excluded for *Hesperornis* [9, 10], might explain the size difference observed in the Campanian East European *Hesperornis* forms. However, the presence of two morphological types of tarsometatarsi [3] supports the coexistence of two taxa. The somewhat smaller form of Campanian *Hesperornis* from the Volga region should most likely be identified as a separate species [3]. We refrain from providing its formal description until the North American species are revised and more representative material is obtained for the Eurasian forms.

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COMPLIANCE WITH ETHICAL STANDARDS

Conflict of interests. The authors declare that they have no conflicts of interest.

This article does not contain any studies involving animals or human subjects performed by any of the authors.

REFERENCES

1. Bell, A. and Chiappe, L.M., *J. Syst. Palaeontol.*, 2016, vol. 14, pp. 239–251.
2. Bell, A. and Chiappe, L.M., *Diversity*, 2022, vol. 14, p. 267.
3. Zelenkov, N.V., Panteleyev, A.V., and Yarkov, A.A., *Paleontol. J.*, 2017, vol. 51, pp. 547–555.
4. Aotsuka, K. and Sato, T., *Cret. Res.*, 2016, vol. 63, pp. 154–169.
5. Panteleyev, A.V., Popov, E.V., and Averianov, A.O., *Paleontol. Res.*, 2004, vol. 8, pp. 115–122.
6. Zelenkov, N.V. and Kurochkin, E.N., *Iskopaemye reptilii i ptitsy* (Fossil Reptiles and Birds), Moscow: Geos, 2015, pp. 86–290.
7. Bell, A. and Chiappe, L.M., *Life*, 2020, vol. 10, p. 62.
8. Zelenkov, N.V., *Iskopaemye reptilii i ptitsy* (Fossil Reptiles and Birds), Moscow: Geos, 2015, pp. 61–85.
9. Galton, P.M. and Martin, L.D., *Mesozoic Birds: Above the Heads of Dinosaurs*, Berkeley: Univ. California, 2002, pp. 489–538.
10. Bell, A. and Everhart, M.J., *Trans. Kans. Acad. Sci.*, 2009, vol. 112, pp. 7–14.

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