Vestnik zoologii, **41**(3): 283—284, 2007

UDC 598.2:636.01+591.47

ONCE MORE ABOUT ORIGIN OF BIRDS AND FLIGHT: "CURSORIAL" OR "ARBOREAL"?

A. I. Bogdanovich

Schmalhausen Institute of Zoology, NAS of Ukraine,
Bogdan Chmielnicky str., 15, Kyiv, 01601 Ukraine

Accepted 1 March 2007

Once More About Origin of Birds and Flight: "Cursorial" or "Arboreal"? Bogdanovich I. A. – Despite the long-time history of studies of origin and early evolution of the birds, some issues remain open. One of them is the evolutional reasons for the hallux reversion in the bird foot. Some functional sequences of such hallux orientation and its possible importance in evolution of birds are shown. In our opinion, the functional universalism of the anisodactyl foot with well-developed, low placed and opposable hallux allows to unit, in certain sense, the theories of "arboreal" and "terrestrial" origin of birds and flight.

Key words: birds, flight, evolution.

Еще раз о происхождении птиц и полета: «наземное» или «древесное»? Богданович И. А. – Несмотря на многолетнюю историю изучения происхождения и ранней эволюции птиц, некоторые вопросы остаются не вполне понятными. Один из них касается эволюционного смысла разворота первого пальца стопы. Мы попытались показать некоторые последствия такой ориентации hallux и их возможное значение в эволюции класса. Функциональный универсализм анизодактильной стопы с хорошо развитым, низко расположенным и противопоставленным первым пальцем позволяет, на наш взгляд, в определенном смысле обьединить «наземную» и «древесную» теории происхождения птиц и полета.

Ключевые слова: птицы, полет, эволюция.

A particular question of the general theory of the origin of birds is the formation and importance of hallux orientation. One of conclusions from recent analyses of morphological and functional patterns of the hallux reversion is that "... more questions than answers may appear to be present..." (Middleton, 2001: 59).

Finding of *Protoavis texensis* by S. Chatterjee (1991, 1995) somewhat refreshed a long-term discussion about origin of birds and bird flight. We consider one of the important features of *Protoavis* morphology to be analysed once again in functional and evolutional aspects with respect to "arboreal" or "cursorial" flight origin. It is the well-developed and low-placed reversed digit I – anisodactyl foot (Chatterjee, 1995).

The arboreal theory somewhat unified by W. Bock (1965) has been criticized by J. Ostrom (1979); his own cursorial theory, however, was also criticized then by L. Martyn (1983). As concerns to the hallux condition, its reversion in birds was defined as a first adaptation to perching (arboreal habitat) from pamprodactyl foot of thecodontian ancestors (Bock, Miller, 1959). Similarly, functional sense of such a hallux condition in bipedal ornitischian *Hypsilophodon* was defined as an adaptation for arboreal habitat; but later conclusion about lack of its reversion was explained in favour of cursorial *Hypsilophodon* adaptation (Galton, 1971). At the same time, we know recent birds with anisodactyl foot that successfully combines arboreal and terrestrial locomotion (many of Passeriformes, Cracidae and Megapodiidae of Galliformes and others).

The beginning of hallux reversion we can see for example in Triassic thecodontian *Scleromochlus*, where it was displaced aside from others (Woodward, 1907). The completion of reversion to a fully opposable hallux condition in birds trend (contrary to the dinosaur lineage) with true anisodactyl foot formation had certain evolutionary importance. Such a limb was equally adapted to both terrestrial and arboreal locomotion with perching of branches just by the pelvic limb, not by fore as had supposed earlier (Martyn, 1983). Besides, the long reversed hallux provided more efficient posterior support for front-back balancing compared to the long and heavy tail in dinosaurian ancestors, while their body centre of gravity had change-over because of transition to permanent bipedalism. One of its consequences is the reduction of tail and the other is emancipation of fore limbs for flapping.

That hypothetical scenario partly dismiss the L. Martyn's objection against a bipedal bird ancestor acceptance: "It must be difficult for an obligate biped that cannot fly to climb vertical trees" (Martyn, 1983: 121); and A. Walker's objection: "...long before a purely terrestrial biped had acquired the necessary muscle-power and wing area for take-off from the ground, it would have become completely inadaptive and at great risk from predators" (Walker, 1977: 346). Some confirmation of our reasoning is the ability of Cracidae (Galliformes) – more primitive flying birds – to spring into the lower branches of a tree and to hop from limb to limb on the branches (Bent, 1932).

It is well known fact of feather acquisition in dinosaurian ancestors (common with that of birds) without relation with flight (Ostrom, 1979; Mayr, 1960; Xu et al., 1999). We regard as quite logical the presence of fore limbs flapping moves to assist in arboreal locomotion in "protobirds", as noted above. Especially on the condition of insolubility of the question about real functional reasons of fore limb emancipation, all of these (including flight) had to be considered only as consequences of such emancipation (Hutchinson, 2001).

Thus, the functional universalism of the anisodactyl foot with well-developed and opposable hallux allow, in our opinion, to unit both "arboreal" and "terrestrial" theories of origin of birds and flight.

Bent A. C. Life histories of North American Gallinaceous Birds. Family Cracidae // U. S. Nat. Mus. Bull. – 1932. – **162**. – P. 345–352.

Bock W. The role of adaptive mechanisms in the origin of higher levels of organization // Syst. Zool. – 1965. – **14**. – P. 272–287.

Bock W. J., Miller W., De W. The scansorial foot of woodpeckers with comments on the evolution of perching and climbing feet in birds // Amer. Mus. Nov. – 1959. – **1931**. – P. 1–45.

Chatterjee S. Cranial anatomy and relationships of a new Triassic bird from Texas // Phil. Trans. R. Soc. Zon. Biol. Sci. (London). – 1991. – **1256**. – P. 277–346.

Chatterjee S. The Triassic bird Protoavis // Archaeopteryx. – 1995. – **13**. – P. 15–31.

Galton P. M. Hypsilophodon, the cursorial non-arboreal dinosaur // Nature. – 1971. – **231**. – P. 159–161.

Hutchinson J. R., Gatesy S. M. Bipedalism // Encyclopedia of life sciences. – 2001. – P. 1–6.

Martyn L. The origin of birds and of avian flight // Current Ornithology. – New York ; London, 1983. – V. 1. – P. 105–129

Mayr E. The emergence of evolutionary novelties // The evolution of life. – Chicago : Univ. Chicago press, 1960. – P. 349–380.

Middleton K. M. The morphological basis of hallucal orientation in extant birds // J. Morphol. – 2001. – **250**. – P. 51–60.

Ostrom J. H. Bird flight: how did it begin? // Am. Sci. – 1979. – **67**. – P. 46–56.

Walker A. D. Evolution of the pelvis in bird and dinosaurs // Problems in Vertebrate Evolution. – London : Acad. Press, 1977. – P. 319–358.

Woodward A. S. On a new dinosaurian reptile (Scleromochlus taylory nov. gen., sp.) from the Trias of Lossiemouth. Elgin. // Quart. J. Geol. Soc. London. – 1907. – **63**. – P. 140–144.

Xu X., Wang X.-L., Wu X.-C. A dromaeosaurid dinosaur with a filamentous integument from the Yixian formation of China // Nature (London). – 1999. – **401** (6750). – P. 262–266.