

ROMANCING
THE BIRDS AND
DINOSAURS

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Forays in Postmodern Paleontology

Alan Feduccia



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*Romancing the Birds and Dinosaurs:
Forays in Postmodern Paleontology*

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To Ernst Mayr (1904–2005)

Harvard Evolutionary Biologist and Ornithologist
A Guiding Light of the Twentieth Century



Ernst Mayr in 1994. Photo taken after receiving an honorary degree at the University of Konstanz.*

*On his 100th birthday, Mayr published an article in *Science* ((2004) 305: 46–47) reflecting on over eight decades of evolutionary research, closing with the following words: "The new research has one most encouraging message for the active evolutionist: it is that evolutionary biology is an endless frontier and there is still plenty to be discovered. I only regret that I won't be present to enjoy these future developments." Meyer, A. (2005) "On the Importance of Being Ernst Mayr." *PLoS Biol* 3(5):e152. Photo 2005 Axel Meyer. CC BY-SA 2.0.<https://doi.org/10.1371/journal.pbio.0030152>.

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PREFACE

“To kill an error is as good a service as, and sometimes even better than, the establishing of a new truth or fact.”

—Charles Darwin¹

One Long Argument is the title of a book by Ernst Mayr, considered by many the greatest evolutionist of the twentieth century. In a distillation of Charles Darwin’s scientific thought, Mayr traces the genesis of modern evolutionary theory, interpreting the evidence and reasoning behind Darwin’s “dangerous” ideas that would change the world forever. Mayr was also well aware of the greatest evolutionary controversy of the latter part of the twentieth century—the origin of birds and the genesis of flight. The controversy heated up in 1965 at a meeting on *Archaeopteryx* in Eichstätt, Germany, the site of the famous Late Jurassic Solnhofen limestone quarries from which the urvogel fossils were extracted. The debates centered on two topics: were birds dinosaurian cousins, sharing ancestry from early archosaurian ancestors, or were they derived directly from already highly specialized theropods? And did flight originate from a trees-down or ground-up scenario?

It became apparent that while a majority favored a “dinosaurian origin,” paradoxically most preferred the arboreal theory for flight origins. It is seldom that scientific debates are such that both sides disagree on almost everything, but that is the case in this imbroglio. It relates to the fact that once one embarks on a set course of an advanced theropod origin of birds, one is immediately

shunted into a constrained, rigid and inescapable cascade of restrictive reasoning, all guided by cladograms claiming to prove the true ancestry. As the thought processes go: birds are nested within already highly derived theropod dinosaurs with already greatly diminished forelimbs and massive hindlimbs. Therefore, flight originated from the ground up, a “gravity-resisted” scenario; birds inherited hot-blooded metabolism from already endothermic dinosaurs that were insulated with feathers; feathers therefore were evolved before flight, as exaptations (in a context other than their current function); and all the highly sophisticated and unique anatomical, aerodynamic architecture of birds evolved in a context other than flight—again, as exaptations. The now-accepted concept that avian pennaceous feathers, perfections of aerodynamics, evolved before flight is easily traced back to a mistaken family tree or phylogeny showing the turkey-size Early Cretaceous *Caudipteryx* (claimed to be the first truly feathered dinosaur) was a theropod ancestral to birds, while a mountain of evidence indicates that it is, in reality, a secondarily flightless bird. Yale’s Richard Prum, author of the recently acclaimed book *The Evolution of Beauty*, made this exact mistake. Thus, all early birds are interpreted as having been, like their supposed ancestors such as *Caudipteryx*, ground dwellers. The earlier, time-honored reasoning, argued here, is that: birds shared common archosaurian (dinosauromorph) ancestry with theropods, flight originated from the trees-down, “gravity-assisted” (arboreal) theory; early birds, like their dinosaurian cousins, were ectothermic or cold-blooded; so-called dinosaurian “protofeathers” do not exist, the result of misidentification guided by the cladogram; and feathers and all the sophisticated aerodynamic features of birds evolved by natural selection in the context of flight. The problem centers on the blend of ideology with methodology in postmodern paleontology, a dangerous liaison with negative implications for both conservation and racism vis-à-vis the expansion of species units.

Among Ernst Mayr’s major accomplishments was the elucidation of the *Biological Species Concept* as a fundamental category of biological organization. For simplification, a “species” is a group of

individuals that can breed together but are reproductively isolated from other groups. It is not without its critics and limitations, as are most biological principles, but it provides a biologically based unit of comparison. By contrast, the phylogenetic concept—a natural offshoot of the cladistics revolution, the basis of modern paleontology—insists that species be defined as the smallest set of organisms sharing an ancestor and distinguished from other such sets. Thus Mayr’s definition is biological, while the latter is based on typology and leads to over-splitting of taxa. According to recent analyses of bird species, the number jumps from slightly over today’s widely accepted 9,000, to 18,000.² The negative implications for conservation are obvious: as the number of animals on the endangered species list increases almost daily, coincidentally the number of phylogenetic species likewise expands. Why is extinction important when, according to the new “science,” we suddenly have almost twice as many species? And, since typology defines phylogenetic species, one can ask how many species of man exist? In modern times we have recognized one “biological” species, but if typology defines species, there could well be fifty or more species of man, with obvious racist implications.³ As the artist of the “race” statues at Chicago’s Field Museum, Gonzales-Day noted, “When produced many believed they were good science and bad art, but I think attempting to remount them proves the opposite.”⁴ Interestingly, instead of trying to ameliorate the debate or find common ground, we see only entrenchment among the cladists. Commenting on a study by Frank Rheindt of the National University of Singapore on five new avian species and subspecies discovered on an Indonesian island, the author remarked on the “internecine battle over species concepts which goes on and on.” Well-known hard-line cladist Joel Cracraft from the American Museum of Natural History noted: “If it’s distinguishable, it’s a new species.”⁵ So, again we can ask the salient question: are there fifty or so species of man?

As we shall see, the entire field of systematics took a dramatic turn in the 1970s and 1980s, away from what was known as “evolutionary systematics” (considered far too arbitrary and driven by

perceived authority figures such as A. S. Romer, Ernst Mayr, G. G. Simpson and Alan Charig), to “phylogenetic systematics” or cladistics, considered a more scientific and quantitative (numerical) approach to discerning relatedness, and discussed in chapter 6.⁶ The latter, however, quickly became a dogmatic, ideologically driven field, and the cladistic authority figures became intolerant of dissenters. The expression “What goes around comes around” is no more vividly illustrated than by the drubbing of Ernst Mayr and other late twentieth-century biologists and paleontologists for being authoritarian figures, and then witnessing the ascendancy of a real ruling aristocracy in modern paleontology, this time from the fundamentalist cladists whose explanations of dinosaur issues is derived from a view that birds—living dinosaurs—are strictly terrestrial obligate bipeds, and therefore all sophisticated aerodynamic adaptations evolved as exaptations (formerly pre-adaptations) before flight, only later co-opted for flight in birds. Everything derives from the cladogram. Examples are legion, but among the more egregious are: flight evolving from the ground up in a “gravity-resisted” scenario, obligately bipedal pterosaurs evolving flight in a similar manner; avian flight feathers evolving before flight; dinosaurs being endothermic because living birds are endothermic; the avian flight brain and flight inner ear evolving in earthbound dinosaurs; all filaments on dinosaurs identified as protofeathers only because birds are dinosaurs; and finally the early evolution of modern birds, dating back 100 to 120 million years ago. Although the above examples have attained a consensus view among many paleontologists, I consider all to be in serious error. Aside from the fact that “consensus” has no place in science, it is commonly used to garner support for cladistic hypotheses: consensus has become, in a sense, simply something to which no one objects! As the “yogi-ism” goes, “It’s déjà vu all over again!”

The transition from old to new authority figures has no better illustration than a March 2020 *Nature* cover article, by Chinese paleontologist Lida Xing, and including among six other authors noted fossil experts Jingmai O’Connor, and Luis Chiappe of the Natural History Museum of Los Angeles County, reporting on a

“tiny hummingbird-sized dinosaur” trapped in amber from the Early Cretaceous, about 99 million years ago,⁷ and named *Oculudentavis* (“eye-tooth bird”). The discovery gained sensationalistic coverage in scientific and tabloid presses, with titles such as “Tiny bird fossil might be the world’s smallest dinosaur.” The authors speculated that the discovery would cast new light on miniaturization of dinosaurs and evolution on island chains. As well, large eyes indicated “that the dinosaur had exceptional vision”⁸ and likely had diurnal activity, etc. Then, nature writer Riley Black in a March 11, 2020 *Scientific American* blog noted that it “appears to be ... a stem bird.” This would seem logical since one of the authors, Luis Chiappe, has been described as “one of the world’s authorities” on bird origins.

Through this haze of speculation they did, however, get one thing right; it has an “ocular morphology that resembles the eyes of lizards.” In fact, as I (and many others) could see within twenty seconds of examining the photo of the skull, the tiny reptile was clearly not dinosaur nor bird, but a lizard. Even the bony rings of the eye (sclerotic ossicles) were distinctively those of a squamate. One author, Jingmai O’Connor noted that “Animals that become very small have to deal with specific problems, like how to hide all sensory organs into a very small head, or how to maintain body heat.”⁸ The truth, however, is that such small vertebrates go well back into the Triassic Period and have been dealing beautifully with such problems for over 200 million years; and even today we have equally small or smaller creatures, such as the Etruscan pigmy shrew (*Suncus etruscus*), the bumblebee bat (*Craseonycteris thonglongyai*) and the Cuban bee hummingbird (*Mellisuga helenae*), all of which can weigh 2 grams or less. The smallest gecko, the Jaragua dwarf gecko (*Sphaerodactylus ariasae*), is even smaller (16 to 18 mm) and when curled can fit on a U.S. 25-cent coin. A small, adult Indonesian fish (*Paedocypris*) can be as small as 7.8 mm! The life reconstruction showed a fully feathered tiny bird, but reptilian scales are evident on the neck of the amber specimen. One can only ask, where were the reviewers, and where was the editor? Encouragingly, a team of highly competent Chinese

scientists, led by Zhiheng Li and Wei Wang of Beijing's Institute of Paleontology and Paleoanthropology, were waiting to pounce on this fiasco with a preliminary paper in Chinese that translated: "The 'smallest dinosaur in history' in amber may be the biggest mistake in history." The rebuttal was submitted to *Nature* in late April 2020,⁹ but was rejected! A vapid and ill-conceived rebuttal was written by the original authors, but had little to convince anyone that the amber lizard was a dinosaur, much less a bird.¹⁰

The tiny-dino paper, immediately known to be an egregious mistake by many paleontologists, had the bright side of bringing many paleontological goblins out of the closet. This debacle harkens back to 1999 with the announcement of *Archaeoraptor*, a fossil hailed as a missing link between dinosaurs and birds, but it turned out to be no more than a forged fossil, combining a *Microraptor* tail with the foreparts of the fish-eating bird *Yanornis*. *Archaeoraptor* was derided as a dinosaur version of the Piltdown Man, and Luis Chiappe mused that "it's puzzling how the description of *Archaeoraptor* ended up in print in *National Geographic*, as 'the red flag for that one should have been raised long before it got to that point'."¹¹ Yet, the demise of *Archaeoraptor* was rapid; science corrected itself. In the case of "tiny dino," the red flags were waving, but the *Nature* paper went on to press. There was no retraction by *Nature's* editors, who were made aware of the issue, and the authors offered no correction. The problem began not only with the authors, but also with editor Henry Gee, who processed the paper and has been publishing highly conjectural articles for decades on the dinosaur-bird nexus, many incapable of withstanding careful scrutiny. One can ask how a team of supposed experts in paleontology could mistake a lizard for a dinosaur or bird. Aside from questioning the supposed impeccable expertise of the authors, this debacle also exposes the frailty of the cherished methodology, since their massive cladistic analyses show the lizard skull to be that of a dinosaur/bird.

After more than four months, *Nature* retracted the now infamous *Nature* paper, "following new evidence from a similar fossil."¹² The truth however is that it was definitively a lizard the

day it was published; no further specimen needed! O'Connor still maintains that the “specimen cannot be unequivocally identified as either a bird or a squamate without more material ...,”¹³ but a single link of the sclerotic ring easily identifies the fossil as a squamate. If the choices for this battered fossil’s identity are still bird vs lizard, the field itself has descended into a truly appalling state. Given the exasperating errors of the “tiny dino” debacle, moving forward, just what and which authority are we to believe?

Authority Still Rules!

The common ancestry view of birds and dinosaurs, as well as the arboreal (trees-down), “gravity-assisted” theory for flight origin, were predominant views of avian origins dating back to the early part of the twentieth century. Incorporating new discoveries, modifications and updates I have found little evidence or reason to abandon this early model over the years. Mayr, who was also an astute ornithologist, and I, carried on a lively correspondence over the years, and he became one of my ardent encouragers, almost up to the time of his death at age 100 in 2005. He called to congratulate me on the first discovery of vestigial digit I (thumb) in birds, which proved their digits to be II-III-IV—a non-theropod, symmetrical hand (chapter 11). Mayr sent me an inscribed copy of one of his last books, *What Evolution Is* (2001), which I proudly display on my shelves. Out of admiration, and because of his encouragement, I take pleasure in dedicating this current “long argument” to the great biologist.

Employing a monolithic, restrictive methodology blended with a hard-line ideology, the field of vertebrate paleontology has largely been confined to the use of cladistics to resolve both family trees—or phylogenies—as well as evolutionary scenarios. All knowledge, according to the current methodology, must flow from the cladogram, and all cladograms can only be tested by competing cladograms, an unscientific fallacy. The “regimen” is front-loaded with “circularity” since homology is assessed *a posteriori* by the cladogram. Consequently, the field cannot diverge from a bird

origin from already highly derived theropod dinosaurs, resulting in all scenarios reflecting the view that sophisticated aerodynamic adaptations, as well as flight itself, evolved in earthbound dinosaurs in a non-flight, “gravity-resisted” context. Exaptational explanations (shift in the original function of a trait in evolution) for the origin of avian structures pervade the field. I have broken off the paleontological “orthodoxy” because, as Ernst Mayr would say, in order for a theory to conform to the norms or standards of science, everything must fit. By the current methodology, once a cladogram provides a phylogeny, all explanations must emanate from that scheme alone. When unidentifiable fibers in dinosaurs are identified as protofeathers to conform to the cladogram’s geometry; when special pleading is needed to match homology of avian and dinosaur digits; when all sophisticated aerodynamic structures of birds, including flight feathers, flight brain and inner ear, are said to have originated as exaptations in dinosaurs in non-flight contexts; when small avian genome size (associated with flight in birds, bats and pterosaurs) is perceived as having evolved in earthbound theropods; and when flight is thought to have had its genesis from ground-dwelling dinosaurs via “gravity-resisted” models, it seems reasonable to suggest that it may be time to have a fresh look at the entire field.

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to chapter 3, with his remarkable, digital, dinosaur reconstructions, and up-to-date text on sauropods. I also thank Frances James and John Ruben who provided constructive comments on a number of chapters. Editor Jeff Young, talented and attentive, was a pleasure to work with.

I have tremendous admiration for the late John Ostrom, scholar and gentleman, who initiated the modern “birds are dinosaurs” movement with his 1960s discovery of the bird-like theropod *Deinonychus*, a discovery that led to much of today’s paleontological research. We first met when he attended my 1974 seminar at Yale’s Peabody Museum. I later invited him to present a plenary lecture at the meeting of the American Ornithologists’ Union at Haverford College in 1976. Despite the academic acrimony, we remained good friends and he once described me as “a worthy adversary.”

THEME: During the 1960s and 1970s postmodern paleontology emphasized dinosaur behavior, physiology and reconstructions, but following Ostrom’s discovery immense speculation quickly expanded on bird and flight origins. The inflexible cladistic methodology of the postmodern movement resulted in a monolithic view that birds evolved directly from advanced theropod dinosaurs characterized by the Early Cretaceous iconic raptor *Deinonychus*, and that most, if not all, of their numerous flight adaptations arose in a non-flight context, long before the origin of birds. Today, there is no middle ground in this debate, no quarter: critics and criticism alike are dismissed with equal ferocity amid imputations of ignorance, charlatanry, and pseudoscience. There is nothing new in history; we can go back to the third-century B.C. when Greek physicist Archimedes was slain by a Roman soldier. On the debate, Ernst Mayr lamented in 1976 that there was “no hope for a meeting of minds.”¹⁴ The cladistic banner was adopted in the 1970s, led largely by the American Museum of Natural History and its associates. In ornithology, massive mistakes arose from their early research, including notably erroneous phylogenies of flightless birds (ratites) and foot-propelled swimmers (loons and

grebes), as well as ongoing speculation on unsubstantiated dinosaur behavior, physiology and protofeathers, to mention a few. Many of these calamitous results were eventually corrected after four long decades, but not before appearing in innumerable texts as being factual. However, the banner still waves, and today we are faced with a still more serious debate that gets to the foundations of all paleontology. *Plus ça change!*

Aside from a general discussion of salient themes, this book fleshes out some notable issues that have driven the debate to its current status:

- First, it is argued here that any creature with avian feathers and flight hand is of the avian lineage; feathers are too aerodynamically complex to have evolved in any context other than flight. For years, paleontologists have argued that there are two major types of feathers, protofeathers and true avian pennaceous feathers. Yet, there is little proof that so-called “dino-fuzz” fibers have any affinity with true avian feathers. Since paleontologists believe that such fibers are protofeathers, they now consider any fossil in which these fibers are present to be a “feathered dinosaur” which further conflates theropods with birds, annulling any possibility of independently testing hypotheses of the relationships of birds and dinosaurs. If we consider *Archaeopteryx* and urvogels “dinosaurs” *a priori*, then the debate is indeed over.
- Second, so-called flightless but feathered dinosaurs exhibit evidence of flighted ancestry. This “Neoflightless Hypothesis”¹⁵ has earlier antecedents but was re-introduced by Gregory Paul in 2002; he considered all maniraptoran groups to be flightless or flying lineages within the avian radiation.¹⁶ Unlike Paul, who placed these maniraptorans within the coelurosaurian dinosaur lineage, here it is argued that the best explanation is that they are part of the avian lineage, derived from an earlier pedigree predating the divergence of true theropods and their anatomical commitment to a grasping raking hand with digits I-II-III (chapter 11).

- Third, fossils do not interpret themselves: any paleontological consensus is only as sound as the methods that have been used to glean information about evolutionary history from mute bones. Problems bedevil this process, to the unending woe of systematists, but postmodern paleontology proceeds with blithe assurance in the soundness of its methods and the infallibility of its results. Nevertheless, the same sources of fundamental error that undermined early applications of cladistics in ornithology are still making mischief: massive parallelism and convergence, where disparate lineages are rendered virtual doppelgängers; fossil decay and deterioration which distort ancestry, causing stem-ward slippage in phylogenies; and very importantly, ontogeny (especially arrested development or pedomorphosis), which as University of Arizona’s evolutionary biologist John Wiens put it “discombobulates phylogeny.”¹⁷ Millions of years of natural selection did not have phylogenetic reconstruction in mind!

It is my hope that these brief and succinct essays will provide a platform for continued and invigorated debate, contributing to a new synthesis of the field.

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1

BURNING DIM: THE NEW THEORY-LADEN STUDY OF FOSSILS

A dramatic fossil discovery in the 1960s and the unearthing of the little-known fossils of the Chinese Early Cretaceous Period beginning in the early 1990s are two events that forever transformed the field of vertebrate paleontology. First, Yale's John Ostrom, continuing what was then the tradition of the student, western paleontological expeditions beginning in 1964, recovered the bird-like dromaeosaur (raptor) dinosaur *Deinonychus* ("terrible claw") from the 108- to 115-million-year-old Lower Cretaceous Cloverly Formation, which led to a re-examination of the origin of birds and the genesis of flight, still a spirited debate today. Dromaeosaurs were thus recognized as the sister group of birds and therefore shared ancestry; since then, numerous new species have been discovered, including some that actually have avian feathers. This single discovery resulted in hundreds of studies related to bird evolution. Two decades later, on the other side of the world, the beautifully preserved fossils of the Lower Cretaceous lagerstätten (sediment with exceptional fossil preservation) of northeastern China, known as the Jehol Biota, provided a previously unknown window into that critical period of the Mesozoic. These discoveries unleashed another flurry of fossil descriptions and biological revelations. Yet, despite these hugely important discoveries, interpretation of fossils and their paleobiology has

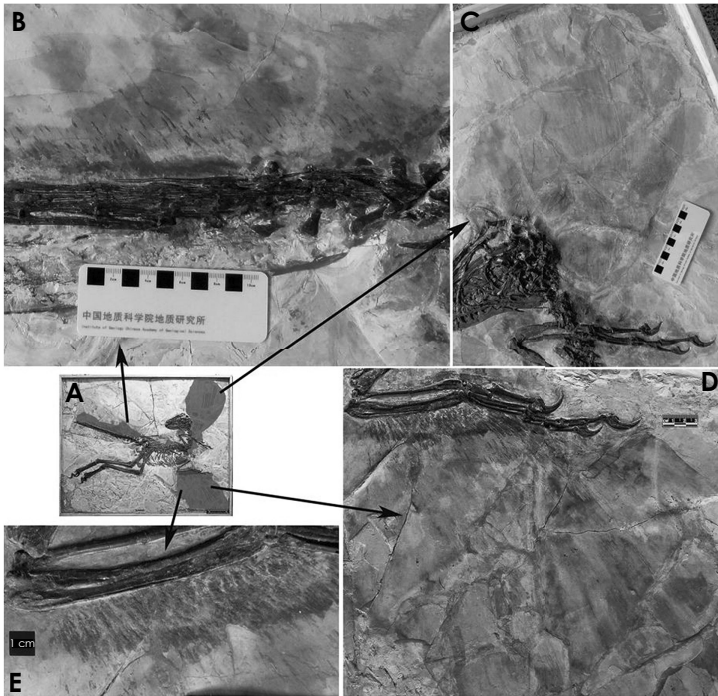
remained among the most problematic, uncertain and speculative fields of the natural sciences.

The so-called “dinosaur renaissance” initially propelled by Ostrom’s discovery, as well as the Chinese discoveries, led to studies reinforcing the prevailing view among paleontologists that birds are living dinosaurs and that flight originated from the ground up, from earthbound dinosaurs.¹ Studies have largely focused on verification of current hypotheses, rather than following the time-honored approach of scientific falsification. Strict adherence to phylogenetic interpretations illustrated by cladograms has meant that discovering homology (descent from common ancestry) is ascertained *a posteriori* from the cladogram, whereas more traditional biologists like myself derive homology *a priori* by studying embryological connectivity and anatomical detail, with myriad fields coming to bear on such issues. The current monolithic approach has resulted in almost all sophisticated avian flight adaptations being interpreted as theoretical “exaptations,” having evolved initially in a context other than aerodynamic, and only later co-opted for flight—a tortuous, improbable explanation, but accommodating the cladogram.² In other words the origin of structures and flight is interpreted based on the “fact” that birds were derived from already highly advanced earthbound theropods, regardless of anatomy or biophysics of flight.

As an example, in 2015 a Chinese Early Cretaceous, 2 meter (6.6 ft), 125-million-year-old feathered dromaeosaur specimen said to be close to the Jurassic Park *Velociraptor*, dubbed “fluffy feathered poodle from hell” was discovered.³ *Zhenyuanlong* (“Zhenyuan Sun’s dragon”) created great speculation about whether it could fly, but there is little reason it could not have been a peaceful semi-terrestrial, trunk climber and glider. Instead, with little evidence, it was reconstructed tearing through the Cretaceous forest with spread wings ready to rip the guts out of anything that it might find, so unlike modern terrestrial birds (e.g., turkey) that keep their wings folded tightly against the body to reduce drag. Aside from the tabloid-style, sensationalistic nickname, the speculative question arose whether its tail feathers were used to attract mates

and intimidate rivals! Again, we are confronted with theoretical speculation based on the cladogram, since traditional “dinosaurs” cannot fly. Although it had an anatomically adapted avian flight hand⁴ (with the middle phalanx broadened and in close apposition, side by side, to the middle finger, like birds; and aerodynamic asymmetric primaries), distinguished University of Edinburgh paleontologist Stephen Brusatte asks if wings first evolved for display or egg brooding and only in some later dinosaurs were co-opted “into airfoils for gliding and flying?”⁴ However, given the aerodynamic perfection of avian flight feathers, the only reasonable biological explanation for airfoil flight feathers is either that their owner flew at some level, or they were derived from an ancestor capable of flight. Like all birds, ancient and modern, the reduced outer finger is in close association with the middle finger, completely lodged in the soft tissue of the postpatagium (wing flight membrane),⁵ and it is thus largely immobile. Like *Archaeopteryx*, this dragon’s wing was approaching the basic pattern of birds, lacking significant grasping ability and of little use for prey capture, but likely the fingers were closely cohered by soft tissue and claws were likely used primarily for trunk climbing. As we shall see, the bird skeleton is characterized by fusion and deletion of bones, providing lightness, rigidity and strength for flight; and the finger bones are modified from those of early birds, urvogels. In addition, fossil birds that preserve feathers (even modern-like Eocene birds from 50 million years ago) frequently look primitive and fuzzy due to modification through preservational deterioration, so extreme caution must be used in any interpretation. According to Brusatte: “*Zhenyuanlong* was a dinosaur that really looked like a bird.” But the real question is: was it a bird?

In 2010, Brusatte joined Bucharest University’s esteemed paleontologist Zoltán Csiki in writing a journal article for the prestigious *Proceedings of the National Academy of Sciences* about the Late Cretaceous Romanian dromaeosaurid *Balaur bondoc* (“stocky dragon”), a desert dweller close to the famous *Velociraptor*, having evolved its weird anatomy because of island endemism.⁶ In an accompanying commentary, the Smithsonian’s Hans-Dieter Sues

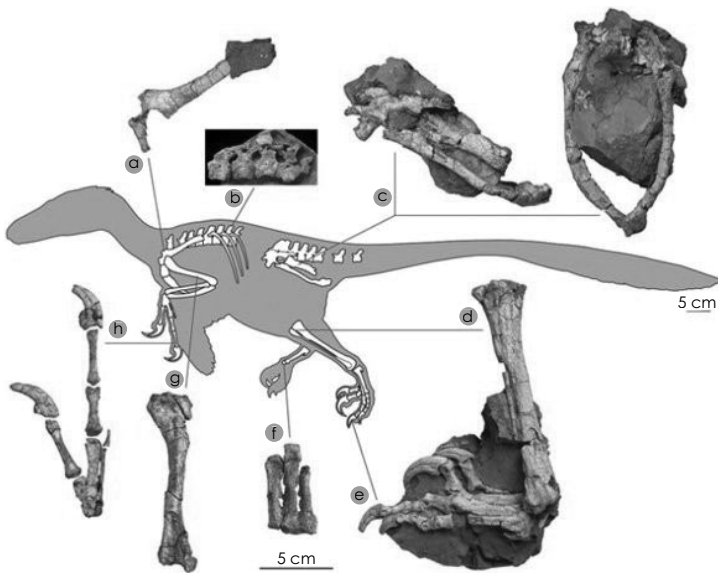


The “poodle from hell,” *Zhenyuanlong*, may be little more than an early bird, and it likely flew. It has a bird-like hand with the outer two fingers positioned side by side as in all birds and asymmetric flight feathers. It was well on its way to being a bird. There is nothing about the wings that would preclude some form of flight, gliding or intermittent wing strokes. (Lü, J., and S. L. Brusatte, “A large, short-armed, winged dromaeosaurid (Dinosauria: Theropoda) from the Early Cretaceous of China and its implications for feather evolution.” *Scientific Reports* [2015] 5:11775. CC BY 4.0 license).

noted that, “The body size ... is comparable with that of most other known dromaeosaurids ...” And a thorough phylogenetic analysis of dromaeosaurid theropods found it most “closely related to *Velociraptor* from the Upper Cretaceous of Mongolia and China.”⁷ A news release quoted Brusatte: “Compared to *Velociraptor*, *Balaur* was probably more of a kick boxer than a sprinter, and it might have been able to take down larger animals than itself ...” One tabloid-style news release described the fossil: “Beefy dino sported fearsome claws,” while another proclaimed, “Stocky dragon dinosaur terrorized Late Cretaceous Europe.”

The paper was followed by a detailed 100-page American Museum monograph. In 2012, having noted the very bird-like hand with manual reduction and fusion, I questioned if it could have been “a large, beefy, flightless bird.”⁸ After all the sensationalistic tabloid hoopla had died down, at least three studies showed indeed the great *Balaur* was little more than a secondarily flightless bird,⁹ with a non-predatory hand and a foot unlike any dromaeosaurs. It was likely a peaceful omnivore, and it certainly did not roam Europe terrorizing the neighborhood!

As another example of the uncertainty of this field, in 1975, fragmentary Romanian fossil leg bones originally described as the



The “stocky dragon” *Balaur*, misidentified as a dinosaur, was little more than a secondarily flightless bird, with a non-predatory hand and a foot unlike any dromaeosaurs—possibly an omnivore. It certainly did not roam Europe terrorizing the neighborhood! Note that the outer finger (lower left) of *Balaur* in the image above is greatly reduced and tightly bound to the middle finger, an avian feature allowing attachment of the primary flight feathers. (Csiki, Z., M. Vremir, S. L. Brusatte, et al., 2010, “An aberrant island-dwelling theropod from the Late Cretaceous of Romania.” *Proceedings of the National Academy of Sciences of the United States of America* 107[35]:15357–15361. Used with permission from PNAS and Z. Csiki⁶).