Ornitología Colombiana Año 2022 I Número 21

http://asociacioncolombianadeornitologia.org/revista-ornitologia-colombiana/

Review of: Feduccia, A. 2020.

Romancing the Birds and Dinosaurs: Forays in Postmodern Paleontology. BrownWalker Press/ Universal Publishers, Inc. Boca Raton, FLA and Irvine, CA.

F. Gary Stiles

[1] Profesor especial. Instituto de Ciencias Naturales, Universidad Nacional de Colombia
✉ fgstilesh@unal.edu.co

The evolution of birds and flight: a controversy definitively resolved?

For over half a century, a heated controversy has existed in paleontology regarding the origin of birds and their feathers and flight. The 'classical' theory, championed by Alan Feduccia in his book "Romancing the birds and Dinosaurs", considers that the bird and dinosaur lineages diverged in the Triassic from early archosaurs, that flight evolved in small, trunk-climbing animals via selection favoring specialization for gliding, with feathers having evolved concurrently to produce aerodynamic airfoils and smooth body outlines to reduce drag by air resistance. The newer, 'postmodern' theory posits that birds evolved more recently from highly specialized cursorial theropod dinosaurs, with flight evolving via fast running to attain takeoff and wing-assisted climbing to reach higher elevations from which to glide, while feathers evolved to reduce heat loss in cursorial, endothermic dinosaurs and only later were adapted for flight. The two theories rely upon very different methodologies to reach their conclusions. The classical theory traces the evolution of different bones and functional complexes through time as well as ontogenetic processes including embryology to determine homology, with consideration of the chronology of the fossils derived from stratigraphy. The postmodern theory is based upon the methodology of cladistic phylogenetics that produces cladograms to express the relatedness of any two specified groups, deducing the characteristics of their common ancestors quantitatively via measurements of numerous characters through computer algorithms and identifying homologies from the cladograms; the temporal component of stratigraphy to date fossils is deemed of only secondary importance.

This review is timely, because the postmodern "birds are dinosaurs" theory is the *only* one presented in all modern ornithology texts, as well as in nearly all of the popular and semipopular literature. Proponents of this theory have proclaimed that the controversy is resolved, affirming that the only valid way to deduce phylogeny is through the cladistic method, thus conclusions reached by any other method are "non-scientific". The arguments presented by Feduccia appear too solid and logical to be so arrogantly dismissed, and the evidence he presents suggests clearly that the controversy is far indeed from having been resolved.

In his preface, Feduccia describes the current controversy and why he considers cladistic phylogenetics to be a "restrictive, monolithic methodology blended with hard-line ideology": all knowledge must flow from the cladogram, and all cladograms can *only* be tested by competing cladograms. He then presents three of his own basic arguments: a) 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; b) nonflying feathered "dinosaurs" exhibit flighted ancestry (the "neoflightless hypothesis") – loss of flight is a derived rather than a primitive character; and c) he points out three fundamental sources of error in cladistic reconstructions of phylogeny: massive parallelism and convergence in disparate lineages, fossil deterioration and decay which distort ancestry, and ontogeny, especially paedomorphosis or arrested development.

Chapter 1. Burning Dim: The New Theory-Laden Study of Fossils. Feduccia considers two events that changed the field of paleontology: John Ostrom's discovery of the lower Cretaceous bird-like "dinosaur" *Deinonychus* and its striking overall resemblance to modern flightless birds, which led him to propose that the origin of birds was to be sought in terrestrial, bipedal theropods; and the discovery of the exceptionally well-preserved and diverse fossils of the Jehol biota of early Cretaceous deposits in China, which included many birdlike forms. Each of these events produced floods of subsequent publications describing these finds – but their interpretations were principally directed toward reinforcing the new view of the earthbound theropod origin of birds, with the presence of feathers and aerodynamic wings being explained as having been evolved for other functions and preadapted for subsequent utility for flight, as now supported by cladistic phylogenetics.

Chapter 2. The Road to Paleontological Postmodernism. The term "postmodernism" represents rejection and replacement of "modern" (latter 20th century) methodologies and ideas: for paleontology, the advent of phylogenetics via cladograms. Also fueling the mix was the recreation of dinosaurs as warm-blooded, colorful, highly active and intelligent animals by Robert Bakker. This was most convenient for the cladogram because it permitted feathers, as essential for endothermy by retarding heat loss, to be viewed as having evolved in this context rather than for flight.

Chapter 3. Make it new! The Dinosaur Renaissance. This chapter actually deals with how much the "new look" at dinosaurs (as triggered by the Bakkerian "renovation") can tell us about their behavior in life. For the bipedal, predatory theropods, some of Bakker's speculations on their locomotion have held up, but for the gigantic, long-necked sauropods, this is not the case. Here, the computer-generated digital reconstructions of dinosaur skeletons, based upon careful measurements taken directly from the fossil bones, have greatly clarified their postures and resultant limits to behavior, effectively consigning Bakker's visions of dancing behemoths with swan-like necks browsing on Mesozoic treetops to the realm of science fiction.

Chapter 4. New and Improved Dinosaur. Here, Feduccia presents a relatively brief but incisive critique of Bakker's and Ostrom's conception of endothermic dinosaurs (for Ostrom, necessary for his hypothesis that birds inherited their warm-bloodedness from theropod ancestors: (in fact, Bakker had depicted *Archaeopteryx* as an earthbound theropod that could not fly). Considering surface/volumen relationships, it had been calculated that large dinosaurs could maintain high body temperatures without necessity of feathers for insulation, obviating the need to consume far higher quantities of food to support heat production: they were in effect, "inertial homeotherms". To attain such large sizes, it had been calculated that such dinosaurs required growth rates far higher than present-day reptiles (or birds), but this study was criticized for serious errors in these calculations; among living organisms, no correlation exists between basal metabolic rate and growth rate. Feduccia concludes that in the uniformly tropical climate of the Mesozoic, endothermy was unnecessary and perhaps even maladaptive.

Chapter 5. The Hot-Blood Dinosaurs. Feduccia continues here developing the arguments for and against endothermy in dinosaurs with a detailed consideration of the physiological and behavioral correlates of endothermy and ectothermy. He describes the variety of behavioral mechanisms involved, with particular reference to the physiology of energy production in muscles and the muscular mass required for flight. He shows that short anaerobic energy bursts produced by a relatively small amount of muscle permit ectothermic animals to move quickly enough to capture food and avoid being captured as food, and considers the capacity of ectotherms to use behavior to acquire daily and maintain high body temperatures, again with a fraction of the energy required for permanent endothermy. Also, he reviews the many variations in thermoregulation by modern birds, including use of environmental heat gradients (*e.g.,* sun-shade) in different contexts to supplement or offset energy requirements of endothermy. With respect to early birds like *Archaeopteryx* as well as small theropods, Feduccia concludes that they simply were ectothermic! Moreover, the supposedly high intelligence of large predatory theropods (deduced from their supposed endothermy) is contradicted by their minute brain casts.

Chapter 6. Methodology: The Endless Search for a Panacea. This chapter presents a detailed critique of phylogenetic systematics, tracing its origins through the phenetic era of the 1960s and 1970s and on to Hennig's cladistic method, and its modified version as currently practiced. This involves moving away from Hennig's careful analyses to identify homologies and separate derived from primitive characters, to deducing homologies from cladograms constructed by computer algorithms incapable of recognizing massive convergence, parallelism and paedomorphosis, all of which have been important in avian evolution. Homologies are discerned by "reciprocal illumination", in effect majority-rule consensus in the cladogram, which in turn is evaluated by the criterion of parsimony. Therefore, the selection of characters to enter into the construction of the cladogram is of paramount importance. Redundant, highly co-correlated characters can exert a disproportionate influence compared to highly unique and diagnostic characters; weighting of such diagnostic key characters is not allowed as this would constitute "special pleading" and bias the cladogram. Feduccia presents a detailed list of cladistic phylogenetic studies that produced results incompatible with whole-genome analyses. In effect, the biological significance of characters and *how* natural selection favored their evolution are ignored, as is stratigraphy, the most conclusive indicator of *when* they evolved.

Chapter 7. Dinosaur: What's That? This turns out to be a difficult question. Feduccia details the supposed defining characters of dinosaurs and theropods, in which evolution of bipedality and associated features of the pelvic girdle, legs and feet figure most prominently. However, looking back to the Triassic, various groups of pre-dinosaurian "protoarchosaurs" are found, and the classification of these is fraught with uncertainty due to frequent and varying degrees of convergence in different lineages toward dinosaurlike posture and locomotion, and the once clear definitions of dinosaurs and theropods (among others) have become increasingly blurred: rather than a neat, straight-line evolutionary sequence, the phylogenetic tree becomes increasingly bushy and tangled. Which group or groups are potential avian ancestors, and when the avian lineage diverged from that of advanced archosaurs, are questions with no clear answers (yet?). Even the question of what currently constitutes a "dinosaur" may depend upon how far back among the various possible nodes one wishes to go – and as sometimes suggested, this "is essentially arbitrary".

Chapter 8. The Rise and Fall of Vicariance Biogeography. Here, the question involves the origins of the ratites, and of the origins of the modern avifauna: were these the gradual consequences of continental drift, or the result of an explosive radiation of modern birds following the meteor strike that abruptly terminated the Cretaceous, producing the extinction of not only the dinosaurs, but also of the dominant lineage of birds of the Mesozoic avifauna, as first proposed by Feduccia's "big bang" hypothesis? Evidence that modern orders existed in the Cretaceous, as favored by the cladists, rested in part on the identification of the Cretaceous *Vegavis* as a modern duck, although subsequent studies showed that it represented an archaic form not clearly ascribed to any modern order. Finally multiple genetic studies including whole-genome analyses of modern orders conclusively support the origin of nearly all modern orders including the ratites as following the extinctions at the end of the Cretaceous, and that modern ratites were descendants of volant ancestors.

Chapter 9. Peter Pan Evolution: Fast Track to Macroevolution. This chapter highlights the work of Gavin deBeer, who developed the ideas of mosaic evolution, applicable to many forms exhibiting combinations of primitive and derived characters (including *Archaeopteryx*), and the importance of paedomorphosis or arrested development: the retention of juvenile characters into the adult stage, with retarding or eliminating the expression of adult flight-related structures. This has been an important feature of many lineages, including secondarily flightless birds, as in the ratites as well as flightless Mesozoic forms. The highly developed aerodynamic wing morphology has been progressively reduced in cases where the selective advantages for its maintenance were relaxed, in order to increase in size beyond that necessary for aerial locomotion, especially in predator-free isolated ecosystems such as oceanic islands. Paedeomorphosis can result in secondarily flightless forms rapidly acquiring the appearance of ancestral stages in the evolution of flight, and such changes may be all but impossible to detect in cladistic analyses: specifically, the resultant bipedal, cursorial animals come to resemble theropods that never flew.

Chapter 10. You Can't Go Home Again: Dollo's Law. This "law" essentially states that once lost over long periods, complex adult characters cannot be reacquired: the statistical improbability of following the previous evolutionary trajectory backwards. Flightless ratites cannot reacquire the ability to fly, just as blind cave organisms cannot reacquire eyes. In the case of birds, flight requires long forelimbs that support wings. In many dinosaurs including theropods, the evolution of shorter forelimbs was part of specialization for fast bipedal, cursorial locomotion. The hypothesis of the "ground-up" origin of flight from a theropod origin requires the re-elongation of the forelimbs (to serve as insect nets or for displays), but no actual evidence supports such a process, which is also aerodynamically highly unlikely.

Chapter 11. Rambo and Clementine: Thanks for the Thumb. The homology of the three digits of the avian hand has long been disputed, because the hand of advanced dinosaurs like theropods also has three digits, clearly identified as 1,2 and 3 in the fossil record, which documents reduction and loss of digits 4 and 5. Working from the eggs of a pair of captive ostriches (named Rambo and

Clementine), a careful embryological study by Feduccia and Nowicki definitively identified the digits of birds as 2,3 and 4, clearly showing the rudiments of digits 1 (the "thumb") and 5 in an early stage of embryology, with the subsequent resorption of these elements at a later stage. The non-homology of avian and theropod hands was conclusively demonstrated. In effect, this affirmed digital homology as a key character distinguishing avian and theropod lineages. However, cladistic algorithms deal with *numbers* of characters and the weighting of *key* characters is denied as "special pleading" by cladists. To resolve the difference in digital homology, a *homeotic frame shift*, whereby the identity of the digits shifted during embryology was proposed. However, what may occur in a genetic laboratory experiment may not occur in the real world, without any demonstrable advantage from natural selection. Further experimentation led its proponents to propose digits in addition to the original five, which would effectively remove embryology from the phylogenetic toolkit. As noted by Feduccia, the question never asked is, "if birds are direct descendants of dinosaurs, why would they not have possessed a dinosaur hand at their origin?"

Chapter 12. Topsy-Turvy Phylogeny. Here, Feduccia discusses a popular figure purporting to show the progression from theropod to bird, taken by many to represent a phylogenetic timeline. It begins with *Sinosaurapteryx*, an early Cretaceous theropod sporting a mane of supposed downy "protofeathers" and continues with Velociraptor of the late Cretaceous, a terrestrial cursor with a birdlike wrist bespeaking avian affinities (much like *Deinonychus*), *Protoarchaeopteryx*, an apparently close relative of *Archaeopteryx* but appearing in the fossil record *after* the latter, on to the late Cretaceous *Caudipteryx*, with many birdlike features including the remnants of a feathered flight wing (considered by Feduccia to represent a secondarily flightless bird), followed by the Jurassic *Archaeopteryx*, definitely capable of at least short-distance flight, then *Eoalulavis*, an enantiornithine bird of the early Cretaceous and definitely off of the main branch leading to the final crow (*Corvus*) exemplifying the modern avifauna. As a chronological progression, the figure is totally meaningless (avian ancestors are placed millions of years later than the earliest birds while the earliest known bird appears almost at the end of the sequence), but it typifies the disregard for stratigraphy by much of cladistic analysis.

Chapter 13. Dino-Fuzz in the Jehol. The mane of supposedly downy protofeathers of *Sinosaurapteryx* was quickly taken by cladists as perhaps the final evidence of a dinosaur-bird link. However, the status as true feathers of this theropod has been severely questioned, and their location as a midback mane obviates any thermodynamic function, especially as no evidence exists for such "feathers" being the insulatory pelt required by Ostrom to support endothermy. Feduccia notes that such a downy covering would be maladaptive in a wet climate, and that downy young of modern birds are often sheltered from wetting by the wing or back feathers of the adults, as well as being vulnerable to predators. Skin impressions of Cretaceous theropods and other dinosaurs, never show external featherlike coverings. Moreover, such fibrous structures are present widely as collagen fiber meshworks that give structural support to the integument in a wide variety of vertebrates, and in *Sinosaurapteryx* probably supported a dorsal frill as seen in some modern lizards. However, their existence prompted Prum and Brush to develop a model for feather evolution starting with such "protofeathers" and progressing through several stages to the aerodynamic airfoils first definitely seen in

Archaeopteryx 30-40 million years earlier. Presence of other stages of feather evolution in the fossil record according to this model have been virtually duplicated by experiments on decay of collagen fibers of scales in vertebrates including dolphins and to decaying collagenous tendons or scales in some fossils including icthyosaurs by Lingham-Solier, the world expert on collagen. Preservational alteration of the integument shown in primitive chordates also produces similar "stemward slipping" and resemblance to earlier, more primitive states, easily misguiding cladistic reconstructions of phylogeny.

Chapter 14. Collagen, Collagen Everywhere! Here, Feduccia reviews the resistant structure and ubiquitous nature of collagen, which is the main structural protein in everything from skin and scales to bone and cartilage, as well as the cornea of the eye, blood vessels and the heart itself. These conclusions derive from the decades of intensive study of collagen by Lingham-Solier, who also collaborated with Feduccia in a number of studies. Feathers are hollow, keratinaceous structures, but there is no clear evidence that "protofeathers" were hollow, and this also calls into question the assertion that the external, hairlike integumentary structures seen in some pterosaurs "must be" feathers, with the alternative explanation being that they are the residue of a mesh of collagen fibers exposed by decay of a wing membrane.

Chapter 15. Iconic Urvogel: Bird to Dinosaur to Bird. Although often considered to be a "Rosetta Stone" of evolution, *Archaeopteryx* is actually rather far removed from the true origin of birds. Its current status is reviewed by Feduccia in this chapter. Until the 1970s, it was generally agreed that *Archaeopteryx* was an arboreal trunk climber, but the discovery of *Deinonychus*, presumably close to avian ancestry, shifted its image to that of a terrestrial predator unable to fly. However, its anatomically avian anatomy has been confirmed in many studies, including the discovery that one specimen had hindwing feathers, symmetrical rectrices and pennaceous feathers on its body, which probably served to produce a smooth outline to reduce air resistance (drag) once airborne. A study of its shoulder girdle indicated that it was probably incapable of sustained flight, but could flap its wings periodically. Other features of *Archaeopteryx* recently documented are the presence of pre-and postpatagia, membranes important for flight function as well as indicating that it could fold its wings as does a modern bird; being embedded in the propatagium restricts digital movement to the extent that use of the digits in predation is untenable. However, its hand digits were well suited for trunk climbing. Its feet, with the reversed hallux, were apt for perching on branches. A cast of the *Archaeopteryx* brain revealed it to be very similar to that of modern birds, albeit slightly smaller. The insistence by cladists that it was a terrestrial predator, required of the cladogram because of its placement in the Jurassic, in turn required that its flight characteristics had evolved as exaptations in the contexts of endothermy or displays, an unnecessarily complicated and tortuous explanation.

Chapter 16. Confuciusornis: Earliest Known Beaked Bird. Like *Archaeopteryx*, the earliest descriptions of *Confuciusornis* portrayed it as a terrestrial runner and insect trapper, but numerous studies have confirmed that it was a fully volant bird, in many ways more advanced than *Archaeopteryx* but like other enantiornithines, lacking certain more advanced features of modern birds of the ornithurine lineage that gave rise to modern birds. Suffice it to say that with literally thousands of well-preserved specimens, its external and internal anatomy is known in detail, as revealed by laser fluorescence and scanning electron microscopy. Feduccia speculated that its extreme abundance and with no identifiable stomach contents such as insect chitinous parts having been found in any specimen, therefore it might well have been a colonial leaf eater, with stomachs full of digesting leaves.

Chapter 17. WAIR WAC-ked! One of the hypotheses advanced to rescue the idea of the ground-up origin of flight is "wing-assisted climbing" or WAIR, first proposed to explain how baby theropods could use their wings to surmount fallen trunks, thereby selecting for re-elongation of their wings. A revival of this hypothesis was based on observations on the chukar, a gallinaceous bird known for its ability for flapping its wings to aid in climbing hills or logs, from which it could glide or fly down. However, there is no evidence that the requisite forelimb musculature existed in any theropod. Finally, Feduccia reviews the evidence that flight only evolved in the "gravity-assisted", trees-down mode (termed wing-assisted climbing or WAC), via parachuting and gliding stages, beginning with a small, trunk-climbing, leaping vertebrate. Any increase in surface area of a small animal could decrease the vertical angle of descent and increase the distance achieved by the leap. Many intermediate stages of parachuting to gliding with increasing surface area are exhibited among modern small vertebrates, and the transition toward active flight could be easily selected via increased development of an airfoil on the forewing permitting flapping to increase the distance reached in the glide; further increase of the wing musculature would permit active flight. By contrast, no modern flying animals appear to have evolved via the ground-up, "gravity-resisting" method embraced by Ostrom and the cladists, via the improbable and aerodynamically inefficient re-elongation of greatly shortened forelimbs as in even the smallest theropods.

Chapter 18. The Mismeasure of Claws. Claws can provide valuable information regarding locomotion, especially when attention is directed toward the extremes of the range of variation in curvature and sharpness. Feduccia shows that strong curvature with a laterally compressed, extremely sharp tip is characteristic of a variety of trunk-climbing vertebrates from lizards to squirrels to woodpeckers and serves to separate these from more terrestrial animals with broader, flatter claws. The forelimb claws of early birds, both gliders and active fliers clearly show them to be arboreal climbers whose claws can function for climbing within the narrow range of movements permitted by the incorporation of the digits into the propatagia. Claws of terrestrial, cursorial theropods are quite different, and their forelimbs are too short and slender to be useful for climbing in any case. Feduccia notes that the horny sheath is the pertinent feature for measuring claws; the underlying bones often fail to reveal claw structure.

Chapter 19. Climbing Wings: The Arboreal Scansoriopterids. When described, these tiny mid-Jurassic animals were originally considered to be the smallest, arboreal coelurosaurs and the closest to the origin of birds. However, these animals lack any salient dinosaur features but show many avian characters, including evidence of elongated, rachis-dominant feathers on both fore and hindlimbs, claws fit for tree-climbing and a reversed hallux for perching. The pelvis is more like those of pre-dinosaurian archosaurs of the Triassic than that of theropods: they have been classed as pre-manoraptorian archosaurs, perhaps ancestral to oviraptorids and most likely represent early departures of the avian lineage from that of theropods and "dinosaurs" generally. They definitely support the "trees-down" evolution of gliding and flight.

Chapter 20. *Caudipteryx*: Feathered Dinosaurs Unveiled. The discovery of the early Cretaceous *Caudipteryx*, with reduced wings supporting avian flight feathers, an avian hand and propatagium and pennaceous body feathers was hailed as the definitive proof that flight evolved among dinosaurs and feathers had evolved for some other function (display?). However, these conclusions were derived from phylogenetic analyses incapable of dealing with secondary loss of flight. A close relative, *Protoarchaeopteryx*, had somewhat larger wings and perhaps was capable of limited flight; both were classified as dinosaurs in the Oviraptoridae. Far from considering these as dinosaurs, Feduccia and others saw them as remnants of a previously unrecognized radiation of flightless Cretaceous birds, distinct from that of theropods and "dinosaurs". Other studies, including a detailed cladistic analysis by Maryanska and Omólska clearly placed these oviraptorids as secondarily flightless birds. Feduccia noted that the complex structure of pennaceous feathers on the body becomes simplified in modern flightless birds, suggesting that such complexity is unnecessary for thermoregulation and could only have evolved in a flight context.

Chapter 21. Pennaraptorans ("Feathered Raptors"): Dinosaurs or Birds? The Penniraptora is a recently described group including the most avian members of the Maniraptora: the Oviraptosauria, Dromaeosauria and Troodontidae, defined phylogenetically by their "most recent common ancestor of *Oviraptor*, *Deinonychus* and *Passer domesticus*", thus it is presumed to be an early derivative of the line leading to modern birds. Including the most avian members of the Maniraptora (and possibly also the scansoriopterids), its characters include avian features like pennaceous feathers and a semilunate carpal that permits the wrist movement essential for flight, an element lacking in classic theropods. This would effectively eliminate theropods from the entire avian lineage, thus placing the nature of the penniraptorans at the heart of the dinosaur-bird debate: are they dinosaurs or birds? Feduccia extends his argument that *Caudipteryx* is a secondarily flightless bird to the penniraptorans, which as a group includes all stages of gliding, flight and secondary loss of flight: they represent descendants rather than ancestors of birds. The earliest known definitive penniraptoran is *Anchiornis* of the mid-to-late Jurassic. Its skeleton suggests that it was a tetrapteryx glider like *Archaeopteryx* and *Microraptor* and recent studies have shown it to have multiple avian characters; it likely was an ancestor of the still more birdlike troodontids.

Chapter 22. The Day the Dinos Died. Here the Cretaceous-Tertiary (KT) extinction is taken up in more detail, including evidence that at least some dinosaurs were still extant when the meteorite collided, as revealed by the "Tanis" fossil site, and evidence in favor of the "big bang" evolution of modern avian orders. Feduccia follows this up with the prospects for the already progressing next major extinction of biodiversity resulting from the human impact of exploding population growth and its consequences, including climate change, dramatic reduction of natural areas and atmospheric contamination.

While reading "Romancing the Birds and Dinosaurs", I made frequent comparisons with parallel conclusions expressed in Luis Chiappe's book "Glorified Dinosaurs: the origin and early evolution of birds", wherein the cladistic method of phylogenetic systematics is explained as the only truly scientific method for deciphering the past. It was interesting to note the different interpretations of the nature and significance of the certain fossils between the two books. However, I was struck by its nearly total absence of presentation and evaluation of alternate hypotheses or contrary evidence: paedomorphosis is nowhere mentioned and secondary flightlessness only briefly (but not explained); collagen is only mentioned in passing in two places; Feduccia's listing of failed examples of phylogenetic methodology is not mentioned, nor is the existence of a competing cladogram of the phylogeny and relationships of *Caudipteryx*.

Epilogue: A Search for Consilience, Not Consensus. Consilience might be defined as the unification of different areas of knowledge reached through agreement among those favoring different approaches and conclusions. In science, this implies open debate and mutual respect between different sides of a controversy and not by simply ignoring the existence of such differences. Consensus rather implies an effort to convince a majority of those interested in a controversy by vehement advocacy through methods sometimes akin to populist proposals to win a political election: winner takes all, alternative proposals are discredited. The consensus view that "birds are dinosaurs" has been reached in much this manner. Ignoring the existence of a controversy when a great deal of contrary evidence has been presented is not the way science is best served. Presenting the cladistic phylogenetic method as the *only* hypothesis in ornithology texts effectively deprives students of the opportunity to compare both sides of this controversy, evaluating both with respect to how well they explain the phenomenon under discussion and withstand falsification: in sum, to reach a more informed decision as to whether the controversy has in reality been definitively resolved. I note that Chiappe's book contains a detailed index (lacking in Feduccia´s book - which also includes numerous citations of the phylogenetic hypothesis). Both books are well-written. I also note that Chiappe also has published a second book I have not seen, and which also should be consulted. In short, I highly recommend Feduccia's book to ornithologists in general, and especially those teaching (or receiving) courses in ornithology, where the "neoflightless" hypothesis is ignored. Comparing the treatments of avian origins by Chiappe and Feduccia would make a superb seminar topic!

Recommended for consultation (in addition to the reference lists of both books):

Chiappe, L. M. 2007. Glorified Dinosaurs: The Origin and Early Evolution of Birds. John Wiley & Sons, Inc., Hoboken, NJ

Chiappe, L. M. 2019. Birds of Stone. Johns Hopkins Publishers, Baltimore, MD.

Feduccia, A. 1996. The Origin and Evolution of Birds. Yale University Press, New Haven and London.

James, F. C. & J. Pourtless IV. 2009. Cladistics and the origin of birds: A review and two new analyses. Ornithological Monographs no. 66:1-78.