Moas and phylogenomics: How nomenclatural errors do a disservice to the understanding of moa taxonomy

Author: Worthy, Trevor H.

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Recent comments to the contrary by Livezey and Zusi (2007) notwithstanding, the flamingo–grebe clade is one of the best-supported higher-level clades of birds.

Storer (2006:1183) introduced his note by remarking that information "on phylogeny is obtainable from at least two present sources: the whole-animal biology of the organisms and molecular biology. The most accurate phylogenies will result from those sets of data in which there is the closest agreement." There is nothing to add to these statements, except that I find it difficult to understand why in this case he did not follow his own advice.—Gerald Mayr, *Forschungsinstitut Senckenberg, Sektion Ornithologie, Senckenberganlage 25, D-60325 Frankfurt a.M., Germany. E-mail: gerald.mayr@senckenberg.de*

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Literature Cited

Chubb, A. L. 2004. New nuclear evidence for the oldest divergence among neognath birds: The phylogenetic utility of ZENK (i). Molecular Phylogenetics and Evolution 30:140–151.

Cracraft, J., F. K. Barker, M. J. Braun, J. Harshman, G. J. Dyke, J. Feinstein, S. Stanley, A. Cibois, P. Schikler, P. Beresford, and others. 2004. Phylogenetic relationships among modern birds (Neornithes): Toward an avian tree of life. Pages 468–489 *in* Assembling the Tree of Life (J. Cracraft and M. Donoghue, Eds.). Oxford University Press, New York.

Ericson, P. G. P., C. L. Anderson, T. Britton, A. Elzanowski, U. S. Johansson, M. Källersjö, J. I. Ohlson, T. J. Parsons, D. Zuccon, and G. Mayr. 2006. Diversification of Neoaves: Integration of molecular sequence data and fossils. Biology Letters 2:543–547.

Livezey, B. C., and Zusi, R. L. 2007. Higher-order phylogeny of modern birds (Theropoda, Aves: Neornithes) based on comparative anatomy. II. Analysis and discussion. Zoological Journal of the Linnean Society 149:1–95.

Manegold, A. 2006. Two additional synapomorphies of grebes Podicipedidae and flamingos Phoenicopteridae. Acta Ornithologica 41:79–82.

Mayr, G. 2004. Morphological evidence for sister group relationship between flamingos (Aves: Phoenicopteridae) and grebes (Podicipedidae). Zoological Journal of the Linnean Society 140: 157–169.

Storer, R. W. 2006. The grebe–flamingo connection: A rebuttal. Auk 123:1183–1184.

van Tuinen, M., D. B. Butvill, J. A. W. Kirsch, and S. B. Hedges. 2001. Convergence and divergence in the evolution of aquatic birds. Proceedings of the Royal Society of London, Series B 268:1345–1350.

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Moas and phylogenomics: How nomenclatural errors do a disservice to the understanding of moa taxonomy.—Recently, Baker et al. (2005) published a Bayesian tree based on 658 base-pair control-region mitochondrial DNA sequences from 125 individual moas from widespread localities in New Zealand, a sample that included all then-accepted taxa (Worthy and Holdaway 2002, Bunce et al. 2003). They recognized 14 clades (interpreted as shown in Table 1) but avoided equating these clades with species by using only geographic identifiers. More recently, however, Baker (2007:18), in a paper whose title claims "advances in the study of geographic variation and speciation," has equated each of the 14 clades with the status of species (Table 1). It is not my intention here to assess the validity of Baker's conclusions, nor is it to assess their relevance to taxonomy, but rather to point out that he applied incorrect nomenclature to 5 of the 14 clades while overlooking an important paper on moa systematics. The result has only further confused the taxonomy and nomenclature of moas.

People often confuse the three components to "labeling" taxa. First, taxonomy is the science of circumscription of a taxon, for example, at the species, generic, familial, or other levels, by diagnosis. Such taxa are based on a type or type series and delimit a group of individuals and their relationships to other such groups. Second, nomenclature is a technique for the naming of such taxa, and it is governed by rules (e.g., International Code of Zoological Nomenclature). Nomenclatural activity includes formulating new names for taxa and determining the correct name to be applied to existing taxa. The issues discussed below involve the determination of lineages leading to either a suggested split of taxa and the attribution of names to those taxa or synonymy of taxa, and thus are of a nomenclatural nature. Thirdly, the assignment of a specimen to a given taxon, or its identification, employs a name but has no bearing on nomenclature or taxonomy.

Clades 1 and 2.—Baker et al. (2005) labeled these clades as *Pachyornis mappini* from eastern and western North Island, respectively. Baker (2007) modified this by calling clade 1 *P. mappini* and clade 2 *Pachyornis*, n. sp. A, which is erroneous in two regards. First, the type specimen of *P. mappini* is from the western North Island (Archey 1941), so that if only a single clade takes the name *P. mappini*, it would have to be the western population, not the eastern one. Secondly, as

TABLE 1. Comparison of the nomenclature applied to clades of moas in Baker et al. (2005) and Baker (2007). Details in square brackets identify the geographic origin of the clade as shown in figure 1 in Baker et al. (2005).

Clade	Baker et al. (2005)	Baker (2007)
1	*Pachyornis mappini* eastern North Island	*Pachyornis mappini*
2	*P. mappini* western North Island	*P.* n.sp. A
3	*P. elephantopus* Canterbury, Otago	*P. elephantopus*
4	*P. australis*	*P. australis*
5	*P. elephantopus* Southland	*P.* n.sp. B
6	*Euryapteryx geranoides*	*Euryapteryx geranodes* [sic]
7	*Emeus crassus*	*Emeus crassus*
8	*Anomalopteryx didiformis*	*Anomalopteryx didiformis*
9	*Dinornis robustus*	*Dinornis robustus*
10	*D. robustus*, northwest Nelson	*D.* n.sp. A
11	*D. robustus*, Otago	*D.* n.sp. B
12	*D. novaezealandiae*	*D. novaezealandiae*
13	*Megalapteryx didinus* [northwest Nelson]	*Megalapteryx didinus*
14	*M. benhami*? [Otago]	*M. benhami*

I have established elsewhere (Worthy 2005), the taxon formerly known as *P. mappini* Archey now takes the name *P. geranoides* (Owen), a nomenclatural change that also affects the genus *Euryapteryx* (see below).

Clade 6.—Baker et al. (2005:8259) referred all specimens of *Euryapteryx* to *E. geranoides*, including birds from far north of North Island that "were previously assigned to *Euryapteryx curtus*," which was followed by Baker (2007), though with the spelling of *geranoides* incorrect. The nomenclatural issue here is that *E. curtus* (Owen, 1846) has priority over *E. geranoides* (Owen, 1848), as is obvious by the dating of the two names and as shown in check-lists (e.g., Turbott 1990) and systematic accounts (e.g., Archey 1941, Worthy and Holdaway 2002). Baker (2007), however, also overlooked the nomenclatural issues raised by Worthy (2005), who transferred *E. geranoides* (Owen, 1848) to *Pachyornis,* where it becomes a senior synonym of *P. mappini* Archey. As a result, specimens referred to *E. geranoides*, as distinct from *E. curtus*, now take the next available name, *E. gravis* (Owen, 1870). However, if only one species name is applied to a clade including all individuals of *Euryapteryx*, then *E. curtus* has priority.

Clades 13 and 14.—Baker et al. (2005) recognized two clades based on two individuals of *Megalapteryx*. They referred the northern specimen to *M. didinus* (Owen, 1883) and the southern one to *M. benhami* Archey, 1941, and questioned the synonymy of *M. benhami* with *M. didinus* (Worthy 1988). First, the type of *M. didinus* comes from Otago in southern South Island, and the type of *M. benhami* from northwest Nelson in northern South Island (Archey 1941), so the application of the names by Baker et al. (2005) and Baker (2007) to the two clades is wrong regarding the geographic origin of the types for the taxa used. Secondly, *M. benhami* was based on a very large specimen that was considered by Archey (1941) to be outside the size range of *M. didinus*. Baker et al. (2005) did not sample any specimens that could be referred to *M. benhami* on the basis of size. The genomic data presented in that paper therefore have no bearing on the taxonomic status of *M. benhami*.

Similar geographic issues of the origin of types may also affect the application of names to other clades in these studies. For example, the type of *D. robustus* Owen, 1846 is from "South Island" (Archey 1941), which can be restricted to "Waikawaiti"(*sic* = Waikouaiti) in Otago, because Owen (1846a:313, 319, 321) made it clear that the bones he named *D. robustus* Owen (1846b:48) came from this locality. Thus, if clades 9, 10, and 11 are to be elevated to the status of species, it is not clear which would take the name *robustus*, given that both clades 9 and 11 were found in Otago.

In conclusion, the phylogenomic results of Baker et al. (2005) and Baker (2007) may have merit in the recognition of unsuspected clades within moa populations, but Baker's (2007) application of existing nomenclature to these clades as though they were species, in disregard of previous literature, rather than advancing the systematics of moas, has only added confusion to an already complex state of affairs. It is lamentable that such profound taxonomic results should have been published as an aside in a review, the more so as such little understanding of nomenclatural issues was shown.—TREVOR H. WORTHY, *School of Earth and Environmental Sciences, Darling Building DP 418, University of Adelaide, North Terrace, Australia 5005. E-mail: twmoa@aapt.net.au*

LITERATURE CITED

ARCHEY, G. 1941. The moa: A study of the Dinornithiformes. Bulletin of the Auckland Institute and Museum , no. 1.

BAKER, A. J. 2007. Molecular advances in the study of geographic variation and speciation in birds.

Pages 18–29 *in* Festschrift for Ned K. Johnson: Geographic Variation and Evolution in Birds (C. Cicero and J. V. Remsen, Jr., Eds.). Ornithological Monographs, no. 63.

Baker, A. J., L. Huynen, O. Haddrath, C. D. Millar, and D. M. Lambert. 2005. Reconstructing the tempo and mode of evolution in an extinct clade of birds with ancient DNA: The giant moas of New Zealand. Proceedings of the National Academy of Sciences USA 102:8257–8262.

Bunce, M., T. H. Worthy, T. Ford, W. Hoppitt, E. Willerslev, A. Drummond, and A. Cooper. 2003. Extreme reversed sexual size dimorphism in the extinct New Zealand moa *Dinornis*. Nature 425: 172–175.

Owen, R. 1846a. On *Dinornis* (Part II), containing descriptions of portions of the skull, the sternum and other parts of the skeleton of the species previously determined, with osteological evidences of three additional species, and a new genus, *Palapteryx*. Transactions of the Zoological Society (London) III (4):307–329.

Owen, R. 1846b. [Proceedings of a meeting: Owen read his second memoir on remains of *Dinornis*]. Proceedings of the Zoological Society (London) for 1846 XIV:46–49.

Turbott, E. G. 1990. Checklist of the Birds of New Zealand and the Ross Dependency, Antarctica, 3rd ed. Random Century, Auckland.

Worthy, T. H. 1988. A re-examination of the moa genus *Megalapteryx*. Notornis 35:99–108.

Worthy, T. H. 2005. Rediscovery of the types of *Dinornis curtus* Owen and *Palapteryx geranoides* Owen, with a new synonymy (Aves: Dinornithiformes). Tuhinga 16:57–67.

Worthy, T. H., and R. N. Holdaway. 2002. The Lost World of the Moa: Prehistoric Life of New Zealand. Indiana University Press, Bloomington.

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Nomenclatural errors in moa taxonomy: A reply to Worthy.—In reproducing the control-region gene tree from Baker et al. (2005), I was careful to state in the text of my review (Baker 2007:22) that "Bayesian analysis of these sequences recovered 14 monophyletic lineages, 9 of which are currently recognized, plus 5 new lineages that may warrant species status." It certainly was not my intention to revise the taxonomy of the moas, but rather to draw attention to some lineages that almost certainly deserve species status on the basis of their phylogenetic depth in the tree. I erred by changing the caption of the figure to include several "n.sp." labels, and provided Worthy (2007) with an opportunity to accuse me of doing a disservice to moa taxonomy. However, although he had no difficulty in suggesting what the correct names should be in the event of a taxonomic revision of the moas, I am not as confident as he in making these assertions. Unless the types have been identified correctly (as they obviously had not been in the past; e.g., Worthy 2005) and they have also been genotyped, there is still doubt as to what nomenclature is correct.

The recent update on moa systematics that Worthy chides me for overlooking was published in the journal *Tuhinga* (Worthy 2005). I was unfamiliar with this journal, as most readers probably are. This does not excuse me for not locating it, because in the paper he purports to have rediscovered the types of *Dinornis curtus* Owen and *Palapteryx geranoides* Owen. Examining the features of a left tibiotarsus confusingly marked with four different catalogue numbers, Worthy determined that this is the missing lectotype of *D. curtus* and that it is referable to *Euryapteryx curtus*. Genomic DNA had been extracted from this bone and a sequence would be published later, but to my knowledge this has not been done. So we lack concrete proof that the above synonymy is correct, though it could well be. DNA sequences of what was then called *E. curtus* and *E. geranoides* were shown to be very similar (Baker 2007), thus invalidating claims by others, including Worthy, that there were two species of *Euryapteryx* in New Zealand. However, as Worthy (2007) pointed out, this does mean that I should have referred to this lineage as *E. curtus* if the above synonymy is correct. Equally, it means that Worthy (2005:40) was wrong to propose that *E. curtus* should be applied to the "small exclusively North Island form" and *E. gravis* to "a larger form found in both the North and South Islands." Instead, this is probably an example of geographic variation in one species. Worthy really ought to practice what he preaches about nomenclatural confusion being a disservice to moa taxonomy.

The other type, an almost complete cranuim labeled *Palapteryx geranoides*, was judged on morphological characters to be conspecific with *Pachyornis mappini*, even though it is very similar to the cranium of *E. curtus*. This judgment may well be correct as well, but again it needs to be confirmed with DNA typing. If it turned out to have a DNA sequence identical to that of *E. curtus*, the synonymy proposed by Worthy (2005) would be a "taxonomic disservice" and much of his criticism of my use of taxonomic names would crumble. I note that Worthy has made nomenclatural errors in labels he has attached to specimens in the Canterbury Museum in New Zealand involving *Pachyornis* and *Euryapteryx*, thereby further confusing the taxonomic identity of these lineages and leaving me wondering how one can be certain about the above synonymy. Femurs of AV8264 from Kapua and THW214 from Cheviot were labelled *E. geranoides* by