Some Issues in the Classification of Zoology†

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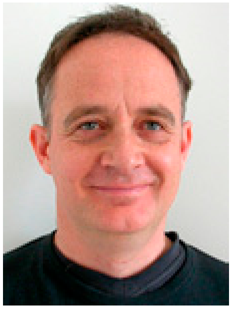

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ABSTRACT: This paper identifies and discusses features of the classification of mammals that are relevant to the bibliographic classification of the subject. The tendency of zoological classifications to change, the differing sizes of groups of species, the use zoologists make of groupings other than taxa, and the links in zoology between classification and nomenclature, are identified as key themes the bibliographic classificationist needs to be aware of. The impact of cladistics, a novel classificatory method and philosophy adopted by zoologists in the last few decades, is identified as the defining feature of the current, rather turbulent, state of zoological classification. However because zoologists still employ some non-cladistic classifications, because cladistic classifications are in some ways unsuited to optimal information storage and retrieval, and because some of their consequences for zoological classification are as yet unknown, bibliographic classifications cannot be modelled entirely on them.

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1.0 Introduction

The classification of animals is central to the discipline of zoology (Heywood 1975, 57; de Queiroz and Gauthier 1992, 472), and zoologists see it as serving two functions. It records scientific knowledge—to be precise, our understanding of the genealogical relationships between species—and it is a method of storing and retrieving information about the different species and groups of species (Simpson 1945, 4, 13; Mayr 1982, 148-9; Groves 2001a, 30). The bibliographic classificationist is likely to be pleased that zoologists place so much importance on classification, and in particular that they view it as a tool for information retrieval. However, a comparison of zoological classifications and the corresponding bibliographic classifications shows that, while the latter are clearly based on the former, they differ from them in significant ways, which are not easily summarised.

There are several reasons for this, two of which deserve mention here. Firstly, the classification of animals is a complex and often problematic activity; as this paper shows, several key features of the classifications used by zoologists need to be understood before they can be used as a basis for bibliographic classifications. Secondly, while bibliographic classificationists are likely to be interested in both scientific accuracy and efficacy in information retrieval, it is a reasonable assumption that, compared with zoologists, they are likely to give more weight to the latter. How much more weight they should give is not a straightforward question to answer. In this regard it is instructive to note that Hjørland and Nicolaisen (2004, 56-7) argue that bibliographic classificationists should in most circumstances base their schemes on scholarly classifications, while New and Trotter (1996, 5) assert that the importance of literary warrant is "hard to overestimate." Reconciling these two injunctions is likely to be central to the work of the bibliographic classificationist.

In this paper, one group of animals, the mammals, is used as a case study. Comments are offered on aspects of the *Dewey Decimal Classication*'s treatment of mammalogy, but no attempt is made to evaluate the scheme comprehensively or to compare it with other schemes.

2.0 Change in zoological classification

Firstly, it is important to note what has been described as the "inherent fluidity" of the classification of organisms such as mammals (Wilson and Reeder 2005b, xix). Comparison of different classifications, such as those summarised by Rose and Archibald (2005, 3), shows that change is constant and of several kinds. The differences between the influential classifications by Simpson (1945) and Wilson and Reeder (2005a) illustrate this. Simpson's 18 orders of mammal have become 29 in Wilson and Reeder, and there are numerous changes in the sequence of orders, too complex to summarise. Other changes reflect new conclusions about relationships within orders. For example, Simpson divides the order Carnivora into terrestrial and marine forms: cats, dogs, bears, etc. (Fissipedia) on the one hand, and seals and sealions (Pinnipedia) on the other. In Wozencraft (2005) in Wilson and Reeder (2005a), the primary division is between cats and their relatives (Feliformia) and dogs and their relatives (Caniformia), the seals and sealions becoming a subdivision of the Caniformia.

An examination of change in zoological taxonomy shows that it has at least two major causes: new theories about the relationships between species, and new ideas about the information a classification should convey. In recent decades, major changes have been caused by molecular studies, which have led to new theories about the relationships between species, and cladistics, which represents a new conception of how a classification should reflect those relationships.

Molecular studies mostly focus on DNA and have proved a powerful tool for studying the relationships between taxa (Rose and Archibald 2005, 2; Lecointre and Le Guyader 2006, 5). The word "revolution," sometimes used in connection with these studies (Groves 2001a, 10), is often also applied to cladistics (see for example Groves 2001a, 8). Cladistics originated in the 1950s and more recently has won near-universal acceptance among zoologists engaged in classificatory work (Groves 2001a, 8; Mishler 2009, 63). Both a philosophy and a suite of methods, it is the philosophy that is relevant to the present discussion.

In zoological classification the taxon, "a group of organisms that is recognised as a formal unit" (Lecointre and Le Guyader 2006, 23), has long been a key concept. In cladistic philosophy, a higher taxon (any taxon above species level) must be a clade: a group composed of an ancestral species, all of its descendants, and no other organisms (Groves 2001a, 9). Ancestry is seen as the only criterion for classification.

The distinctiveness of the cladistic approach can be appreciated by comparing it with another classificatory school, evolutionary taxonomy, one that has now been largely discarded (Groves 2001a, 7). An issue in the classification of humans and our closest living relatives illustrates the difference in approach. Traditionally, humans were placed in one family, the Hominidae, and apes in another, the Pongidae (Simpson 1945, 67-8). Molecular studies, however, indicate that chimpanzees are more closely related to humans than they are to gorillas (Lecointre and Le Guyader 2006, 494).

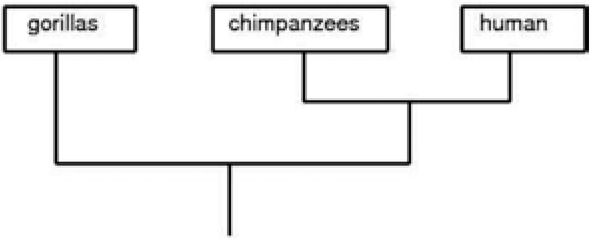

Figure 1. Evolutionary relationships between gorillas, chimpanzees and humans

With a cladistic approach, the ape-human distinction cannot be maintained, because a chimpanzee-gorilla grouping that excludes humans is not a clade. Evolutionary taxonomists, by contrast, would not necessarily object to the ape-human distinction, even while accepting the molecular data. They would view the traditional ape family as being acceptable in consisting of an ancestral species and some of its descendants. Furthermore, they might see value in placing humans in a separate family to indicate how different we are from our relatives in, for instance, intelligence. Cladists regard this approach as unsatisfactory because this "evolutionary distance" cannot be measured (Groves 2001a, 7). Cladistics thus brings both simplicity and rigour to the process of classification, contrasting with the more complex and subjective judgements necessary in earlier schools of zoological classification.

The combined effects of molecular studies and cladistics have in some respects been relatively modest for the classification of mammals. Mammals as a whole are still regarded as forming a valid taxon, as are many important groupings, such as rodents, bats, primates and carnivorans. In another sense, cladistics has brought profound change because a rigorously cladistic approach produces hierarchies of taxa of very different shape to traditional taxonomy. The diagram below shows a traditional classification of the family Hominidae (as defined by Groves 2005, 181-2). The Linnaean system of ranks provides the classification's basic structure. As in this diagram, Linnaean classifications often make use of certain obligatory ranks only, in this case family and genus. Intermediate ranks such as subfamily are omitted even though their use would convey information about relationships between the taxa.

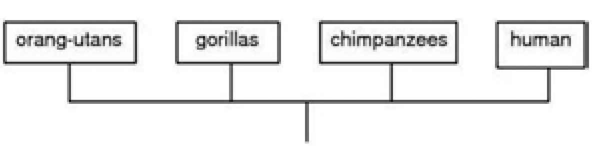

Figure 2. The Hominidae divided into genera

A rigorously cladistic approach produces a classification that looks rather different, as shown below:

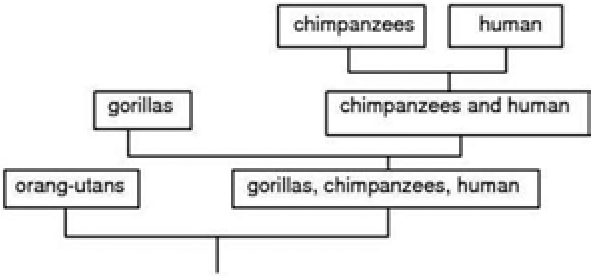

Figure 3. The Hominidae divided into clades

The differences between these two classifications stem from the information each aims to convey, rather than conflicting views about the relationships between the species concerned. It is a distinctive feature of the second approach that many more levels in the hierarchy are shown—in other words, there are many more higher taxa—and that each higher taxon contains only two daughter taxa. It should be noted that the two hierarchies shown above represent extremes. Many Linnaean classifications use more ranks than the obligatory ones (for example Simpson 1945). Equally, even the most rigorously cladistic classifications are generally unable to present complete hierarchies of clades, principally because zoologists know too little about the relationships between the taxa concerned.

Turning to the use of the two kinds of hierarchy in the zoological taxonomic literature, a distinction can be drawn between works whose main aim is to provide information about the relationships between higher taxa (for instance McKenna and Bell 1997; Lecointre and Le Guyader 2006) and those that principally provide lists of species (such as Wilson and Reeder 2005a). The latter are less likely to follow a strictly cladistic approach, being interested in the higher taxa more as a way of structuring a list of species than as a mapping of evolutionary relationships; information retrieval is prioritised over the expression of scientific knowledge. A Linnaean classification has benefits from an information retrieval point of view; as well as familiarity, the smaller number of levels in a Linnaean hierarchy leads to a simpler arrangement of the material. A striking example of this approach is the website *Encyclopedia of Life*, which aims to offer a web page for every living species of organism and makes use of only the seven obligatory Linnaean ranks, from species to kingdom.

3.0 Disparities in the size of higher taxa

Another feature of the classification of organisms that the bibliographic classificationist needs to be aware of is the tendency of higher taxa to vary greatly in the number of species they contain. As Linnaean and cladistic hierarchies differ in structure, they need to be considered separately when quantifying this. The Linnaean classification of mammals can be examined using Wilson and Reeder's (2005b, xxvi-xxx) summary of the number of species and genera in different orders. In their classification, 42 percent of species are members of the rodent order while another 21percent are bats; 11 out of 29 orders have 10 or fewer species.

Analysis of the number of mammal species in various clades shows that cladistics makes the disparities between species numbers in different higher taxa even greater. Here the clades described by Lecointre and Le Guyader (2006, 389) are considered in conjunction with species numbers from Wilson and Reeder (2005b, xxvi-xxx), a work which is more authoritative at the species level but does not attempt a rigorously cladistic classification.

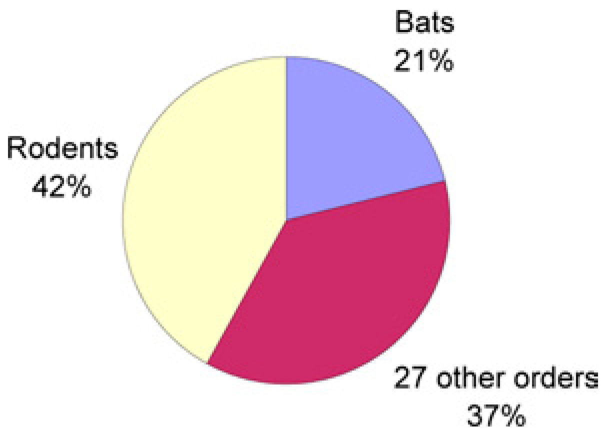

Figure 4. Percentage of mammal species in different orders

Looking at mammals cladistically, the primary division is between monotremes (5 species) and eutherians (5411 species). The eutherians then divide into 331 marsupials and 5,080 placentals. Among the placentals, the primary division is between 31 xenarthrans (American anteaters and relatives) and 5,049 others.

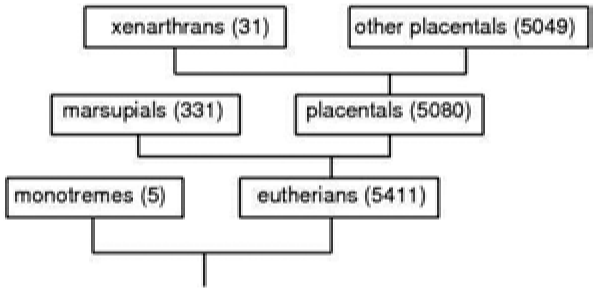

Figure 5. Species numbers in some major mammalian clades

Examining the mammals as a whole, we do find sister groups where the difference in size is less extreme. For example, the marsupials divide into 93 opossums and 238 others. Deeper down the hierarchy, however, there are still many sister groups of wildly unequal size.

Bibliographic classificationists have discussed the usefulness of notational expressivity from a variety of standpoints (Vickery 1956; McIlwaine 1996; Broughton 1999), while Broughton (1999) has also identified the sensible use of notational space as one of the features of a well-constructed classification. The divergent sizes of higher taxa mean that a bibliographic classification whose notation attempts to encapsulate the hierarchy of those taxa will be wasteful of notational space. In a classification based on the Linnaean model, taxa with few species, such as monotremes, will be allotted far more space than they are likely to need. The problem will be more acute for a bibliographic classification that attempts to follow a strictly cladistic approach by, for instance, allotting monotremes the same notational space as all the other mammals put together. It seems doubtful if even a specialist scheme employing a large notational base could model a schedule on cladistic hierarchies to any meaningful extent, though techniques such as Ranganathan's telescopic notation would help to an extent at least (Bhattacharyya and Ranganathan 1974, 138-9).

As already noted, zoologists see biological classification as both an expression of theories about the relationships between taxa and as an information storage and retrieval system. Mayr (1982, 240-1) argues that the second of these functions imposes limits on both the number of taxa a higher taxon can sensibly contain and on the number of levels appropriate in a hierarchy. Thus cladistics, with its deep hierarchies, can be seen as a move towards greater scientific accuracy at the expense of efficient information retrieval. This inefficiency with regard to information retrieval helps explain why many monographs and other publications continue to organise their material using Linnaean ranks rather than hierarchies of clades.

4.0 Quasi-taxonomic groupings in zoology

Although the concept of the taxon has always been important, zoologists group animals in a great number of other ways, as well, even if they do not necessarily think of this activity as classification. Many of these groupings, such as the faunas of particular countries, have little to do with evolutionary relationships; the ways in which bibliographic classifications may make provision for all these is beyond the scope of this paper. Other groupings may be termed quasi-taxonomic, because, while they are not taxa, they bear some relationship to them.

An example is monotremes-and-marsupials. It has long been agreed that the deepest division within living mammals lies between the monotremes on the one hand and the marsupial and placental mammals on the other (Simpson 1945, 39; Lecointre and Le Guyader 2006, 389). There have, however, always been many monographs and other publications that take as their subject monotremes-and-marsupials, even though this combination of groups does not constitute a taxon. A search of WorldCat found 39 monographs about monotremes-and-marsupials, but only 20 solely about the monotremes. (This total excludes works on particular kinds of monotreme.) The titles of two monographs illustrate the principal reasons these taxa are so often linked: *Monotremes and*

Marsupials: the Other Mammals (Dawson 1983) and *A Handbook of New Guinea Marsupials and Monotremes* (Menzies 1991). Monotremes and marsupials are united by their otherness: they are different to the placental species that account for the great majority of mammals. They also together form the distinctive part of the Australasian mammal fauna (Wilson and Reeder 2005a).

It is noteworthy that works on monotremes-and-marsupials continue to be written in the cladistic era. The most zealous cladists, such as Lecointre and Le Guyader (2006, 6-7), criticise the use of such groupings, pointing out an inconsistency in the way contemporary zoologists subscribe to cladistic theory but continue to study, and write about, non-cladistic groups. Yet it seems likely that many quasi-taxonomic groupings will continue to prove useful to zoologists. Monotremes-and-marsupials, for example, provide an obvious focus for an Australasia-based mammalogist. Some of these quasi-taxonomic groups were once regarded as taxa; although zoologists no longer believe them to be such, they continue to be studied and written about. Hoofed mammals, which form the subject of works such as *Exotic Animal Field Guide: Nonnative Hoofed Mammals in the United States* (Mungall 2007), are an example.

While cladistics has focused the attention of taxonomists on defining taxa rigorously, it may also be having the effect of creating a greater division between the groupings zoologists create as part of their taxonomic work and the groupings they study and write about for other purposes. Cladistics now has very wide acceptance among taxonomists. The strenuous efforts made in the late twentieth century by zoologists such as Mayr (1982, 209-50; 1995) to argue the case for other schools of taxonomy would seem to have failed. Yet zoologists' acceptance of cladistics must be seen in the context of their practical work with non-cladistic groupings. In one sense, the cladists' victory has been incomplete. This is even more apparent beyond mammalogy: major groups of animals which are no longer regarded as valid taxa, such as fishes and reptiles, continue to be studied and written about (see for example Nelson 2006; Vitt and Caldwell 2009).

Bibliographic classifications need to make provision for these quasi-taxonomic groups. In the case of mammals, relatively few quasi-taxonomic groups seem to have a significant literature, meaning that it should be feasible to offer specific classmarks, or specific instructions, for each of these in any schedule. While few in number, these groups can account for a significant number of publications, and so bibliographic classificationists are likely to find it worthwhile to spend time working out how to make provision for them.

5.0 Change and ambiguity in zoological nomenclature

There is an intimate relationship between zoological classification and zoological nomenclature, and the bibliographic classificationist needs to be aware of the complications that arise from this. The current system of zoological nomenclature (summarised by Mayr 1982, 171-5) derives from the work of Linnaeus in the eighteenth century. Species are given a two-part scientific name, with the first element in the name indicating the genus the species is part of. Linnaeus grouped genera into orders, orders into classes, classes into phyla, and phyla into kingdoms. Other rankings have been added since. It is now obligatory to assign species to a family, a rank between genus and order (McKenna and Bell 1997, 20), while other, intermediate ranks are used at taxonomists' discretion.

While it is common knowledge that the vernacular names of animals are often uninformative or misleading about a species' affinities, it is perhaps less widely appreciated that, because of the link between nomenclature and classification, as well as other factors, scientific names are often also ambiguous and liable to date. This is despite the existence of well-established rules for naming taxa (summarised by Groves 2001a, 21-2), which aim to limit the potential for confusion.

New theories about the relationships between taxa often mean that existing names take on new meanings, or new names need to be coined for the same animals. For example, Simpson (1945, 101) places four species of river dolphin in the family Platanistidae. Mead and Brownell (2005, 738) consider three of these different enough to be classed in a separate family, leaving just *Platanista*, from the Indus and Ganges, in the Platanistidae. When a zoologist uses the term Platanistidae, it may therefore be unclear which animals are being referred to. Moreover, just as one scientific name can refer to different taxa, so multiple names can refer to the same animal or group of animals: Simpson's Platanistinae (which is a subdivision of his Platanistidae) and Mead and Brownell's Platanistidae both refer to the river dolphins of the Indus and Ganges.

These ambiguities mean that extensive guidance may be necessary if cataloguers and other non-zoologists using bibliographic classifications are to classify works correctly. While scientific names are often less ambiguous than their scientific equivalents, the reverse can be true; in English, "river dolphin" is an example. Therefore a scheme that uses both vernacular and scientific names will often be preferable. It is noteworthy that in successive editions, the *Dewey Decimal Classification* (*DDC*) has gradually provided both increasingly comprehensive lists of vernacular names to complement the scientific ones and more guidance about potential sources of confusion.

6.0 Nomenclature: current debates

There is currently much debate among zoologists about whether the Linnaean system of nomenclature should be retained, modified, or replaced. This is fuelled by both a long-standing awareness of the arbitrary nature of important elements of the system and newer uncertainties over whether it can be satisfactorily combined with cladistic classification. There is agreement that the ranks assigned to taxa are arbitrary and artificial, even if this is not necessarily true of the taxa themselves. For example, Rose and Archibald (2005, 2) note that the meaning of the term "order" has gradually shifted over the centuries since Linnaeus, now denoting much narrower groupings than originally. As the ranks are artificial, then the Linnaean system's privileging of the obligatory ranks such as order and family is artificial too.

Although the concept "species" is problematic (de Queiroz 2007), recent debates about nomenclature have focused more on higher taxa. Many suggestions have been made. For example, Groves (2001a, 17-20) discusses the possibility that ranks might be used to identify taxa which emerged at a particular time, with the rank of genus, for instance, being reserved for taxa which first appear in the fossil record four to six million years ago.

Other taxonomists have suggested that each rank should represent a particular level in the cladistic hierarchy (Lecointre and Le Guyader 2006, 23). This represents an attempt to do rigorously something which taxonomy has long aimed at in rather a vague manner. As with all but the most modest proposals for change, there would be upheaval. For example, Lecointre and Le Guyader (2006, 23) demonstrate that while birds and mammals are traditionally both assigned the rank of class, birds are now thought to occupy a deeper position in the hierarchy of vertebrates. If mammals are to remain a class, birds will have to become, perhaps, an order. An additional problem lies in the fact that many more ranks would need to be used. This is because, as discussed above, Linnaean and cladistic hierarchies have very different shapes. McKenna and Bell (1997) attempt a partial alignment of rank with position in the cladistic hierarchy and, as a result, have to use an extensive range of obscure and sometimes newly-coined ranks, such as magnorder, grandorder, and parvorder.

Mishler (2009, 64) suggests that the use of ranks is incompatible with a genuinely cladistic approach to classification. Similar thinking is apparent in the proposal for the PhyloCode (Cantino and de Queiroz 2010), which is presented by its authors as an alternative to the Linnaean system. The PhyloCode makes the assignment of ranks to clades optional. This proposal does have some advantages. For example, in Linnaean nomenclature rank names are often inflected: in animals (though not plants), family names end in -idae and subfamily names in -inae. These names therefore have to be amended if changes in our conception of the relationships between taxa mean that they move up or down the hierarchy. If it is decided that the river dolphins of the Indus and Ganges are best ranked as a family rather than subfamily, their name has to change from Platanistinae to Platanistidae. No such change is necessary with the PhyloCode, which thus has the potential for bringing additional stability to zoological nomenclature, by breaking some of the links between taxonomy and nomenclature. As a result, names convey less information in the PhyloCode: an uninflected and unranked clade name tells us nothing about how the taxon concerned is related to other taxa (Vitt and Caldwell 2009, 24). Vitt and Caldwell also point out that any long-term benefits the PhyloCode might bring would need to be balanced against the huge initial upheaval as the switch was made.

It does not seem that any consensus is yet emerging about the future of nomenclature in the cladistic era (in addition to the works cited in the three paragraphs above, see for example Schuh 2003; Kuntner and Agnarsson 2006; Mishler 2009). Debates among these taxonomists often centre on questions of how to balance stability with currency and how to combine effective information storage and retrieval with the expression of our understanding of the evolutionary relationships between taxa. For example, Groves (2001a, 6-7, 17) offers thoughts on when scientific accuracy should take precedence over stability and when the reverse is of benefit.

In practice, much recent zoological literature makes pragmatic compromises. McKenna and Bell (1997, 20) include some groupings that are not valid clades in their classification, as this reduces the number of ranks they need to employ. Groves (2001a, 18) believes it acceptable to use some ranks to enhance information retrieval by dividing large taxa into manageable units, even if those units are not valid taxa in themselves.

With nomenclature such a live topic among zoologists, it would be unwise for bibliographic classification schemes to rely solely, or perhaps even primarily, on current scientific names or ranks to define the contents of classes. For example, if inflected rank names are retained, but clades are re-ranked according to age, then a great number of taxa will have names with different inflections. If taxonomists decide that rank-free nomenclature is the appropriate and desirable complement to cladistic classification, there will be even greater consequences for the bibliographic classificationist. This is because, at present, the obligatory ranks provide an obvious way to organise a schedule for zoological literature, for example playing a key role in DDC. Furthermore, without ranks, hierarchies of taxa will tend to be of the cladistic rather than Linnaean kind; as discussed above, these hierarchies present problems for the bibliographic classificationist.

7.0 The current state of the classification of mammals

While historically the classification of mammals has been in a constant state of change, the rate of change has not been uniform. For example, the historical review by Rose and Archibald (2005, 3) shows that Simpson (1945) ushered in a period of relative stability, his classification forming the basis for major works as late as Nowak and Paradiso (1983). Soon after this, the effects of molecular studies and cladistics became more apparent, meaning that the classifications of McKenna and Bell (1997) and Wilson and Reeder (2005a) are different both from each other and from all earlier works. More recently, with cladistics well-established and a great number of molecular studies completed, many authorities have argued that a relatively solid consensus about the broad-scale classification of mammals is emerging (Lecointre and Le Guyader 2006, 390; Springer et al 2008).

At least three factors mean that, at best, only a limited stability in the way mammals are classified is likely to emerge. Firstly, cladistic classifications may be inherently less stable than others (Groves, 2001b, 291). According to Groves, this is because cladistics is committed to reflecting our understanding of the evolutionary relationships between different organisms as accurately as possible; thus cladistic classifications change whenever that understanding changes, and compromises in order to preserve stability are less acceptable. We can see this as a shift in emphasis in zoological taxonomy, towards a more accurate expression of scientific hypotheses at the expense of some convenience in information storage and retrieval; the same theme has already been noted with respect to the deep hierarchies found in cladistic classifications. Secondly, at present, many zoologists still make use of non-cladistic or semi-cladistic classifications, for instance when organising the contents of monographs. It is not obvious if this practice will remain commonplace or whether a trend towards a more rigorously cladistic approach will emerge. Finally, debates about nomenclature seem far from resolution.

Beghtol (2003, 71) writes that "information retrieval classifications are revised only when new ideas have already been generally accepted." Whether or not this is always true, it would certainly seem to be a prescription for good practice, even though other factors will also affect the timing of revisions. For example, New (1996, 387) emphasises the importance, in a general scheme such as DDC, of prioritising the subjects which are currently most poorly served, and of restricting the overall pace of change to that which the scheme's users are likely to find manageable. In practice, the bibliographic classificationist is left dealing with the familiar issues of balancing currency with stability, pragmatism with intellectual rigour (Gnoli 2006 148; Miksa 1998, 73-6; New 1996, 386-7).

Beghtol's prescription is not necessarily easy to put into practice in a discipline in which change is continuous. Bibliographic classificationists seeking to update their zoology schedules will need to choose their moment judiciously. As the classification of mammals may be on the cusp of a period of relative stability, now may not be the ideal time to make changes. Another few years may well reveal if the novel hypotheses about the relationships between the major mammalian clades, developed in recent decades, do represent a genuine consensus. Even so, it is unclear when other important issues, such as the question of the most suitable system of zoological nomenclature, will be resolved.

At present, many, perhaps most, current bibliographic classifications for mammals reflect quite outdated science. The latest edition of DDC, for example, arranges mammals in essentially the same way as the second edition of 1885. Revisions since DDC2 have mainly focused on adding detail and giving more guidance to users about where to place certain taxa. New (1996) and New and Trotter (1996), in their accounts of the changes introduced to the zoology schedule in DDC21, emphasise pragmatic concerns such as avoiding the re-use of numbers, rather than keeping up with developments in zoology. Indeed, some of the changes made in DDC21, such as moving the monotremes to a position between the marsupials and placentals (Mitchell 1996, 1181), represent a move *away* from scientific accuracy in the interests of practical concerns such as the efficient use of notational space. Such "outdated" classifications may still do their job well. The library of the Zoological Society of London uses its own scheme, devised in the 1960s and largely based on the Bliss Bibliographic Classification, to classify the monographs it holds. The librarian reports that, in most cases, her patrons are able to retrieve items and browse the collection effectively (Sylph 2009). The forthcoming revision of UDC's zoology schedule (Civallero 2010, in press) will hopefully shed further light on how a scheme may manage change in this subject area.

8.0 Conclusion

Understanding contemporary zoological classification means understanding cladistics. There are several good reasons why bibliographic classifications should not, at least at present, entirely be re-modelled on the cladistic hierarchies of taxa that zoologists now construct. Firstly, zoologists still make use of "unofficial," non-cladistic classifications in many situations, for instance in some of the literature they produce. Bibliographic classificationists may here face a conflict between reflecting scientific knowledge and reflecting literary warrant. This conflict can perhaps be at least partially resolved by seeing both as part of a broader task of paying attention to what may be called zoological practice: the totality of what zoologists do. This will include making provision in bibliographic classifications for all the non-taxonomic and quasi-taxonomic groupings of animals that zoologists employ; while these groupings have always been a feature of zoological practice, they seem to be proving to be particularly important in the cladistics era.

Secondly, cladistic classifications are often not ideal for information retrieval. The best bibliographic classification schemes will be based upon, not only knowledge of zoological practice, but also an understanding of what affects the usability of such schemes. Zoologists are themselves interested in effective information retrieval, and so useful lessons may be learned from their own classificatory practices. Their continued use of Linnaean as well as cladistic hierarchies suggests that the former are superior for some purposes. They are more stable, generally contain more manageable numbers of hierarchies, and exhibit disparities in the size of taxa, which, while still sometimes problematic, are more modest than those found in cladistic classifications.

Thirdly, cladistics is new enough and different enough that the exact extent of its impact on zoology, let alone on bibliographic classification, is as yet unclear. Will the current system of zoological nomenclature endure? Will the current practice of continuing to use Linnaean classifications for certain purposes remain widespread? Will zoologists find ways of responding to the greater instability of cladistic classifications? The answers to these questions are as yet unknown, meaning that major changes to any bibliographic classification for zoology, if aimed at bringing that classification into line with cladistic thinking, would at this point be premature. Evaluating change in zoological classification, and responding appropriately to it, is thus a major task for the bibliographic classificationist. In particular, assessing whether zoological classification is in a period of lesser or greater stability is useful.

The link between classification and nomenclature in zoology means that this is an area to which the bibliographic classificationist needs to pay particular attention. The ambiguous and changeable nature of zoological nomenclature means that users of a bibliographic scheme will benefit from extensive guidance about where to place works on particular taxa, as well as from the use of both scientific and vernacular names. The possibility of radical change in zoological nomenclature in the near future means that a scheme should not be overly dependent on current scientific nomenclature.

The features of zoological classification discussed here cannot be directly translated into a prescription for the bibliographic classification of the subject. Bibliographic classification is perhaps best seen as an art as well as a science, involving the balancing of competing priorities (such as attention to literary warrant and attention to scholarly classifications), the exercising of judgement about likely future trends, and an understanding of both how zoologists work and the factors that make for efficient information retrieval. Careful consideration of the distinctive features of zoological classification provides a necessary, and yet not in itself sufficient, foundation for the work of the bibliographic classificationist concerned with this area.

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