# The Systematist

Newsletter of the Systematics Association

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# Editorial

## 26th Issue of *The Systematist*

Dear fellow systematists, this 26th issue of *The Systematist* brings you the customary diversity of familiar sections, including a provocative lead article by Olivier Rieppel on the philosophical underpinnings of modern taxonomy, two book reviews by John Grehan and Samuel Turvey, and a listing of upcoming *Systematics Association* events, but also two new sections titled *Inspirations* and *Systematics in Cyberspace*. In *Inspirations* we intend to profile a succesful systematist by way of an interview. In this issue we present Gonzalo Giribet, invertebrate zoologist at the Museum of Comparative Zoology of Harvard University. For *Systematics in Cyberspace* we ask readers of *The Systematist* to look out for informative or funny websites broadly related to systematics and biogeography for inclusion in this section so that others may delight in them as well. In addition, in a joint article, past and present coordinators of the Systematics Research Fund provide a set of guidelines intended to help future applicants for SRF grants to write even higher quality proposals.

The editors Ronald Jenner (left) and Malte Ebach discussing serious business

On a sadder note, we have failed to find anyone willing to write a report on the past biennial meeting of the SA. We therefore want to use this opportunity to urge readers to volunteer to write a short report on future SA meetings that they will attend. This will certainly be greatly appreciated by our readers!

We are grateful to all authors for the material included in this issue, and to Gonzalo Giribet for taking the time to answer the questions for his interview in *Inspirations*. It is the selfless dedication of time and effort of our contributors that shapes each issue of *The Systematist*.

## New Co-Editor

The timely appointment of Ronald A. Jenner as the new co-editor by the *Systematics Association* in October 2005 has helped greatly in keeping this issue on schedule. Preparing each issue for printing is a time consuming task. The effort, commitment and time involved in producing each issue requires two dedicated editors. The generation of copy (inviting writers, acquiring books for review) and production (typesetting and proofing) is handled equally between both editors over a period of four months. The *Systematics Association* is grateful for Ronald's immediate commitment that has helped produce half the content in the current issue.

Ronald is at the Department of Biology and Biochemistry at the University of Bath. His general interests are the deep phylogeny of the Metazoa, and methodological and conceptual issues relating to using and choosing phylogenies to study evolution of animal body plans. Ronald is also a regular essayist of *The Palaeontological Association Newsletter*.

## Call for papers

*The Systematist* is not only a newsletter for *Systematics Association* news and events, but also a vehicle for students, scholars and academics to express their ideas and views about current or past issues in systematics and biogeography. We especially encourage students and young researchers to submit ideas for general articles and points of view on topics in systematics and biogeography, or about the projects with which they are currently involved. Contributed works should be written in an easily accessible and popular style. Previously we have published articles on student field trip experiences (Brown 2003), on the history of systematics in different countries, and *Spotlight* pieces on systematists themselves (Flannery 2004). We look forward to your contributions by 31 July '06.

## Editorial Policy

We have introduced an editorial policy in order to ensure that the copy we receive is of high quality and relevant to the interests of our readers. We wish to ensure authors that they are welcome to submit ideas for articles or news pieces but also take into account that:

- *The Systematist* does not intend to publish original research papers and is not peer-reviewed
- *The Systematist* requires articles to be written in an easily accessible popular style
- articles may cover any aspect of systematic biology and biogeography, and may include reviews, opinion pieces, meeting reports, news items, and book reviews

Cover illustration : The centipede *Scolopendra morsitans* and the harvestman *Pettalus* are among Gonzalo Giribet's favourite invertebrates (see *Inspirations* on page 11. (Copyright 2006 Gonzalo Giribet)

- the editors maintain the right to decide not to publish any contribution submitted to *The Systematist* without the possibility for appeal.

### Guide for Authors

*The Systematist* publishes six types of articles:

*Lead articles* – on current topics in systematics and biogeography.
*Spotlight articles/Inspirations* – on historical events, revisions of theoretical ideas or short biographies
*QuoVadis* – opinion pieces on any topic in systematics and biogeography
*Book Reviews* – usually invited, but we will consider reviews of old classics or favourites.
*Meeting Reports* – of *Systematics Association* meetings or sponsored events.
*News items* – announcements of *Systematics Association* related events

If you have been invited to contribute an article please submit your manuscript as an rtf or MSWord file. We ask authors to only use a **Primary** (bold) and *Secondary heading* (italic) after the TITLE HEADING (in capitals).

*Citations*
All citations are to be made **without** using commas between author and year (Wallace 1855) and **with** commas between multiple authors (e.g. Nelson & Platnick 1981, Brandon-Jones 1998). The '&' symbol is used in all citations (but not in the references). Please refer to this issue for further usage of figures, tables and numerals.

*References*
Please include the full titles of journals and books. Do not use abbreviations! Please keep your references in the styles listed below.

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*Proofs*
All authors will be sent proofs of their articles. Authors should also make sure that they have the copyright for any photos or diagrams used in their articles.

Malte C. Ebach and Ronald A. Jenner
Co - editors

## President's Report

# Welcome to 2006!

Traditionally, New Year is a time for taking stock of what has passed and what is in prospect. With respect to 2005 and the *Systematics Association*, the central and outstanding feature was the fifth biennial meeting at Cardiff in August. We owe a debt of gratitude to Dr Ray Tangney (Local Secretary), Dr Eurwyn William, Professor Dianne Edwards and many other friends and colleagues from the National Museum and Gallery of Wales and Cardiff University for their generous welcome and hospitality. Scientifically, with three symposia and a day of student presentations, and socially, with receptions in the University, in the Civic Hall as guests of the Lord Mayor, and dinner at the Millennium Stadium, the meeting proved to be a round of enjoyable activity and achievement.

As is now customary, during 2005 we hosted two presentations at the Linnean Society. These included the Sir Julian Huxley lecture at the beginning of July given by Dr Richard Fortey and the recent lecture by Dr Rod Page following the AGM. Throughout 2005 the *Systematics Association* continued its key activities of supporting meetings and sponsoring publications. In particular, we supported meetings at Kew, the NHM London and in Copenhagen.

In prospect, scheduled meetings for 2006 include *Unravelling the Algae* (April 2006), *Biodiversity in Time and Space* (April 2006) and the Sir Julian Huxley lecture on July 5th, which will be given by Loren Rieseberg (Indiana University). 2006 also promises to be a bumper year on the publications front with seven further special volumes in the pipeline. The sixth biennial meeting has been arranged for August 21st-23rd, 2007 and will be hosted at the Royal Botanic Gardens, Edinburgh so please note these dates in your diary. Our thanks go to Pete Hollingsworth and Steve Blackmore for their generous invitation to Edinburgh. For the future, we are planning to forge closer links with colleagues in Europe and to this end we are now exploring the possibilities of holding the 2009 biennial meeting on mainland Europe.

During 2005 we continued to support systematics research and allied activities through our system of grants and awards. Now with the expanded Systematics Research Fund, sponsored jointly by the

*Systematics Association* and the *Linnean Society*, a total of 31 small grants were allocated. Student prizes for oral and poster presentations were awarded at both the biennial in Cardiff and at the 7th Young Systematists' Forum at the Natural History Museum, London in December.

**There is no room for complacency... The recent public announcement of the possible closure of established research institutions... means that we must be forever vigilant**

However, in spite of all these achievements there is no room for complacency. There is still much to be done and at the time of writing the systematics community at large is faced with further threats including possible severe cutbacks in activity. The recent public announcement of the possible closure of established research institutions and the threatened losses of staff, essential databases, libraries and other precious systematic resources means that we must be forever vigilant. The *Systematics Association*, in collaboration with the *Linnean Society*, finds itself fulfilling an ever more important role in making the case for the retention and furtherance of systematics and taxonomic resources and activities. Fortuitously, on behalf of the SA and the *Linnean Society*, Richard Bateman has recently drafted a document reviewing the current status and future of systematics and biodiversity in the UK and much of what is said in that document is highly pertinent to the current situation. There is still plenty of mileage in the adage that 'to be forewarned is to be forearmed.'

The coming of the New Year is a time for thanking those members of council who have recently stepped down from their respective tours of duty. In particular our thanks go to Gordon Curry who has given nine years of service to the SA as Treasurer. We are particularly pleased to receive the news that Gordon is making a good recovery from a serious illness. Since ill-health prevented Gordon from travelling to London to be thanked in person, Council decided to make a presentation of books and CDs reflecting his interests in cricket and music. We also wish to thank the six ordinary members of council who stood down at the end of 2005. Of the new intake, we offer our congratulations to Richard Bateman, who was recently elected as President-elect, and we welcome Colin Hughes as our Treasurer. We also greet six new ordinary members to council. Changes in editorship of *The Systematist* are afoot as we thank Paul Wilkin for his term of office and welcome Ronald Jenner as co-editor with Malte Ebach. These comings and goings are a timely reminder that the Association is only as good as its members and the fact that we are able to maintain such an extensive portfolio of activities is a result of the generosity, in terms of time and commitment, of all those concerned. With best wishes for 2006.

Barry Leadbeater

## The Systematics Association Publications

**Following the acquisition of CRC Press by Taylor & Francis, Systematics Association book production operations have been transferred to the CRC Press offices in Florida. Members of the Systematics Association receive a 25% discount of all Systematics Association volumes published by Taylor & Francis.**

**All volumes published by Taylor & Francis/CRC Press should now be ordered via either the CRC Press offices or the CRC press office in London (details below). The 25% SA members' discount is claimed by using a promotion code, for details of this code please contact Alan Warren, Systematics Association Editor-in-Chief.**

**ORDERING INFORMATION:**
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**United Kingdom**

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**http://www.systass.org/publications/index.html**

# The Taxonomic Hierarchy

**Olivier Rieppel**

The Field Museum, Chicago, USA

**Hennig treated species, and taxa, as individuals. This view has become widespread in contemporary systematics. Hennig's phylogenetic system is consequently subject to the part – to – whole relation, not to the membership relation. The conceptual basis for this system is Woodger's 'division hierarchy'. It is argued that such a 'division hierarchy' can also accommodate a hierarchy of natural kinds, which results in a greater explanatory power for systematics.**

Following the philosopher Theodor Ziehen (1934, 1939), Hennig (1950, 1966) considered species, and supraspecific taxa, to be individuals. The same view was later, and independently, articulated by Ghiselin (1974; see also Ghiselin, 1997) and Hull (1976; see also Hull, 1999). The thesis has received broad acceptance in systematics, and has become the foundation for the PhyloCode (e.g., de Queiroz and Gauthier, 1990; Härlin and Sundberg, 1998). In contrast to individuals, classes or sets are considered abstract, universal concepts. In a famous essay, Quine (1953: 13, emphasis added) highlighted the consequences of considering species as classes or sets: "When we say that some zoölogical species are cross-fertile we are committing ourselves to recognizing as entities the several species themselves, *abstract* though they are. We remain so committed at least until we devise a way of [showing that this] was an avoidable manner of speaking." Considering species as individuals, their names as proper names, offers an elegant solution to this conundrum. That species, and taxa, are individuals, as opposed to classes, sets, or natural kinds (Hull, 1999), is a metaphysical issue. The goal of this essay is to investigate what the consequences are of such ontological commitments for the taxonomic hierarchy.

## Individuals

There are different kinds of individuals. Individuals can be logical particulars, bodies or objects extended through and localized in space-time, or spatio-temporally restricted (i.e., particular) events. A spatio-temporally extended entity can be conceived of as the sum of its space-time slices (the 'semaphoronts' of Hennig, 1966). For bodies, a spatial and temporal overlap of those space-time slices is required, as opposed to objects, which form individuals no matter how dissociated and scattered their space-time slices are. For species to be bodies would require their space-time slices to overlap in space *and* in time; for species to be objects requires their space-time slices to overlap in space *or* in time (Rieppel, 2005a): "We should think of Hull and Ghiselin as having shown that species are historical objects" (K. Sterelny, cited in LaPorte, 2004: 176). If individuals are events, then species *qua* individuals are bundles of events (Rieppel, in press).

Naturalism in philosophy claims that nothing exists over and above the space-time system. Nominalism in philosophy claims that only individuals are real. Both underlie the claim that species, and taxa, are individuals. These individuals can in turn be members of intentionally defined classes, members of extensionally defines sets, or tokens of natural kinds. Individuals can also be parts of an individual of higher complexity, or include individuals of lower complexity as parts. Finally, sets or classes of individuals can be included in more encompassing sets/classes or include less encompassing sets/classes. Deferring the discussion of natural kinds to a later section of this paper, it becomes apparent at this juncture that the membership relation is one of individuals in sets or classes, the inclusion relation is one of sets/classes within sets/classes, whereas individuals are subject to the part – to – whole relation.

An intentionally defined class or set is defined by essential properties; it is by virtue of shared essential properties that individuals are members in such a class or set. An extensionally defined set is defined by the exhaustive enumeration of its members, where the set has its members essentially. If one of the members of an extensionally defined set does not exist, then the set does not exist. The membership relation contrasts with the part – to – whole relation: a cell is not a member of an organ, but a part of it; an organ is not a member of the

organism, but a part of it. An organism is not a member in a species, but a part of it – if species are individuals. Metaphysicians consider the membership relation and the part – to – whole relation to belong to different ontologies, i.e., to represent different ways of being.

Nominalism considers individuals as real, in contrast to properties that are considered abstract and universal. The individual apple I am picking up here and now is real, the property 'redness' instantiated by this apple is abstract and universal: it can also be a property of dreamcars, or rainbows. Consequently, sets or classes defined intentionally by one or more essential property(ies) are abstract concepts, spatio-temporally unrestricted, and potentially infinite in their possible instantiations. Such classes, or sets, cannot be evolving entities, which are spatio-temporally restricted, and hence finite in their possible instantiations (Hull, 1989). Nor can their members evolve, at least not with respect to their essential property(ies).

The part – to – whole relation characterizes a mereological sum, i.e., a sum whose identity conditions are given simply by the way their individual constituents are. The identity conditions for a species *qua* individual are given simply by the way its constituent individual organisms are, not by any shared, let alone essential property(ies). But for the same reason, the three individuals that are the desk lamp before me, my nose, and an apple, can form a mereological sum. They can also be members in an extensionally defined set. But they cannot be members of an intentionally defined class, unless all three share some essential property, such as being red (they would then be members of the class of all red things).

If species, and taxa, are individuals, then the taxonomic hierarchy must be one of individuals too, subject to the part – to – whole relation. It must also be a natural hierarchy, reflecting the phylogenetic relationships between species, and taxa. But if a desk lamp, a nose, and an apple can be a mereological sum, then mereology by itself seems too weak to mark out natural (monophyletic) groups; paraphyletic groups could constitute a mereological sum. So an additional requirement must be met, which is spatio-temporal continuity (spatio-temporal causal relatedness) amongst the individuals that are parts of species, or taxa (Ziehen, 1934; Hennig, 1950; Hull, 1989, 1999). This holds for species, or taxa, whether these are conceived of as the sum of their space-time slices (in a substance/attribute theory), or as bundles of events (in a bundle theory). Causal connectedness through space and time cannot qualify as a criterion of membership in an abstract, universal, spatio-temporally unrestricted class, or set. The taxonomic hierarchy cannot, therefore, be one of universal sets within sets, or universal classes within classes, which both are hierarchies based on inclusion/exclusion according to the presence or absence of shared essential characteristics. Instead, the taxonomic hierarchy is a 'division hierarchy' (Woodger, 1952; Gregg, 1954; Hennig, 1950, 1957, 1966).

**If species, and taxa, are individuals, then the taxonomic hierarchy must be one of individuals too, subject to the part - to - whole relation**

## The 'Division Hierarchy'

Hennig (1950) initially got Woodger's (1952) analysis of the hierarchical organization of organisms, or taxa, from Bertalanffy (1932; see also Rieppel 2003); he became acquainted with Woodger's (1952) and Gregg's (1954) original work only at a later date (Hennig, 1957, 1966). In systematics, a hierarchy of sets within sets is commonly and intuitively thought to be built on a substance/attribute theory that conceptualizes individuals as substances that instantiate attributes, i.e., properties. It is in virtue of such properties ('characters') that individuals are included in, or excluded from sets (Patterson, 1982). This is the concept of hierarchy that Woodger (1952) aspired to transcend with his 'division hierarchy'. Such a division hierarchy is built not on substances that instantiate certain properties (i.e., intrinsic properties), but instead on relations (i.e., extrinsic properties)[1] that hold between substances or events (as well as between logical particulars). Woodger's (1952: 11) definition of the 'division hierarchy' is stated "in the language of the theory of relations". The set theoretical tool used to formalize relations are ordered pairs or ordered n-tuples (Gregg, 1954; see Rieppel, 2003, for discussion). Woodger's (1952) first example of a 'division hierarchy' that holds for logical particulars is a square subdivided into four smaller squares, each of which again subdivided into four smaller squares, etc. Here, a particular '*P'* (the square) can be analyzed into parts *'p*' (four squares), which stand to the particular *'P*' in a certain relation '*W*' ('*W*' in this example is the relation of 'being a quarter of'). Graphically, this relational hierarchy can be symbolized by four relation arrows (standing for the relation 'being a quarter of') that run from the particular '*P*' to its parts '*p1*', '*p2*', etc. (see Fig. 2 in Hennig, 1966, taken from Gregg, 1954). An important aspect of the 'division hierarchy' is that there be a 'highest' hierarchical level (the 'beginner' of Gregg, 1954), which stands in no relation '*W*' to any part(s) of the system (to

**[1] To be six feet tall is an intrinsic property of Peter; to be taller than his cousin Paul is an extrinsic property of Peter.**

which no relation arrow points), but to which every part of the system is related, i.e., from which relation arrows emanate (the relation characterizing a 'division hierarchy' is thus 'one – many'[2]). The lowest level of the hierarchy is composed of parts, which cannot be analyzed ('decomposed') any further.

A classical biological 'division hierarchy' is the zygote dividing, and the resulting cells dividing again, etc. Here, a pair of relation arrows that symbolize the relation "to be an immediate descendant of" (Bertalanffy, 1932: 265) run from a dividing cell to its two daughter cells. Hennig (1957) proposed a topologically isomorphic hierarchy for characters and their stages of transformation, and for species that split into two daughter species (Rieppel, 2003, 2005b). At Hennig's (1957, 1966) hands, the lowest, i.e., most elementary parts of the taxonomic (phylogenetic) hierarchy are the species, because below the species level prevails the 'many – to – many' relation that characterizes tokogeny, and that renders a hierarchical conception of relations impossible (Gregg, 1954; this holds for bisexually reproducing species, as was already recognized by Woodger, 1952). The 'beginner' in Hennig's (1966) system is the ancestral species to which no relation arrow points, but from which relation arrows emanate. The division hierarchy thus reflects ancestor-descendant relationships; Gregg's (1954) 'beginner' becomes the ancestor. But this is not Hennig's (1966: 194) goal: "The task of the phylogenetic system is not to present the result of evolution, but only to present the phylogenetic relationships of species and species groups" in the form of a hierarchical system. Such an inclusive hierarchy is not built on shared intrinsic 'characters', but on shared relations instead (Gregg, 1954).

**Ample reasons have been given above for why classes or sets, defined intentionally by 'characters', cannot evolve, nor can their members.**

A zygote divides into two daughter cells; these 'descendant' daughter cells are not included in the zygote, but are related to the zygote. A species undergoes dichotomous speciation; the daughter species are not included in the ancestral species, but are genealogically related to the ancestral species. In that sense, the division hierarchy is a hierarchy of sequential branching events. But the ancestral species and its two daughter species are also part of, and as such included in, a monophyletic taxon of higher rank (an individual of greater complexity), just as cells can be part of (included in) the organismal body. But the inclusion of two sister-species in a monophyletic taxon is for Hennig (1950, 1966) not based on intrinsic properties instantiated by species substances, but rather on extrinsic properties that are phylogenetic relations. Consider the mother species *A* splitting into two daughter species *B* and *C*. The relation 'to be an immediate descendant of' is symbolized as *w*. There will then be a *w*-arrow running from *A* to *B*, and a *w*-arrow running from *A* to *C*. We can now write these relations as ordered pairs: $w(A; B)$, and $w(A; C)$. Stipulating bifurcating speciation events, both ordered pairs and none other belong to the same relation, such that the relation *w* has two ordered pairs: $w = \{(A; B), (A; C)\}$. The upshot is that the monophyletic taxon $\{(A; B), (A; C)\}$ marked out by the relation *w* includes the ancestor (*A*) and all of its descendants (*B*, *C*). The same argument can be extended over a hierarchy of monophyletic groups.

## A Hierarchy of Natural Kinds

Hennig's (1950, 1966) phylogenetic system is built on Woodger's (1952) concept of a division hierarchy. It is built on phylogenetic relations as reflected in a nested hierarchy of complex wholes that indicates relative recency of common ancestry. All of these concepts – phylogenetic relations, recency of common ancestry – are theoretical concepts that apply to unobservable states of affairs. Hennig's (1950, 1966) system therefore is a theoretical construct. As was emphasized by Hennig (1957, 1966: 80), synapomorphies are only "aids used to apprehend" the natural system. His is a theoretical construct that 'lies behind the observable world', but nonetheless is built on observable, i.e., epistemologically accessible relations, which are relations of homology that are tied to organisms and their parts, i.e., their 'characters' (Woodger, 1945; Rieppel, 2004).

Ample reasons have been given above for why classes or sets, defined intentionally by 'characters', cannot evolve, nor can their members. Here is one more. Members of universal, spatio-temporally unrestricted classes or sets that are marked out by essential properties may be governed by natural laws, or the other way around: the names of such classes or sets can function in the formulation of universal laws of nature. If the same (numerically identical) individual member of such a class or set would instantiate different properties through time, then these properties would not be essential but accidental ones. The laws governing such individuals would change, or become invalid, through time. In either case they could not be universal natural laws. Since species

[2] **Possible relations are: many – to – many: many readers read many newspapers; many – to – one: many readers read the same newspaper; one – to – many: one reader reads many newspapers; one – to – one: one reader reads one newspaper.**

change through time and space, species names cannot function in the formulation of universal natural laws. Species names therefore must be proper names; species must be individuals (Hull, 1989).

The classic notion of a natural kind, the one of John Locke or John Stuart Mill, is one of such universal classes or sets of stuff or things that occur in nature: water and gold, tigers and elm trees. Gold can be a class of naturally occurring stuff that is intentionally defined by its atomic number 79, such that gold bracelets and wedding bands are members in the class of all things made of gold. Such a natural kind is subject to the membership relation; its members are governed by natural laws. But if tigers can be of a natural kind, then the natural kind term (predicate) '*x*… is a tiger' can apply to a mereological sum also. If natural kinds can be both, subject to the membership relation as well as to the part – to – whole relation (Soames, 2002, 2003), then species, and taxa, can be natural kinds under the provision that spatio-temporal causal connectedness is added to mereology pure and simple, even though species are not governed by natural laws. The hierarchy of species and taxa then turns into a hierarchy of natural kinds (Rieppel, 2005c), although not kinds of the kind Locke and Mill had in mind.

Individuals or natural kinds – does it matter? Natural science is about the discovery of the causal structure of the world. If species like tigers, or elm trees, were individuals, they would be historically unique yet ever-changing entities with fuzzy boundaries and with no kind-ness to them. Continuous evolutionary transformation would prevent any kind-ness for them to become established. Differences between such individuals could only be differences in degrees, not in kind. The tree of life would be a maximally complex individual composed of parts, each of which an individual of lesser complexity yet historically unique and hence comprehensible exclusively in terms of its uniqueness exhibited at any particular point in the space-time system (comprehensible only as a theoretically infinitely thin space-time slice or as a fleeting event). Hennig (1950) rejected such an idiographic approach to systematics, as it would not allow generalizations across multiple space-time slices or events.

However, tigers, and elm-trees, do have a kind-ness to them that allows certain generalizations. Tigers are striped feline carnivores; they have a certain morphology that allows their identification and re-identification; they exhibit repeated patterns of behavior; they have a certain geographic distribution; and most importantly, they all share the property of phylogenetic relatedness, i.e., a common evolutionary origin (LaPorte, 2004). It is true that there can be an albino tiger, or that a tiger does not cease to be one if it lost a foot in an accident. It is also true that Martian tigers cannot be tokens of the Earthling tiger kind since they would not share the same phylogenetic relationships. But that only shows that tigers are not tokens of an intentionally defined class or set in the classical sense, but tokens of a weaker and non-essentialistic sort of natural kind, i.e., of a homeostatic property cluster natural kind (Boyd, 1999).

The distinctive feature of a natural kind is that its tokens engage in natural causal processes. Token organisms of species engage in all sorts of causal processes, such as competition, reproduction, and speciation. If genealogy is itself one (amongst others) of the causally relevant properties of a natural kind that is a species (Boyd, 1999), then the natural kind marked out by that property (and others) is historically delimited, i.e., spatio-temporally restricted, and finite in its possible instantiations (Keller et al., 2003). This, admittedly, is not the classic notion of a natural kind (compare Boyd, 1999, and Hull, 1999), but it is one that fits the genealogical hierarchy (Grene, 2002; Rieppel, 2005c), and that provides an explanatory power (as well as an ontological parsimony) for that hierarchy which surpasses that of a hierarchy of individuals.

Tigers are not only feline carnivores, they are also mammals, a fact that spells out a lot about their history, their anatomy, their reproductive biology, etc. Tigers are tokens of tetrapods, amniotes, gnathostomes, vertebrates, which means that tigers are tokens of an entire hierarchy of natural kinds, each hierarchical level tied to other causally relevant properties that allow different generalizations about tigers and their nature, or kind-ness (Platts, 1997). To discover the causal structure of the world means to explain the world in terms of natural causal processes. Within the hierarchy of natural kinds, the explanatory force increases, the explanatory range decreases, as one progresses from vertebrates through amniotes and mammals to carnivores and tigers (Platts, 1997). This is because tigers instantiate the causally efficacious properties not only of their species, but also those of carnivores, mammals, and vertebrates, but not the other way around. The same epistemological gain does not obtain for a hierarchy of historically unique individuals.

## Conclusions

The thesis that species, and taxa, are individuals is a metaphysical thesis that is decoupled from epistemic input (Hull, 1989, Grene, 2002). Systematics, like all natural sciences, is about the discovery of the causal structure of the world. To take the taxonomic hierarchy as one of natural kinds not only allows, but indeed requires, epistemic input, in that it reflects the way systematists discover the tree of life. But it also requires that the monophyletic groups that are natural kinds be causally grounded (Rieppel, 2005c).

Relations of homology must be, but cannot only be grounded in congruence; in addition, they must at least approximately be aligned with the causal structure of the world as captured by theories of inheritance, of ontogeny, and of evolution. If sight is lost of such causal grounding, it becomes very hard to distinguish between individuals, sets, classes, and natural kinds.

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## Student Talk Prize Winners at the Biennial Meeting, Cardiff, August 2005


Niamh Redmond


In 2003 I graduated with an honours BSc in Biology from the National University of Ireland, Maynooth. My final year research project, which was supervised by Dr Grace McCormack, involved PCR primer design and PCR optimisation for amplifying HIV-1, subtype C blood samples from Malawi in Africa. On completion of my degree I continued working for Dr McCormack,

initially as a Research Assistant before registering for a research Masters in NUI Galway in 2004. During this time my research has focused on sponges. The project is constructing a molecular phylogeny of the Order Haplosclerida, Phylum Porifera. Our molecular results to date show major disagreement with the current morphological classification, the *Systema Porifera*. We have begun to assess the morphological characters with respect to these molecular trees. We may investigate other datasets such as biochemical and cytological characters in the future.

Outside of college, I am a massive sports fan, playing gaelic football at all levels, camogie and I have started rowing this year. I also enjoy socialising with friends, going to music and comedy gigs and reading.


Niamh Redmond (centre), Dr Grace McCormack (left) and Dr Jean Raleigh (right)

## Roy Erkens

Roy was born in Maastricht, The Netherlands in 1976. Following highschool education at Sint Maartens College, Maastricht, he studied for a BSc and MSc in Biology at Utrecht University (1994-2000). For one year he undertook a thesis at the University of Amsterdam, and a seven-month research programme at Erasmus University, Rotterdam. From 2001 onwards, Roy has been carrying out research for a PhD at the Utrecht University branch of the National Herbarium of the Netherlands. The title of his research programme is 'The evolution and phylogeny of *Guatteria* (Annonaceae).'

Roy takes an active part in student life, having been a student representative on the Faculty and University Councils. In 2003 he was winner of the 'Utrecht University Young Teacher Award'. His hobbies include karate and studying the history of his home city, Maastricht.

Roy Erkens

## Student Prize Winners of the 6th Young Systematists' Forum, Natural History Museum, London, December 2004

Student prize winners of the 6th YSF were accidentally not reported previously in *The Systematist.* Winners of the 7th YSF will be reported in the next issue.

## Oral Presentation: Maria Vorontsova

Maria Vorontsova was born in Moscow, Russia, and moved to the UK with her parents at the age of 11. She studied molecular biology and ecology within the Natural Sciences Tripos at King's College, Cambridge, graduating in 2000. Maria has carried out botanical fieldwork in the UK, South Africa and Panama, and is currently working with Dr Petra Hoffmann on her PhD at the Royal Botanic Gardens,

Maria Vorontsova

Kew. She is a keen artist and sculptor, with an interest in botanical illustration. Her scientific interests include botanical systematics and plant diversity.

## Poster Presentation: Lavinia Robba

Lavinia Robba is from Palermo, Italy and has recently completed her PhD at Palermo University on the systematics of *Cynara* L. Lavinia has carried out field work in several Mediterranean countries and conducted molecular work at the Natural History Museum, London, funded by an EU Sys-resource scheme fellowship and a Systematics Association Small Research Grant. She is currently

Lavinia Robba

moving to the UK to be reunited with her family. Her botanical loves are spiny plants with big bright inflorescences.

# Inspirations

In the great horror writer's memoir of his craft, *On writing*, Stephen King has simple advice for aspiring novelists who are struggling to decide what to write about. "People love to read about work. God knows why, but they do. If you're a plumber who enjoys science fiction, you might well consider a novel about a plumber aboard a starship or on an alien planet." Whatever the manifold reasons why different people might be interested in reading about other people's work, one reason is likely to stand out. It can simply be very inspirational. And in this respect there is scarcely a finer crowd than impassioned scientists. From imaginary adventurers like Indiana Jones to genuine Nobel prize winning oddballs like Richard Feynman, they capture our collective imagination, and spur us on to embark on our own intellectual endeavours, even if it is just a secretive session with your son's chemistry set.

This is the reason why we decided to introduce a new section in *The Systematist* to be called simply *Inspirations*. Each issue will feature a short interview with a systematic biologist featuring his or her work, and attempting to reveal what drives them in their research.

In the first *Inspirations* we introduce Dr. Gonzalo Giribet. He did his undergraduate studies and PhD research at the University of Barcelona, and after a postdoctoral stint at the American Museum of Natural History in New York, he moved to Harvard University where he is currently associate professor of biology and associate curator of invertebrates in the Museum of Comparative Zoology.

Giribet's specialty is in the field of higher-level phylogenetics of the animal kingdom, in which he has become one of the world's leaders over the last decade. The hallmark of Giribet's papers is the combination of large amounts of molecular and morphological evidence in phylogenetic analyses in the context of sensitivity analysis, where the same data set is repeatedly analysed using different input parameters. So far Giribet's phylogenetic research has focused chiefly on chelicerates, myriapods, bivalves, and the animal phyla. Giribet's success is especially remarkable when you realize that he is barely in his mid-30s, having been born in 1970.

Gonzalo Giribet diving for marine invertebrates in the Bahamas

## *Introduction*

**When did you decide to become a systematist?**

Well, I decided I wanted to be a zoologist much earlier than my undergraduate days. As far as I can remember I always wanted to be a zoologist and I already started my shell collection—which I still have—when I was about 6 years old. My determination to become a systematist grew stronger while I was an undergraduate and the introduction to PCR opened my mind about the possibilities of molecular systematics.

While an undergraduate I worked at the marine benthos group at the Department of Animal Biology at the Universitat de Barcelona, but I decided I wanted to move on to work on systematics for my PhD. At that time I wanted to work on molluscan systematics, but the only research group working on molecular systematics was led by an arachnologist, so I was convinced to work on arthropod molecular systematics.

**What are the main goals of your research?**

Understanding the origins and maintenance of animal diversity has always been my main interest, especially at the deepest levels—origins and early splits of metazoans. More recently I have become interested in smaller problems that can be approached from other angles. Biogeography and evolutionary radiations in continental islands can also teach us a lot about the evolution of organisms during the last 150 million years to recent times.

**What are your favourite organisms and why?**

Molluscs and arthropods, for the reasons explained above. Molluscs have been my passion since my youth days and arthropods have been the most important group for my professional development. Within arthropods my absolute favorite is the Opiliones suborder Cyphophthalmi, a group that has been the center of my research for the last 5 years. But I also love centipedes and other arachnid groups such as Ricinulei.

## *Work and responsibilities*

**How many hours per week do you work?**

Way too many. But I love most of those hours. 16 hour-days are not uncommon, and 7-day weeks are the norm. But I have tried to reduce the number of hours during this year and dedicate more hours to myself.

**What percentage of time do you spend on each of your different responsibilities, such as reading, writing, lab work, teaching, administration, etc.?**

The numbers are hard to estimate. Normally I teach 2-3 days per week and those days are pretty much full with lecture preparation, teaching, and other sorts of commitments like lab meeting (once a week), faculty meetings, or committee meetings. I try to keep one day per week open for my research. In the normal days, I try to get some research done after my other commitments have finished. So, the norm is that days are for commitments and evenings and nights are for my own work.

**How many undergraduate, PhD students, postdocs, and technicians are there in your lab?**

Currently in my lab there are two undergraduate students working on their senior theses, three graduate students, one post-doc, one technician and one visiting student from Colombia. I have two new postdocs starting in 2006. I always have visiting students that come for periods of 3-6 months to do a specific study. Most of my students participate in different lab activities and fieldwork. Having these many people results in a lot of responsibilities for me to raise funds and to try to give them quality time to discuss their research, results, and manuscripts.

**What gives you the most satisfaction and frustration in your job?**

I am lucky that my work gives me many satisfactions, including success in field expeditions, success of my students, phone calls or e-mails announcing funding, and acceptance of publications. I also find it extremely satisfactory when one keeps meeting interesting people from all over the world while doing science. Among some of the frustrating activities, are those that take time out of my science.

**Do you have any international collaborations?**

Yes, many. My main collaborator (Greg Edgecombe) [expert on centipedes, trilobites and high level arthropod phylogeny (ed).] is in Australia and I also have excellent collaborators in Denmark, Germany and Spain.

## *Fieldwork*

**Where has field work taken you so far?**

To all the continents except Antarctica. I am fortunate to do field work both in marine and terrestrial environments and I can spend more than 60 days in the field every year. Just to give an example, in the last two years I have been doing field work in Europe: Portugal, Spain, France, Italy and Sweden; Asia: Japan and Sri Lanka; Oceania: Australia and New Zealand; Africa: Equatorial Guinea; South America: Colombia and Brazil; and North America: Bahamas, USA and Mexico. I can't complain!

**What kinds of organisms have you collected?**

In terrestrial environments I mostly collect harvestmen (Arachnida: Opiliones) and centipedes (Myriapoda: Chilopoda). Many of my trips focused on the Opiliones suborder Cyphophthalmi. In marine environments I have been collecting all sorts of protostomes for our AToL (Assembling the Tree of Life) project [Giribet is principal investigator on this project dedicated to reconstructing a phylogenetic backbone of protostomes (ed).].

Giribet and a student in Japan rooting around in the undergrowth in search of arthropods

**Did any memorable incidents happened during field collecting?**

Yes. I have had broken bones and been chased by a rhino. But the

largest amount of stories happened during my 2003 field trip to Equatorial Guinea. I have put those memories in a book that I will try to publish soon.

### *Influences*

**Is there any paper or book that has been very influential for your thinking?**

At this stage, many books have been influential or inspirational. As a young boy I enjoyed reading Darwin's books along with those of the British naturalists. There are perhaps three papers that have had the biggest impact in my career and that made me choose my postdoctoral training with Ward Wheeler [Curator of Invertebrate Zoology at the AMNH in New York (ed).]. These are his arthropod phylogeny paper, the first total evidence analysis, I believe, from 1993, and his two seminal papers on sensitivity analysis (1995) and direct optimization (1996):

Wheeler, W. C., P. Cartwright & C. Y. Hayashi. 1993. Arthropod phylogeny: a combined approach. *Cladistics* 9: 1-39

Wheeler, W. C. 1995. Sequence alignment, parameter sensitivity, and the phylogenetic analysis of molecular data. *Systematic Biology* 44: 321-331.

Wheeler, W. C. 1996. Optimization alignment: the end of multiple sequence alignment? *Cladistics* 12: 1-9.

**Who was the most important mentor in your career**?

Ward Wheeler, from the American Museum of Natural History, without any doubts.

**What is the best advice you have ever received?**

To apply for the position I currently have.

### *Output*

**How many scientific publications do you have at the moment?**

Counting journal articles, book chapters and edited volumes I have ca. 90 publications with another 8 submitted.

**How many gene sequences do you think you have generated so far, covering howmany animal phyla?**

This is hard to estimate. Together with my students, we may have generated between 3000 and 5000 sequences—including more than 500 species of invertebrates. But now we are generating ESTs and get thousands of sequences done for us in Korea… Do these count? As for the animal phyla, all but Placozoa and Mesozoa; this includes the first sequences for Micrognathozoa and Loricifera (yet unpublished).

**Could you nominate any of your discoveries or papers as the most important one, or the one that you personally like best?**

There are many papers that I like and some that supposed something special for the impact they caused in the field—often with discussion arguing both ways. The first one was our *Nature* paper on arthropod phylogeny from 2001 [a combined molecular and morphological phylogenetic study analysed on a beowulf cluster of 256 parallel processors (ed).] where we synthesized a lot of the work that Ward Wheeler, Greg Edgecombe and myself had initiated almost independently several years earlier. Our recent *Nature* paper with my former student Amy Maxmen showing that pycnogonids [sea spiders (ed).] have a pair of appendages (the chelifores) innervated by the protocerebrum was one of those findings that clicked in my brain as something unique and that also related to the position of pycnogonids proposed by us in our earlier *Nature* paper [this paper shows that the chelifores of sea spiders may not be homologous to the chelicerae of chelicerates, but may instead represent the only homologues in an extant arthropod of the large frontal appendages in long extinct forms from the Cambrian (ed).].

### *Advice*

**What skills do you think a successful researcher in your discipline must possess?**

I think that any modern invertebrate systematist should be equally comfortable working with molecular and morphological/anatomical data. We tend to be classified as molecular systematists or morphologists, but this is changing—fortunately. I give the same importance to both aspects of my research and this is what I try to teach to my students—together with a sound background in systematic theory.

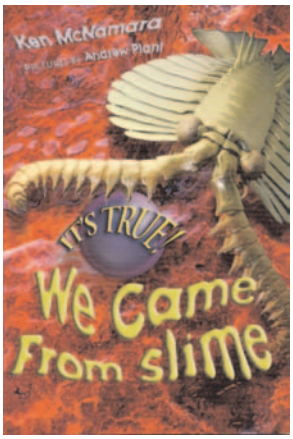
**Do you have any tips for students aspiring to a career in systematic biology?**

Well, there are many aspects that one could try to recommend to students, but perhaps the ones that I value the most is to read and understand the literature, being critical, and try to learn at least one group of organisms!

# Book Reviews

## Slime of your Life

A review of McNamara K. 2004. *It's True! We Came From Slime*. Allen & Unwin, Crows Nest NSW, Australia.




I suppose that most professional palaeontologists got bitten by the fossil bug very early on in their lives, and in the not too distant geological past when I was a child, my parents were sufficiently patient with my fixation to supply me with a range of books on prehistoric life. By far the most magnificent of these was an almost complete set of cloth-bound volumes by Josef Augusta, containing Zdenek Burian's famous paintings of extinct animals, which I was given one marvellous Christmas in the early 1980s, and which gave the impression that the key to understanding the fossil record lay in dusty museum displays in obscure Eastern European countries. As for many other children, dinosaurs and their temporal successors – the weird and wonderful range of extinct Tertiary mammals – were my main obsessions, and organisms from time periods more ancient than the Mesozoic were under-represented in my prehistoric library. Of course, I knew about trilobites and other flagship denizens of deep time – nautiloids, crinoids, early amphibians with heads shaped like coat hangers, and the sail-backed *Dimetrodon* – but these animals were usually restricted to the introductory pages of dinosaur books rather than being allocated substantial accounts all their own. The only associated science in these accounts of the Palaeozoic was typically a brief description of the formation of coal from the fossilised swamp forests of the Carboniferous. The dawn of animal life in the Cambrian was familiar only as a gloomy world populated by floating pineapple-ring shaped jellyfish (now recognised to be the mouthparts of the giant predator *Anomalocaris*), and the immensity of the Precambrian was worthy of little more than a sentence. But why should I care about bacteria, or even *Bothriolepis*, when I had *Brachiosaurus*?

Popular interest in the Palaeozoic has increased significantly since the days of my childhood, though. Reading '*Wonderful Life*', Stephen Jay Gould's enthralling account of the discovery and evolutionary significance of the Burgess Shale, reawakened my passion for palaeontology in the sixth form, and was instrumental in making me study trilobites for my doctorate. The latest discoveries from this and other Palaeozoic Lagerstätte now make international news. This year, a range of Palaeozoic faunas has been reconstructed for prime-time television, in the latest instalment of the BBC's multi-million pound prehistoric special effects extravaganza, '*Walking With Monsters*'. And now palaeontologist Ken McNamara has written an engaging children's book for the popular Australian '*It's True!*' series, exclusively devoted to life before the dinosaurs.

McNamara's book is aimed at 8-12 year olds, as highlighted by the wobbly writing and day-glo strawberry-jam-like slime on its cover. It is similarly full of references to smelly drool, farts, nose-picking, and prehistoric animals sliding around on their bums or winning ugly contests. Lots of species have convergently evolved 'steak knives' either for predation or defence, and there are many grisly descriptions that will appeal to kids, such as that of the fossilised Gogo placoderm which presumably choked to death, as it was found with another smaller fossil fish stuck in its mouth – its eyes were too big for its palaeo-belly. But since the super-predators of the Palaeozoic really did have 'fearsome crab-like pincers' or 'huge needle-like claws that locked together to form a cage in which their next meal could be trapped', then describing these monsters educates as well as entertains. Indeed, the account of giant sea scorpions includes my favourite line in the book: "That last word [scorpion] is enough to scare the pants off some people. Put 'giant' in front and we are in a whole new state of terror." In his academic life, McNamara is another trilobite specialist, and he also recounts the delightful story of an American palaeontologist who attached the tiny crystalline lens from a trilobite eye onto a special camera, and used it to produce a recognisable photograph of the FBI Building! These descriptions are illustrated with a series of catchy line drawings by Andrew Plant, one of which even namechecks the BBC series (it shows a sunbathing *Dimetrodon* reading a book entitled '*Walking Without Dinosaurs*').

But behind all this fun, a surprising amount of serious science gets explained in a very approachable fashion. As well as the usual suspects such as the first vertebrates and the 'conquest' of land, McNamara ably describes such topics as the process of fossilisation – with special attention to trace fossils, how they are made, and how to identify their makers – the formation of our oxygen-rich atmosphere and the Greenhouse Effect, taxonomic nomenclature, the suite of adaptations associated with the evolution of endothermy, and continental drift. The immensity of geological time is effectively conveyed

McNamara's book is aimed at 8-12 year olds...But behind all this fun, a surprising amount of serious science gets explained in a very approachable fashion...

through the reader being instructed to imagine travelling from their nose down their arm to the tips of their fingers, with important stages in evolution represented at different points along the arm – a more immediate visual image than the standard 'coil' of geological time depicted in the books of my youth. Not only natural selection, but also other, less well-known evolutionary mechanisms such as heterochrony (which McNamara has previously described in a more academic text, '*Shapes of Time*'), are also covered. Many of these topics are treated in special 'fact sections' separate to the main text. These potentially complex topics are made accessible through McNamara's easy, evocative writing style, which repeatedly draws comparison to everyday objects and activities in order to actualize the fossil record and its geological context, and which only rarely seems affected (although discussing the difference between sushi and sashimi may not be the most appropriate metaphor for the evolution of predatory behaviour in the Cambrian Explosion – the target audience would surely be more familiar with Western fast food than Japanese cuisine!).

McNamara is Senior Curator of Invertebrates at the Western Australian Museum, and the book largely uses Antipodean examples to illustrate the evolution of life before the dinosaurs. That this in no way restricts the scope of this palaeontological narrative highlights the wealth and diversity of the Australian fossil record. From the fossilised stromatolites of the Pilbara region, through the world-famous Ediacaran fossils of the Flinders Ranges (discovered by Reg Sprigg in the 1940s), up to the wonderfully preserved Devonian fish fauna from Gogo Station, the continent contains key fossil sites from nearly all of the different stages of life on Earth. Ironically, only its younger dinosaur fauna remains patchily known, despite the best efforts of researchers such as Tom and Pat Rich at Dinosaur Cove and other sites. Of course, the living stromatolites at Shark Bay – also memorably described by Bill Bryson in his book '*Down Under*' (who would have thought that these cauliflower-shaped lumps of slime and mud could prove to be so magical?) – can't fail to receive a mention as well. And I certainly cannot criticize the author for spending some time discussing *Mcnamaraspis*, the placoderm genus named in his honour as a fortieth birthday present, especially when he reveals that a group of primary school pupils successfully petitioned the state government to make it the official Fossil Emblem of Western Australia.

'*It's True! We Came From Slime*' is a highly entertaining account of the early evolution of life on Earth, with few faults. I was only able to find one incorrectly spelled scientific name (the pelycosaur *Sphenacodon* was written as '*Sphenocodon*'), although the apocryphal story of the discovery of the Burgess Shale, involving Walcott's wife's horse stumbling on a rock that was found to contain strange fossils, was effectively debunked by Gould but is here presented as fact. The 'de-weirding' of *Hallucigenia*, from stilt-walking nightmare to spiny but standard lobopod, is also alluded to in one of the line drawings but not mentioned in the accompanying text, a wasted opportunity for teaching kids about the difficulties in accurately reconstructing extinct organisms from their fossil remains. Possibly my only real complaint is that some of the accounts of major evolutionary developments, in particular the Cambrian Explosion, are largely descriptive and do not really consider what triggered these changes to occur in the first place (although a notable exception to this is the emergence of arthropods on land, with predation and competition neatly explained for children in terms of 'bullying'). However, I fully recommend it to the parents or teachers of any junior fossil devotee, or indeed of any child whose imagination can be excited by magical worlds full of creatures stranger than the attendees of Hogwarts School, but which once really existed on our planet. And, frankly, if it gives kids an alternative to reading bloody Harry Potter, then it's alright by me.

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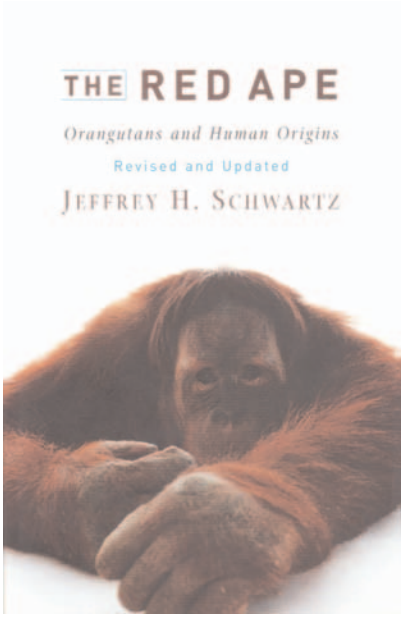
## Why you should read this book

A review of Jeffrey H. Schwartz 2005. *The Red Ape: Orangutans and Human Origins.* Revised and updated. Westview Press.




It does not really matter if you are not particularly interested in human origins and seemingly obscure debates about which of the great apes is our nearest living relative. On one level, Jeffrey Schwartz's *The Red Ape* is an exposition on evidence for the orangutan being our nearest living relative. On another level *The Red Ape* confronts the reader with subjects rendered

largely taboo within the evolutionary biology and systematic communities. These taboos concern the independent status of morphological systematics, and the non-cladistic qualities of DNA-sequence systematics. In both areas there is a virtual hegemony over scientific discussion and investigation that relegates morphology to the poor handmaiden of modern DNA-sequence systematics that has somehow been furnished with the holy grail of phylogenetic reconstruction. Morphology, on the other hand, can only grasp at the molecular shirt-tails to retain a glimmer of its former respectability. In *The Red Ape*, Schwartz makes the case that this reality rests on very questionable historical and scientific foundations.

In modern approaches to human origins it seems that morphology cannot say anything much that is reliable on its own recognizance. Not unlike a police suspect, morphology needs a molecular alibi for its story to be verified. *The Red Ape* points out, for example, how Collard and Wood (2000) dismiss hard tissue features as evidence for human and great ape relationships because they do not match an accepted molecular relationship. The reverse case was then made by Gibbs *et al*. (2003) for soft tissue characters which did match their molecular expectations even though the morphological features were not separated into primitive and derived states. The real irony of the hard-tissue study is that they found the orangutan, and not the chimp, to be most closely associated with humans. This is the hidden story of primate systematics, the dark side of our origins. For in morphological systematics it is the orangutan, and not the chimpanzee that comes out as sharing so much uniquely in common with humans.

*The Red Ape* takes the reader through the historical maze of human evolution and grounds systematic theory in a systematic reality – the search for human ancestry and our closest living relative.

**The real impact of the orangutan theory is seen in the almost total absence of discussion and debate. This is one of the most profound and troubling silences in modern evolutionary biology.**

Schwartz outlines the irony of palaeontological research that first declared the fossil *Ramapithecus* – when known only from gnathic remains – was a direct human ancestor. Palaeontologists were convinced of its hominid status in large part because of its hominid dentition, only to then discover the skull looked more like the orangutan than any African ape from which hominids were believed to have evolved. This major palaeontological discovery brought the science of human origins to a cross roads - either the orangutan is more closely related to humans than previously thought, or *Ramapithecus* can no longer be seen to be directly involved with human origins because orangutans are not. A close phylogenetic relationship between humans and the orangutan was evidently against tradition and considered too much to swallow. So *Ramapithecus* was ignominiously disowned and exiled to obscurity where it lies today along with the orangutan (Pilbeam 1982). This profound reversal of fortunes left some palaeontologists lost and bewildered. Pilbeam (1978) who supported the hominid status of *Ramapithecus* resolved that he "would never again cling quite so firmly to one particular evolutionary scheme." This newfound sense of uncertainty was, however, soon forgotten as Pilbeam (1982) found salvation in the truth of molecular systematics. Having built his scholarly reputation upon a foundation of morphology, Pilbeam now dismissed his own science as being so riddled with ambiguity, arbitrariness, and selectivity that one cannot even use cladistic reasoning to legitimate the statistical testing of phylogenetic hypotheses derived from anatomical data (Pilbeam 2000).

And yet our acknowledged hominid ancestors, the australopiths, do not look like African apes, much to the bewilderment of palaeontologists. *The Red Ape* points out that australopiths look more like orangutans – not only look 'like' but actually share derived features otherwise found only in orangutans or their fossil relatives. This is the straw that breaks the camel's back. It is not solely a matter of Schwartz marshalling the morphological evidence now comprising over 40 derived features compared with almost nothing that is uniquely shared between humans and chimpanzees. It is also a matter of how the systematic evidence for living humans and primates is congruent with the hominid fossil record. *The Red Ape* throws down a systematics gauntlet in arguing that if morphological systematics is unreliable for extant organisms, it must also be unreliable for fossils. He argues that one cannot have it both ways, and even the fossil calibration of molecular clocks is rendered meaningless. Morphology is not magically transformed into something independently informative just because genetic information is unavailable. And yet that is the apparent absurdity of modern primate palaeontology.

*The Red Ape* explores the chimera of so-called 'genetic' evidence – that part of our genetics comprising DNA-base sequences. In *The Red Ape,* Schwartz asks the most basic and critical questions that need to be addressed by every modern systematist: Why should molecular similarity always reflect phylogenetic sequence? Why couldn't similarity in molecular or DNA sequences reflect primitive retention and, therefore, non-relatedness? Why couldn't genetic difference indicate that a taxon has changed relative to those that remained primitively sim-

ilar? These are pertinent questions, Schwartz argues, since the molecular assumption that genetic similarity is necessarily correlated with phylogenetic relationship grew out of a general agreement between molecular and morphological trees in the first place. One should, therefore, be able to question the interpretation of molecular or sequence data with morphological data.

*The Red Ape* also discusses the question of whether there is anything to indicate that sequence characters are limited to uniquely shared features, as required by cladistic theory. Apparently the answer is 'no', as all identified sequence matches are analyzed using 'cladistic' algorithms that determine derived sequences from the tree-building process itself. A phylogeny is constructed to determine which characters are informative and therefore designated as uniquely shared – the exact opposite of cladistic theory. That the non-cladistic approach has developed a strangle-hold on systematic and evolutionary theory is one of the major developments of late 20$^{th}$ century biology, and perhaps nowhere else is this better seen than with the way both morphologists and geneticist use molecular evidence to dismiss the orangutan from consideration. And yet it is not always a matter of conflict. As pointed out in *The Red Ape*, genetic evidence can sometimes be consistent with an orangutan relationship or inconsistent with a human-chimpanzee relationship. Schwartz reviews the twists and turns of molecular reasoning that may start off with the assumption that the orangutan is least related, and so orienting the 'cladistic' study, or at other times rejecting molecular evidence when it does not give the right answer. Schwartz asks: "If morphology is considered an untrustworthy reflection of phylogeny when conclusions drawn from it conflict with molecular interpretations, why should it occasionally be acceptable to use morphology to support one molecular conclusion over another?" Schwartz also points out the incongruities of different genetic results linking gibbons closely to humans and African apes than to the orangutan, or Old World monkeys with chimpanzees and gorillas followed by the orangutan and then humans, and then New World monkeys. As Schwartz points out, nobody embraces these unusual groupings, but it is from morphology that they are considered unpalatable. *The Red Ape* shows that molecular techniques provide competing results, which is not the expectation if they are the automatic door into the truth of phylogeny.

The orangutan is the broken thread in the tapestry of primate evolution and human origins. Molecular and morphological evidence often come into conflict in systematics (usually with the result that the molecular tree is taken to be true or some kind of consensus is invoked), but these conflicts usually gain little attention. The orangutan theory is a different matter, as it concerns our own origins. The real impact of the orangutan theory is seen in the almost total absence of discussion and debate. This is one of the most profound and troubling silences in modern evolutionary biology. Even creationism, a purely religious or philosophical set of metaphysics, gets more scientific attention in the scientific literature. The editor of the popular science journal Natural History even went so far as to declare that the orangutan theory was unacceptable for publication because it brought the genetic model into question. One prominent orangutan biologist declared that the orangutan theory should be withheld from public view because it was such a minority opinion.

Exploring the shadier side of primate systematics is not something Schwartz started out to investigate, but it may be the inevitable consequence of his background in both morphology and systematic theory. This includes direct exposure to the theoretical debates on cladistic theory at the American Museum of Natural History generated by Gareth Nelson's pioneering challenge to the goliath of traditional evolutionary systematics that now seems to have resurrected itself in the form of molecular systematics. It is in the context of this original debate that the orangutan theory finds its roots as *The Red Ape* demands of the reader consideration of what is really cladistic and what is not.

Is morphology as arbitrary and meaningless as implied by Pilbeam, or is there a case for staying true to the morphological evidence? Perhaps the orangutan theory will herald a resurgence of morphological systematics as an independent modern science? Perhaps Pilbeam's original *Ramapithecus* theory was closer to the phylogenetic truth than he can now admit? Perhaps the orangutan theory is not only another look at ourselves, but also at the way we do systematics. That is why the *The Red Ape* is worth reading.

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# Reflections on a decade of small grants

## Subjective advice to prospective applicants for Systematics Research Fund grants

Richard Bateman, Pete Hollingsworth, Tim Littlewood, Julie Hawkins

The Systematics Association Small Grants scheme – more recently amalgamated with most of the Linnean Society's previous grant schemes to form the Systematics Research Fund (SRF) (**application forms can be downloaded at www.systass.org**) – has made 11 rounds of annual awards since its widely welcomed reappearance in the autumn of 1995. In early years, annual awards totalling *ca* £6,000 were typically made to 8–10 of the 30–35 applicants, who were dominantly from the European Union. This year, awards totalling £29,300 were made to 29 of the 84 applicants, who represent a truly international constituency. Thus, allowing for inflation, the scheme has triumphantly trebled in both size and geographical reach, though the percentage of successful applicants has steadfastly remained one quarter to one third.

Another consistent factor across the years has been the bell-curve defined by the aggregate scores awarded by panel members to the proposals. This represents a large number of *Good* proposals sandwiched between much smaller numbers of proposals rated *Excellent* or *Poor*. The *Poor* tail was never large, and happily has decreased through time. However, based on our respective experiences as SRF coordinators (Bateman 1995–7, Hollingsworth 1998–2000, Littlewood 2001–5, Hawkins 2006>) and frequently as assessors, it is our perception that the *Excellent* category has not shown significant expansion relative to the *Good*. The following (admittedly subjective) advice is offered primarily in an attempt to achieve that outcome.

***Recognise the likely benefits of following the rules.*** SRF has been organised with the expressed intentions of maximising simplicity and minimising the time invested in the scheme by both applicants and assessors (even so, this year's applications took each of the six assessors two full days to score). Confining an application to a single side of A4 paper means exactly that; it does not somehow implicitly excuse images, or bibliographies, or budgets, or supporting letters solicited by the applicant; these supplements consume unnecessary time and paper. Also, the December 31st deadline for applications is real; it does not carry a ten-day error bar.

***Optimise your use of the single side of A4.*** Much of the skill of formulating a one-page proposal lies in a combination of prioritising the content and optimising the logic and structure of the text. Waste neither words nor space, yet don't be afraid to use paragraph headings; after all, this is a short proposal, not an abstract. And illustrations are rarely included by applicants, despite the fact that well-chosen images (small, of course!) can substitute for a significant number of words.

***Include a budget.*** Budgets are still omitted from a substantial minority of proposals, and many of those that are presented are inadequate. Estimates that are clearly over-inflated are laudably rare. Nonetheless, applicants should realise that a scheme that by definition distributes funds in small measures is unlikely to be impressed by the inclusion of budget lines labelled "miscellaneous", "contingency" and even "overhead"!

***Avoid appearing greedy.*** Requests approximating the maximum allowable sum of £1500 will not be funded to that level unless they are accompanied by a particularly strong justification. There is a good reason for preferring applications in the £500–1000 range; the more modest the requirements of individual applications, the larger the proportion of the assembled applications that we can fund.

***Explain why you have approached us rather than another funding body***. Relatively few applicants tell us why their primary funding body (including their current employer) is unable or unwilling to fund the fieldwork, or collection visit, or laboratory analyses, or item of equipment, or temporary assistant, that they are proposing. Often, assessors will assume that the applicant has ready access to such funding or materials when in fact that person does not.

***Predict the ultimate outputs.*** The majority of applications fail to specify any explicit outputs, and those that do usually simply state that the SRF will be acknowledged in any resulting peer-reviewed publications. For most projects, it is feasible to predict in advance which journals or publishers are most likely to receive written outputs. Similarly, tell us if web-based outputs, such as interactive keys or educational packages, are envisaged.

***Partition large projects into fundable portions.*** Although they are fundamentally altruistic, the bodies who invest in the Systematics Research Fund are nonetheless seeking an element of quid pro quo from recipients. Wholly amalgamating the SRF contribution into a broader project that is being funded from multiple

sources is unlikely to achieve this goal. Specifying at least an element of the project that is particular to the SRF, and will be acknowledged accordingly in ensuing outputs, always encourages assessors. Indeed, why not consider emphasising this element of the overall project in your proposal, rather than giving equal space to every element of the larger project?

***Look forward more than backward.*** Many applicants expend the bulk of their side of A4 in describing the taxonomic history of their chosen group and/or geographical region, often supported by an extensive bibliography. That precious space is better used to describe the details of the approaches to be taken in the proposed research, and to show us that you understand the main strengths and weaknesses of each.

***Stand out from the crowd.*** Remember that almost all applicants to SRF are proposing to study, with commitment and enthusiasm, a particular taxonomic group in a specified geographical area using a limited range of specified approaches. Most applicants aim to generate a taxonomic revision and/or reconstruct a phylogeny, thereby by definition filling gaps in our existing knowledge. Hence, none of these features will, in itself, distinguish your proposal from the others.

*Consider the broader impact of your outputs.* All too often, biologically fascinating groups are undersold by their advocates, particularly where their study implicitly offers clear benefits to one or more user constituencies. And by user constituencies we mean other academic biologists studying evolution, development and related aspects of molecular biology, as well as more applied disciplines such as conservation, agriculture, medicine or education. In this competitive age, it is essential that you demonstrate the broader relevance of your proposed research.

***Keep your feet on the ground.*** Lastly, please remember that a modest but achievable project is more likely to be funded than an all-singing, all-dancing proposal that would more appropriately receive larger scale funding from a research council. We are seeking to achieve substantial advances from small investments, and there are many ways of achieving that goal. For an established professional, a small amount of pump-priming sequence data can successfully deliver the aforementioned large research council grant. For an "amateur" researcher, a specially designed net can trap sufficient tropical bats to populate a raft of papers. For a postgraduate student, a well-targeted field trip can bring revolutionary insights into the biology of their study organisms. And for a retired researcher, a digitiser–laptop package can greatly increase the efficiency and affordability of a self-funded collections visit.

In the meantime, those of us involved in administering the Fund will renew our efforts to seek additional sources of cash, in the hope that we can continue to fund a substantial percentage of the applications submitted to this increasingly popular scheme. Naturally, we are anxious to be in a position to fund your *Excellent* proposal once we receive it.

# Systematics in Cyberspace

The internet contains a vast amount of information, ranging from the exhilarating to the dreadfully dull. However, even a brief bout of harmless displacement activity sandwiched between the demanding duties of our research might yield some tasty morsels for us systematics aficionados. Therefore, the editors ask readers to keep their eyes open when surfing the web in the future, and to let us know about any webpages that may be worth knowing about. Of course, we only want to know about webpages for which proof of being older than 18 and credit card information is not required...

Dr Mark Siddall of the American Museum of Natural History should have the easiest job of any systematist in collecting his organisms. He specializes in the evolution of leeches, and just placing himself in the right environment is normally all that is required for the leeches to charge him. He relates an amusing travelogue about a recent expedition to Madagascar here: http://research.amnh.org/~siddall/madagascar/

Dr. Jennifer Forman Orth's weblog on invasive species should interest most systematists. Although chiefly focused on North America, she keeps track of a lot of media coverage relating to invasive species, ranging from zebra mussels to feral hog. Check it out here: http://invasivespecies.blogspot.com/

Dr John Alroy hosts a website devoted to the history of evolution, and it includes mini-biographies, photos, and more, about important palaeontologists, systematists, and biogeographers who were active roughly between 1800 and 1950. Check it out at: http://www.nceas.ucsb.edu/~alroy/lefa/lophodon.html

*Evolving thoughts* is a blog written by Dr John S. Wilkins from the University of Queensland and boasts 'Evolution, culture, philosophy and chocolate!' It mostly contains philosophical discussions about natural selection, species concepts and several commentaries about the current ID debate raging in the US and Australia. It is highly informative and well worth a visit. http://evolvethought.blogspot.com/

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## Forthcoming Events

April 10-13, 2006
**Palaeogeography and Palaeobiogeography: Biodiversity in Space and Time**
*National Centre for Environmental e-Science, Centre for Mathematical Sciences, University of Cambridge*
For further information: http://www.tethys.org.uk/biogeography/

March 28 - April 7, 2006
**Intensive Course in Molecular Systematics**
*Centre for Plant Diversity and Systematics, University of Reading.*
For further details contact Julie Hawkins (j.a.hawkins@reading.ac.uk).

April 11-12, 2006
**Symposium on the state of Molecular Systematics in Algae**
*Natural History Museum, London.*
Contact: Juliet Brodie and Jane Lewis.

July 5, 2006
**The Sir Julian Huxley Lecture**
*The Linnean Society, London*
It will be given by Loren Rieseberg, University of Indiana
Contact: Bill Baker (W.Baker@rbgkew.org.uk)

August 4, 2006
**Plants, people and evolution**
*The Linnean Society, London*
Contact: Julie Hawkins (j.a.hawkins@reading.ac.uk)

September 18-21, 2006
**Third International Rubiaceae Conference**
*K. U. Leuven, Belgium*
Contact: Steven Dessein (steven.dessein@bio.kuleuven.be), Petra De Block (petra.deblock@br.fgov.be)

December 6, 2006
**Annual Lecture**
It will be given by Barry Leadbeater, followed by the AGM
Contact: Bill Baker (W.Baker@rbgkew.org.uk)

December 7, 2006
**8th Young Systematist Forum**
*Flett Theatre, The Natural History Museum, Cromwell Road, London*
Contact: Jonathan Bennett (j.bennett@nhm.ac.uk), Juliet Brodie (j.brodie@nhm.ac.uk)

June 2007
**A Linnean Tercentenary Celebration: The Evolution of the Animal Phyla**
*The Royal Society, London*
Contact: Max Telford (m.telford@ucl.ac.uk), Tim Littlewood (dtl@nhm.ac.uk)

**Details of the SA research grants, conference bursaries and funding for the organisation of meetings can be found at: www.systass.org**

**The Systematics Association Registed UK Charity No. 270429**

**The Systematics Association** is committed to furthering all aspects of Systematic biology. It organises a vigorous programme of international conferences on key themes in Systematics, including a series of major biennial conferences to be launched in 1997. The association also supports a variety of training courses in systematics and awards grants in support of systematics research.

Membership is open to amateurs and professionals with interests in any branch of biology, including microbiology and palaeontology. Members are generally entitled to attend the conferences at a reduced registration rate, to apply for grants from the Association and to receive the Associations newsletter, *The Systematist* and mailings of information.

For information on membership, contact the Membership Secretary, Dr G. Reid (membership@systass.org), Department of Botany, Natural History Museum, Cromwell Road, London, SW7 5BD, U.K.

*The Systematist* Newsletter of the Systematics Association.

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