Postgraduate teaching for the next generation of taxonomists

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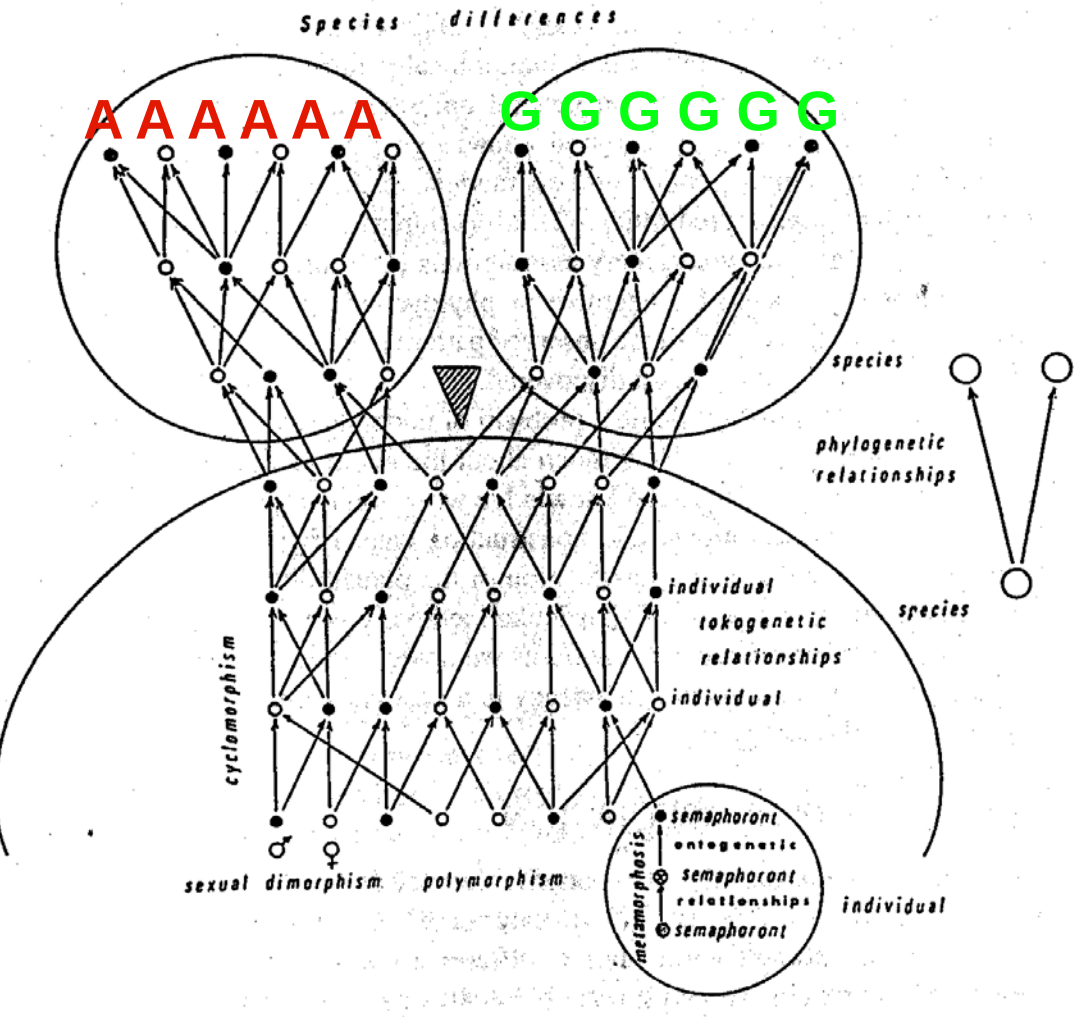
MSc in Taxonomy and Biodiversity
MRes in Biosystematics

- Taught jointly by NHM and Imperial staff, on NHM premises
- Why the NHM is interested:
  - NHM's mission to promote the understanding of the natural world through education and training
  - Focus on core areas of NHM science, including biodiversity, origins and evolution, and sustainable resource use and environmental change
  - Increasing opportunities at the interface of university research and collection-based research, including digital resources

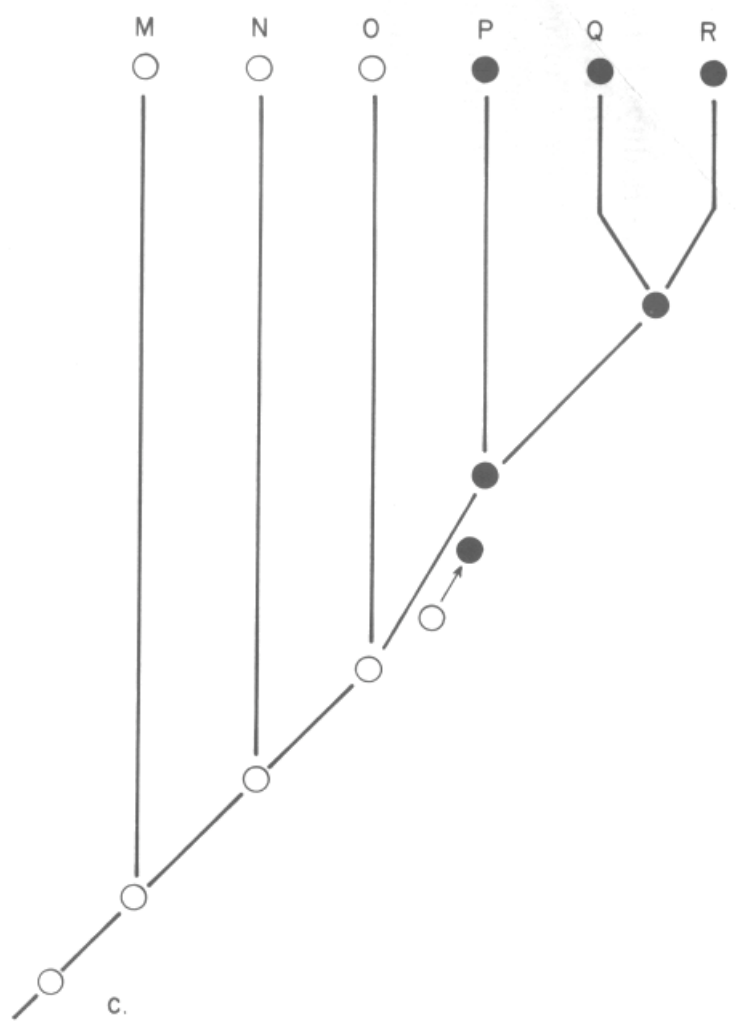
The two roles of taxonomy

Cicindela dorsalis

Cicindela puritana



W. Hennig, 1966



Taxonomy:

(i) species delimitation and recognition

(ii) phylogenetic classification, predictive

Broader aims of training

- Understand ‘taxonomy’ as a hypothesis based scientific discipline
- Learn the methodology: techniques for identification, phylogeny reconstruction etc. (not taxon specific)
- Provide an evolutionary (historical) understanding of biodiversity (what and WHY)
- See the power of ‘tree thinking’ in biology
- Learn to apply taxonomic methods in: conservation, ecology, evolutionary biology, genomics etc.,

Curriculum

Aim: An evolutionary understanding of biodiversity

- ***MSc Taxonomy and Biodiversity***: 20 weeks of taught modules, including:
  - The Tree-of-Life
  - Statistics and computing
  - Principles of phylogenetics (Cladistics)
  - Molecular Systematics
  - Genomics
  - Morphology and Imaging
  - Biodiversity: Evolution of diversity; species & speciation
  - Collection management, principles of taxonomy
  - Palaeontology
- Four-months hands-on research project

- ***MRes Biosystematics***: 3 projects of 15 weeks (specimen-based phylogenetics; molecular systematics; biodiversity informatics)

Projects (examples)

- What can we learn from body length? A study in Coleoptera.
- Preliminary evidence that brain and labyrinth morphology can be used to study the early radiation of the core Corvoidea and the potential applications for future studies
- Phylogenetic diversity measures in Agricomycete ectomycorrhizal fungi: preliminary evidence, future applications and potential pitfalls.

- Key features of the alimentary canal in weevils (Curculoinoidea: Coleoptera): is there a phylogenetic signal?
- Staphyliniformia phylogenetics (Coleoptera) from *de novo* mitogenomic assemblies
- Laditudinal gradient in the beta diversity and phylobetadiversity of British beetles (Coleoptera)

- Biodiversity patterns in the Cenozoic macroperforate planktonic foraminifera
- A molecular phylogenetic study of adaptive radiation in a remote oceanic island group
- The lichen genus Caloplaca (Teloschistaceae, Ascomycota) in Chile: an overview of its diversity and descriptions of four potential new species

MSc Taxonomy – History of course since 1996/7

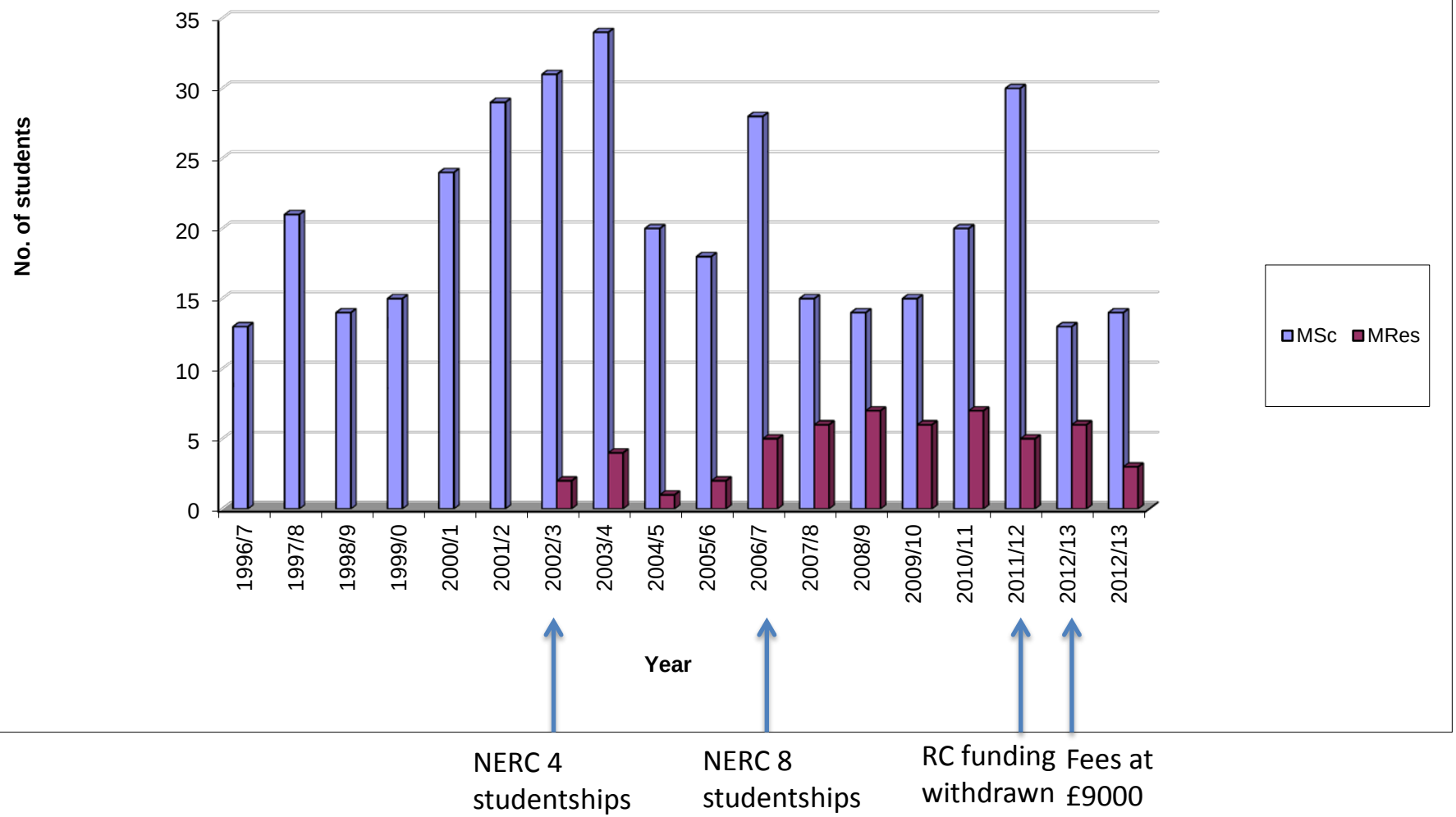
YEAR WEEK	1	2	3	4	5	6	7	8	9	10	11		12	13	14	15	16	17	18	19	20	21	22
1996/1997	TBP	TBP	CL	SS	ID	PR	PR	PR	MS	MS	RW		MS	CB	CB	CM	CM	PS	PTT	BTP	BTP	BTP	RW
1997/1998	TBP	CL	CM	CM	IO	IO	BTP	BTP	BTP	BTP	RW		SS	PR	PR	PR	MS	MS	MS	CB	CB	PS	RW
1998/1999	TBP	CL	CM	CM	IO	IO	RW	BTP	BTP	BTP	BTP		SS	PR	PR	PR	MS	MS	MS	CB	CB	PS	RW
1999/2000	TBP	CL	MCM	MCM	ID	OTT	RW	BEC	BEC	BEC	BEC		SS	PR	PR	PR	MS	MS	MS	RW	CB	CB	PS
2000/2001	TSP	TSP	BC	BC	OTT	RW	SS	SS	PR	PR	PR		RW	BA	BA	BA	MS	MS	MS	MS	CB	CB	PS
2001/2002	TSP	TSP	BC	BC	OTT	RW	SS	SS	PR	PR	PR		BA	BA	BA	MS	MS	MS	MS	RW	CB	CB	PS
2002/2003	TSP	TSP	TSP	BC	BC	BC	RW	OTT	PR	PR	PR		BA	BA	BA	MS	MS	MS	MS	RW	CB	CB	PS
2003/2004	TSP	TSP	TSP	BC	BC	BC	RW	OTT	PR	PR	PR		BA	BA	BA	MS	MS	MS	MS	RW	CB	CB	PS
2004/2005	TSP	TSP	TSP	BC	BC	BC	RW	OTT	OTT	PR	PR		BA	BA	BA	AM	AM	AM	AM	CB	RW	CB	PS
2005/2006	TSP	TSP	TSP	BC	BC	BC	RW	OTT	OTT	PR	PR		PR	BA	BA	BA	MS	MS	MS	MS	RW	CB	PS
2006/2007	TSP	TSP	TSP	BC	BC	BC	RW	OTT	OTT	PR	PR		PR	BA	BA	BA	MS	MS	MS	MS	RW	CB	PS
2007/2008	TSP	TSP	TSP	BC	BC	BC	OTT	OTT	PR	PR	PR		RW	MS	MS	MS	MS	PS	BA	BA	BA	RW	RW
2008/2009	TSP	TSP	BC	BC	OTT	OTT	BC	BC	RW	PR	PR		MS	MS	MS	MS	RW	BA	BA	BA	RW	PS	RW
2009/2010	TSP	TSP	TSP	ToL	OTT	OTT	BC	BC	RW	PR	PR		RW	MS	MS	MS	MS	BA	BA	BA	RW	PS	PS
2010/2011	TSP	TSP	TSP	ToL	PR	PR	BC	BC	RW	OTT	OTT		MS	MS	MS	MS	RW	BA	BA	BA	RW	PS	PS
2011/2012	Ind	ToL	PR	PR	BC	BC	MS	MS	MS	MS	MS		OTT	OTT	TSP	RW	BA	BA	BA	RW	S-R	PS	PS
2012/2013	Ind	ToL	PR	PR	BC	BC	MS	MS	MS	MS	RW		OTT	OTT	TSP	RW	BA	BA	BA	RW	PS	PS	S-R
2013/2014	Ind	ToL	PR	PR	BC	BC	MS	MS	MS	MS	RW		OTT	OTT	RW	TSP	BA	BA	BA	S-R	PS	PS	RW

Change in molecular systematics

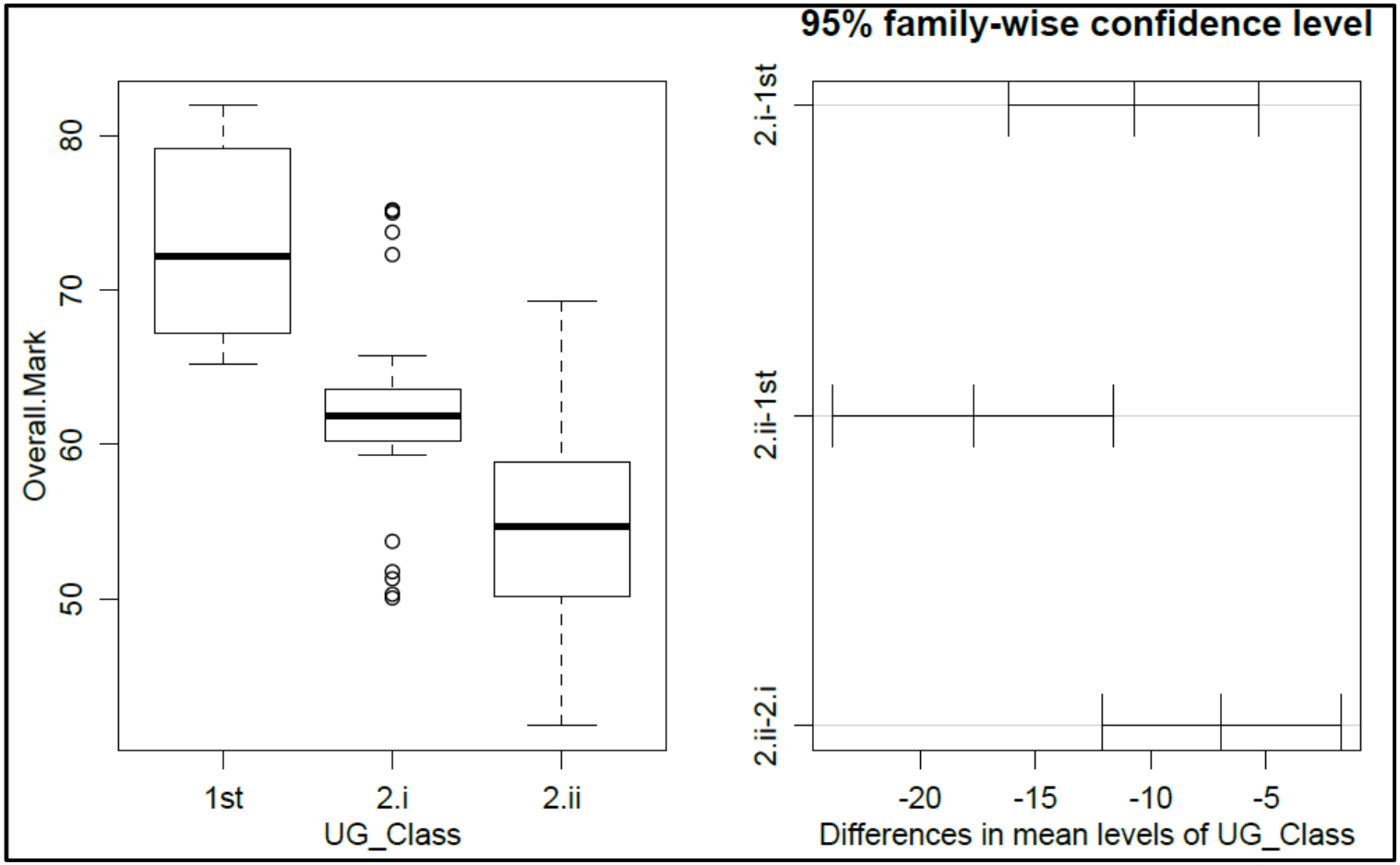
1996/7
PCR-based, a few
thousand base pairs

2013/4/7
Genomic sequencing,
several billion base pairs

MSc & MRes student numbers



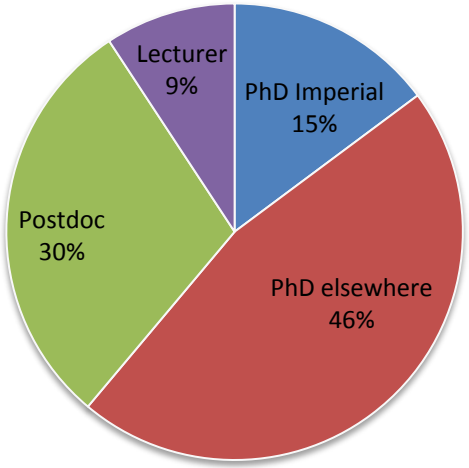
Student performance



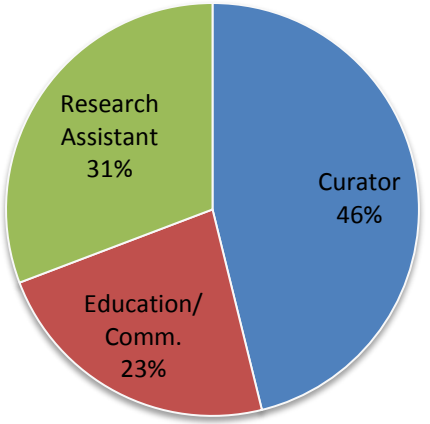
Final mark and entry UG Class

Student destinations (total 450)

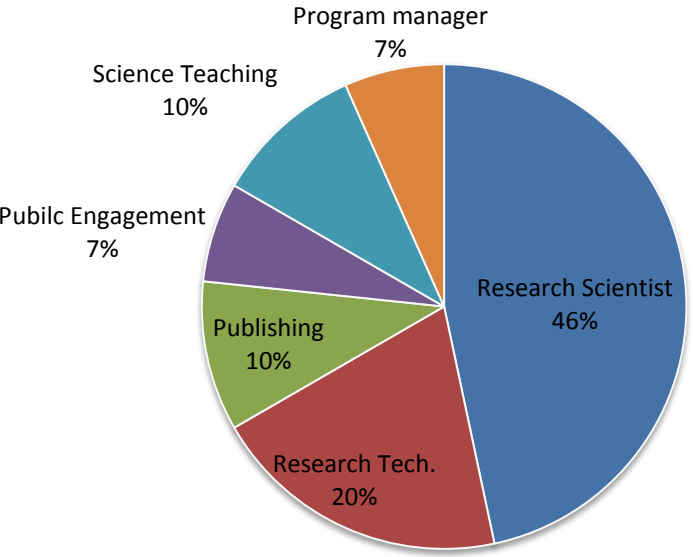
Academia (total 54)



NHM staff (total 13)



Others (total 27)



Research Scientists

- Freshwater Ecologist, CEH
- Research Entomologist, Forestry Commission
- Palaeontologist, BAS
- Marine Biologist, CFAS
- Research Scientist, INRA

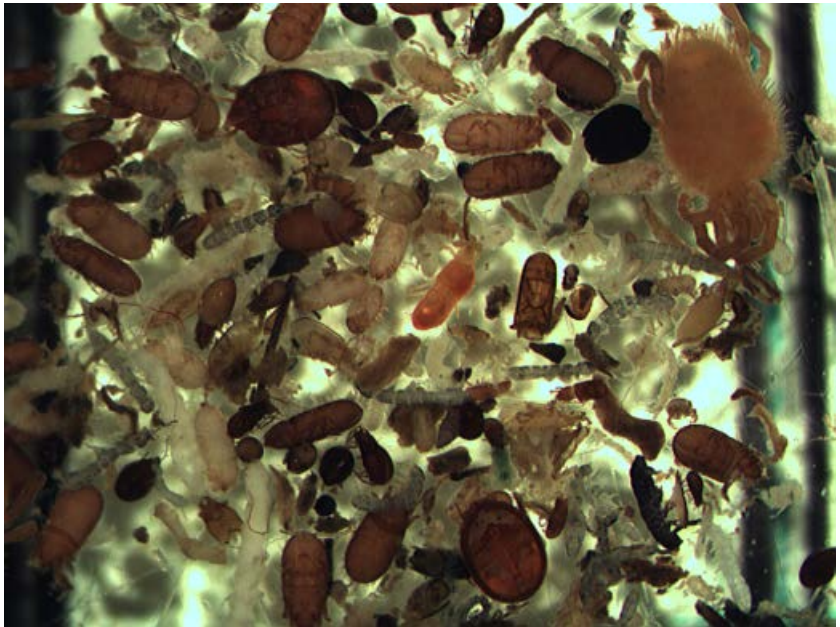
PG teaching in taxonomy in UK

- MSc with “taxonomy” in title
  - Biodiversity & Taxonomy of Plants (Edinburgh)
  - MSc Plant Diversity (Reading)
  - Taxonomy & Biodiversity (Imperial/NHM)
- Keywords in FindAMasters
  - Taxonomy: 24
  - Biodiversity: 163
  - (Forensics: 330)

What would you like to see in future regarding teaching in T&S?

- Improved job prospects for graduates and broader uptake of T&S in biology generally
  - Resolving the disconnect of academic teaching and employer/stakeholder requirements
  - Better appreciation of the needs for T&S by government and public bodies, and by society at large
  - Quicker acceptance of new methods of taxonomy by taxonomists

Sampling the ‘biotic frontier’: arthropods from tropical forest canopies or the soil



Metagenomic analysis of ‘biodiversity soup’

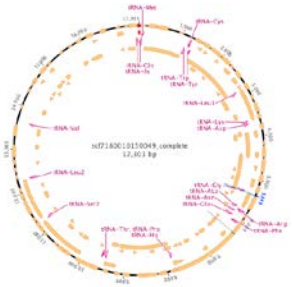
Mixed sample

480 beetles

DNA extraction

1x Illumina MiSeq run (15 Gb)

De novo assembly into contigs



Mitochondrial contigs

New opportunities

- Next-generation DNA methods for monitoring complex communities and entire ecosystems
- Digital sources for identification, collection records, historical information for assessing long-term change
- Wide application of ‘tree thinking’ to all of biology
- Genomics as a source of both phylogenetic and ecological information (a synthesis)
- Taxonomy is quickly modernising and has to stay abreast with technological advances; a highly trained workforce is required