DNA barcoding and FinBIF

FinBIF seminar 2017

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FINBOL
FINNISH BARCODE OF LIFE

The need for identification of species and the taxonomic impediment

- The particular role of species
  - Everybody has an idea of ‘species’
  - Central in all biological research
  - Central in legislation
  - Central in nature conservation
  - Central in food industry
  - Central for our own survival










The need to be able to delimit and identify species

Are we currently able to read our biodiversity? The taxonomic impediment

- 10-50 M species globally
- <2 M species described so far
- Limited and biased expertise
- Most groups too difficult to delimit/identify by traditional means (example: gall midges 6K described vs. 2M estimated)
- The situation in Finland better because of many species experts and lower number of species
- Still, many important groups lack experts or are not manageable without **genetic tools**

Solution: DNA barcoding

THE ROYAL SOCIETY

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Accepted 30 September 2002
Published online 8 January 2003

Biological identifications through DNA barcodes

Paul D. N. Hebert*, Alina Cywinska, Shelley L. Ball and Jeremy R. deWaard

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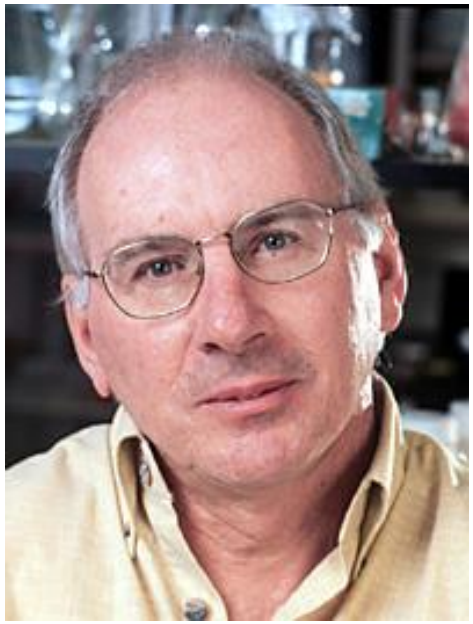
Although much biological research depends upon species diagnoses, taxonomic expertise is collapsing. We are convinced that the sole prospect for a sustainable identification capability lies in the construction of systems that employ DNA sequences as taxon 'barcodes'. We establish that the mitochondrial gene cytochrome *c* oxidase I (COI) can serve as the core of a global bioidentification system for animals. First, we demonstrate that COI profiles, derived from the low-density sampling of higher taxonomic categories, ordinarily assign newly analysed taxa to the appropriate phylum or order. Second, we demonstrate that species-level assignments can be obtained by creating comprehensive COI profiles. A model COI profile, based upon the analysis of a single individual from each of 200 closely allied species of lepidopterans, was 100% successful in correctly identifying subsequent specimens. When fully developed, a COI identification system will provide a reliable, cost-effective and accessible solution to the current problem of species identification. Its assembly will also generate important new insights into the diversification of life and the rules of molecular evolution.

Keywords: molecular taxonomy; mitochondrial DNA; animals; insects; sequence diversity; evolution



Planetary Biodiversity Mission

Canadian scientist's mission: Barcode every single species on earth

IVAN SEMENIUK - SCIENCE REPORTER
The Globe and Mail
Published Sunday, Aug. 09, 2015 9:38PM EDT
Last updated Sunday, Aug. 09, 2015 10:44PM EDT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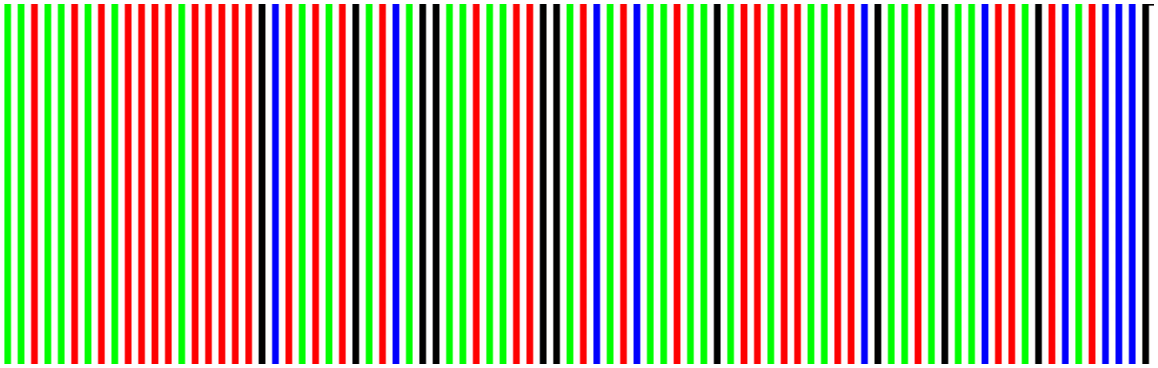


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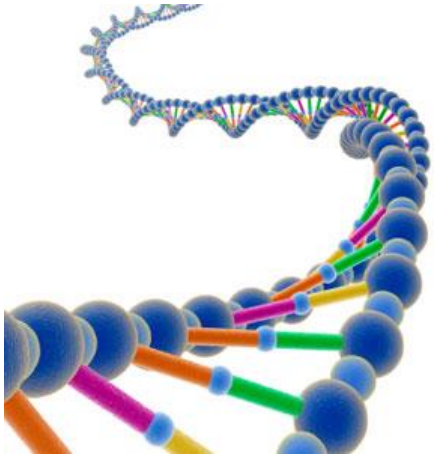
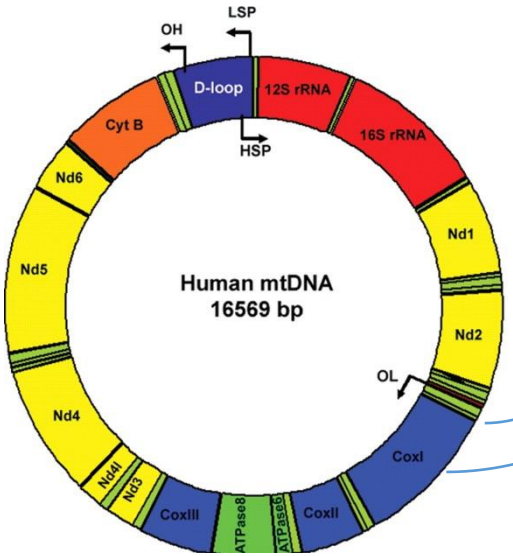
DNA barcode is a short standard region of the genome used to identify organisms into species





Nuclear genome: 3,2 billion bp in human

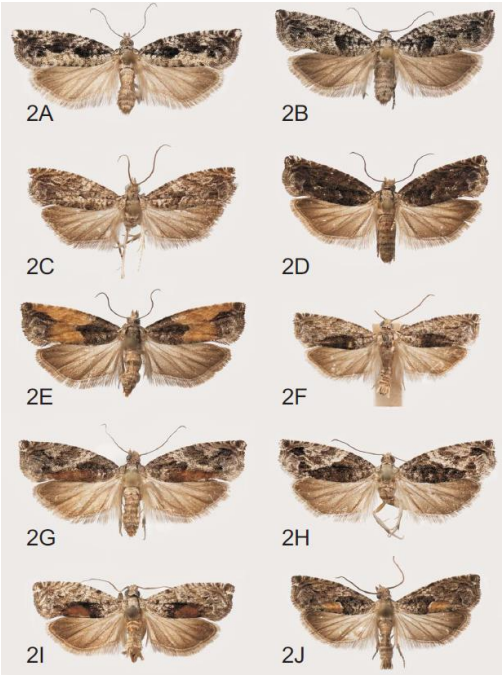
Mitochondrial genome: 16 600 bp in human

DNA barcode: 658 bp in human (4% of mtDNA, 0.00002 % of nuclear genome

In animals, the barcode is 658 bp fragment of *COI* gene

Benefits of DNA barcoding

- Works for fragments
- A single and same character used for all species
- Works for all stages of life
- Unmasks look-alikes
- Reduces ambiguity
- Speeds up species discovery and taxonomy
- Enables automatization of identification



MOLECULAR ECOLOGY
RESOURCES
Molecular Ecology Resources (2014) 14, 706–715 doi: 10.1111/1755-0998.12233

DNA barcode-based delineation of putative species: efficient start for taxonomic workflows

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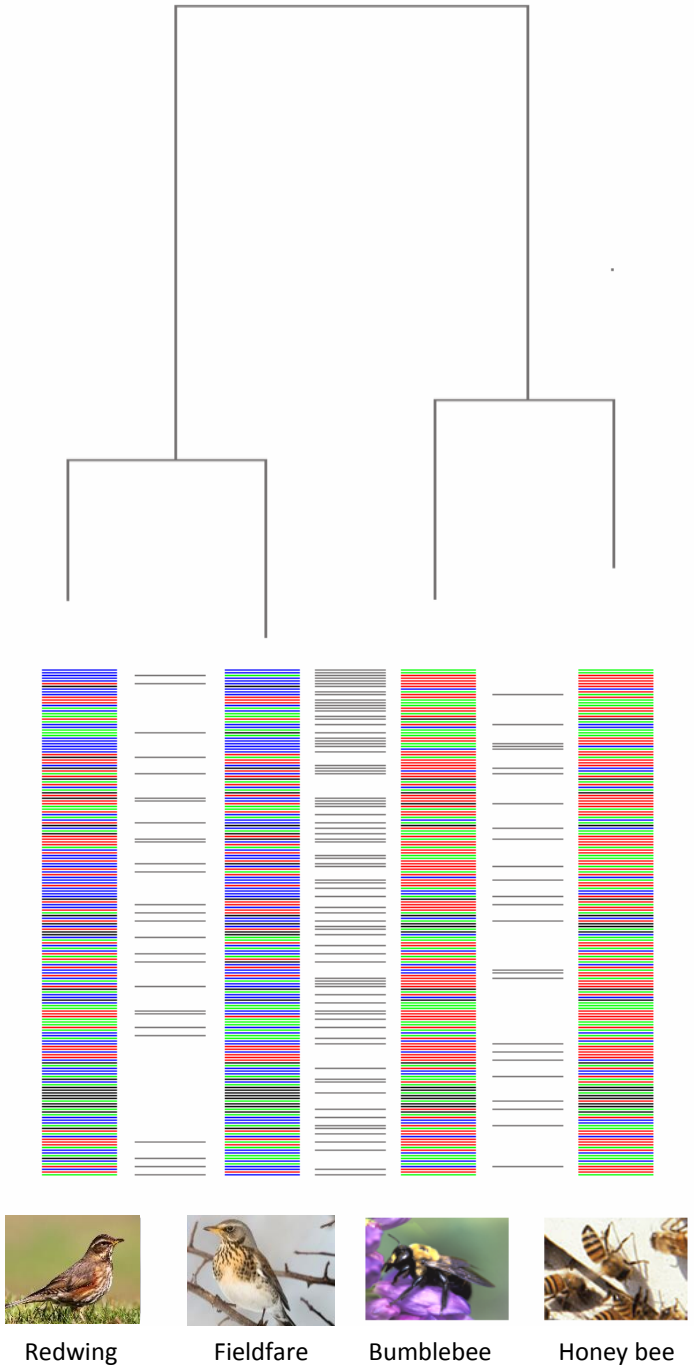
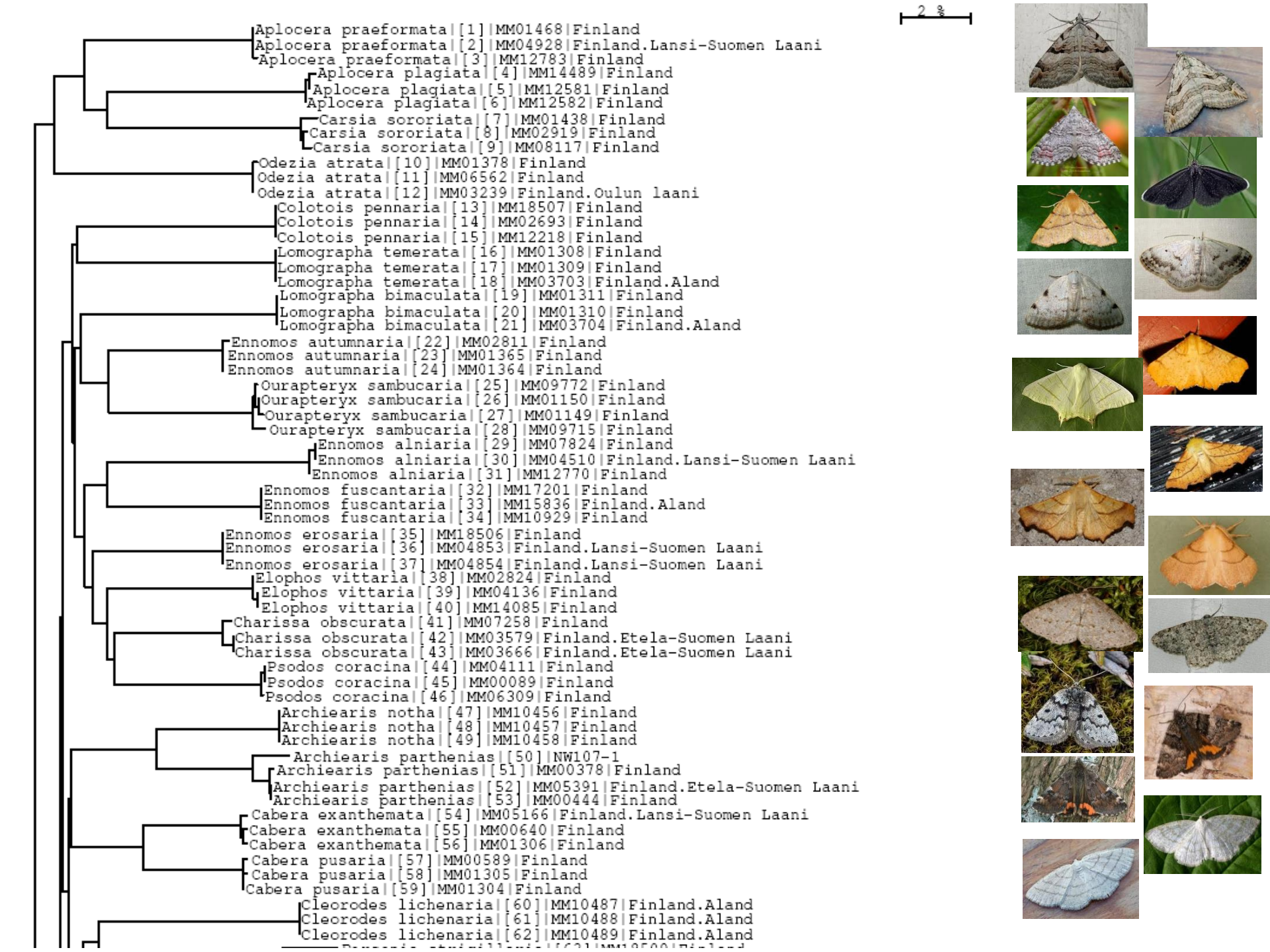
†Biodiversity Institute of Ontario, University of Guelph, Guelph, ON N1G 2W1, Canada

Do DNA barcodes work?

Yes, they do!




2 %
Aplocera praeformata|[1]|MM01468|Finland
Aplocera praeformata|[2]|MM04928|Finland.Lansi-Suomen Laani
Aplocera praeformata|[3]|MM12783|Finland
Aplocera plagiata|[4]|MM14489|Finland
Aplocera plagiata|[5]|MM12581|Finland
Aplocera plagiata|[6]|MM12582|Finland
Carsia sororiata|[7]|MM01438|Finland
Carsia sororiata|[8]|MM02919|Finland
Carsia sororiata|[9]|MM08117|Finland
Odezia atrata|[10]|MM01378|Finland
Odezia atrata|[11]|MM06562|Finland
Odezia atrata|[12]|MM03239|Finland.Oulun laani
Colotois pennaria|[13]|MM18507|Finland
Colotois pennaria|[14]|MM02693|Finland
Colotois pennaria|[15]|MM12218|Finland
Lomographa temerata|[16]|MM01308|Finland
Lomographa temerata|[17]|MM01309|Finland
Lomographa temerata|[18]|MM03703|Finland.Aland
Lomographa bimaculata|[19]|MM01311|Finland
Lomographa bimaculata|[20]|MM01310|Finland
Lomographa bimaculata|[21]|MM03704|Finland.Aland
Ennomos autumnaria|[22]|MM02811|Finland
Ennomos autumnaria|[23]|MM01365|Finland
Ennomos autumnaria|[24]|MM01364|Finland
Ourapteryx sambucaria|[25]|MM09772|Finland
Ourapteryx sambucaria|[26]|MM01150|Finland
Ourapteryx sambucaria|[27]|MM01149|Finland
Ourapteryx sambucaria|[28]|MM09715|Finland
Ennomos alniaria|[29]|MM07824|Finland
Ennomos alniaria|[30]|MM04510|Finland.Lansi-Suomen Laani
Ennomos alniaria|[31]|MM12770|Finland
Ennomos fuscantaria|[32]|MM17201|Finland
Ennomos fuscantaria|[33]|MM15836|Finland.Aland
Ennomos fuscantaria|[34]|MM10929|Finland
Ennomos erosaria|[35]|MM18506|Finland
Ennomos erosaria|[36]|MM04853|Finland.Lansi-Suomen Laani
Ennomos erosaria|[37]|MM04854|Finland.Lansi-Suomen Laani
Elophos vittaria|[38]|MM02824|Finland
Elophos vittaria|[39]|MM04136|Finland
Elophos vittaria|[40]|MM14085|Finland
Charissa obscurata|[41]|MM07258|Finland
Charissa obscurata|[42]|MM03579|Finland.Etela-Suomen Laani
Charissa obscurata|[43]|MM03666|Finland.Etela-Suomen Laani
Psodos coracina|[44]|MM04111|Finland
Psodos coracina|[45]|MM00089|Finland
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Archiearis parthenias|[51]|MM00378|Finland
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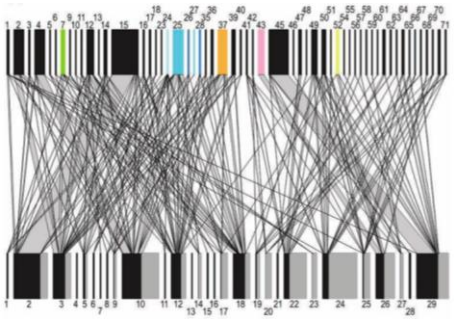
Cleorodes lichenaria|[62]|MM10489|Finland.Aland

Huge potential of metabarcoding

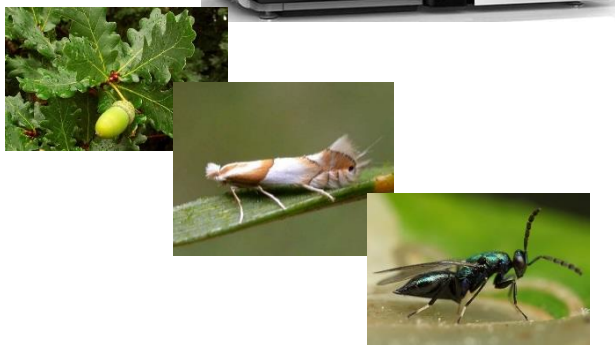


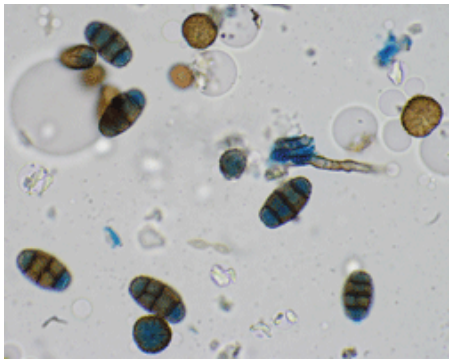
Ecological Entomology

Ecological Entomology (2010), **35**, 623–638 DOI: 10.1111/j.1365-2311.2010.01224.x

Revealing secret liaisons: DNA barcoding changes our understanding of food webs

RIIKKA KAARTINEN,[1] GRAHAM N. STONE,[2] JACK HEARN,[2] KONRAD LOHSE[2] and TOMAS ROSLIN[1]* [1]Metapopulation Research Group, Department of Biosciences, University of Helsinki, Helsinki, Finland, [2]Institute of Evolutionary Biology, The University of Edinburgh, The Ashworth Labs, Edinburgh, U.K.



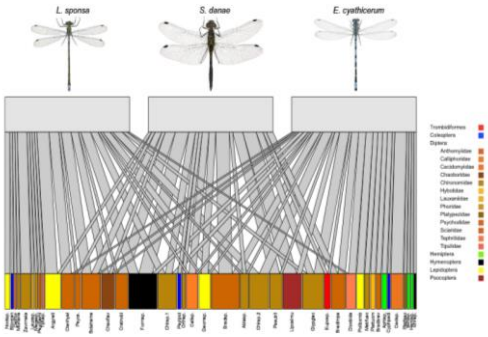


Ann Microbiol (2016) 66:495–498
DOI 10.1007/s13213-015-1118-x

SHORT COMMUNICATION

Effective detection of indoor fungi by metabarcoding

Helena Korpelainen[1] · Maria Pietiläinen[1] · Tea Huotari[1]



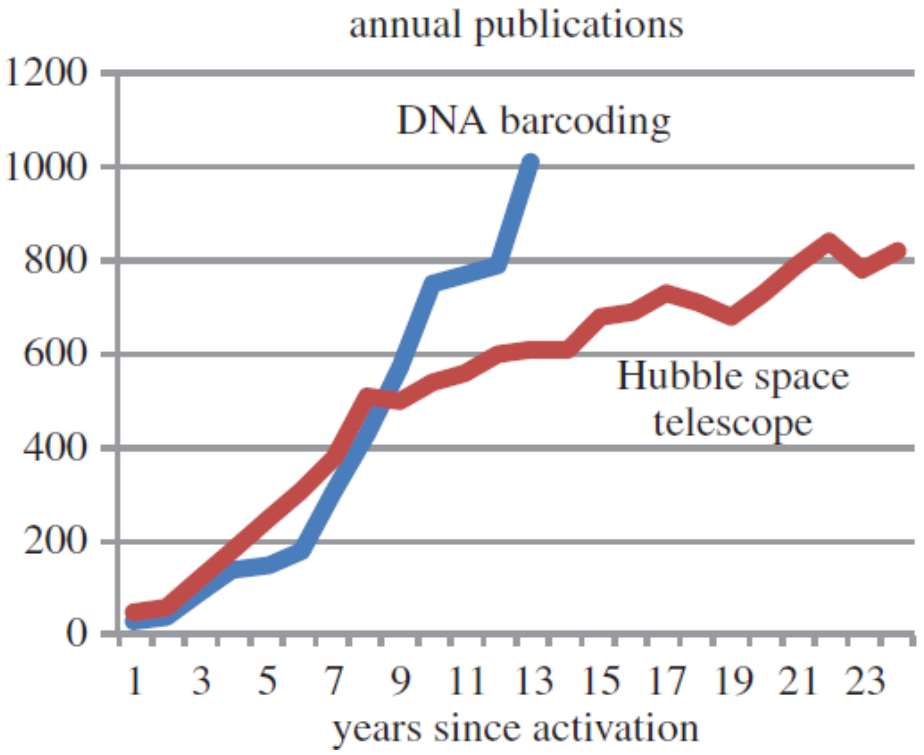
ORIGINAL RESEARCH

WILEY Ecology and Evolution Open Access

Pellets of proof: First glimpse of the dietary composition of adult odonates as revealed by metabarcoding of feces

Kari M. Kaunisto[1] | Tomas Roslin[2,3] | Ilari E. Sääksjärvi[1] | Eero J. Vesterinen[1,3]

The scientific breakthrough of DNA barcoding

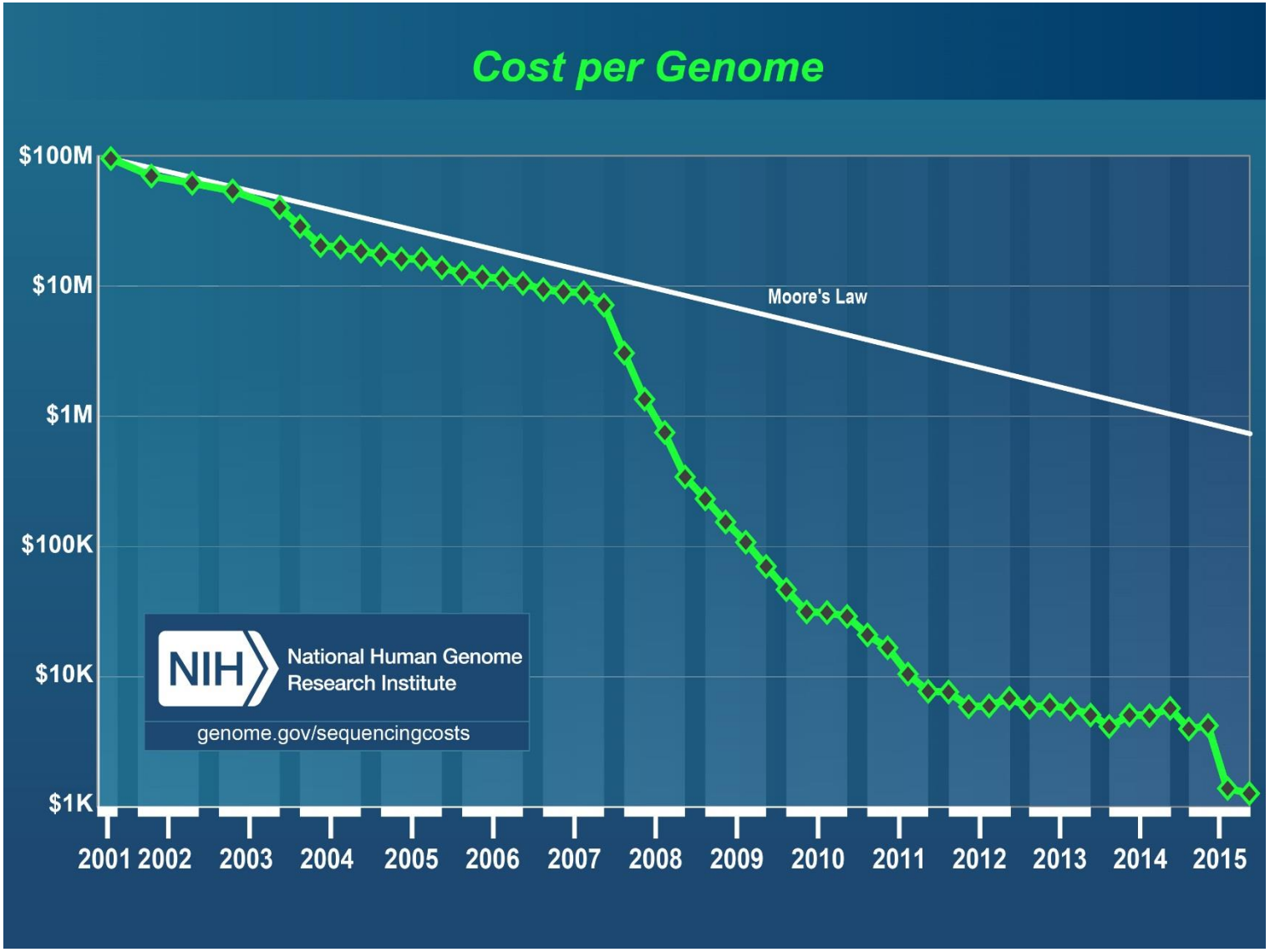


PHILOSOPHICAL TRANSACTIONS B

rstb.royalsocietypublishing.org

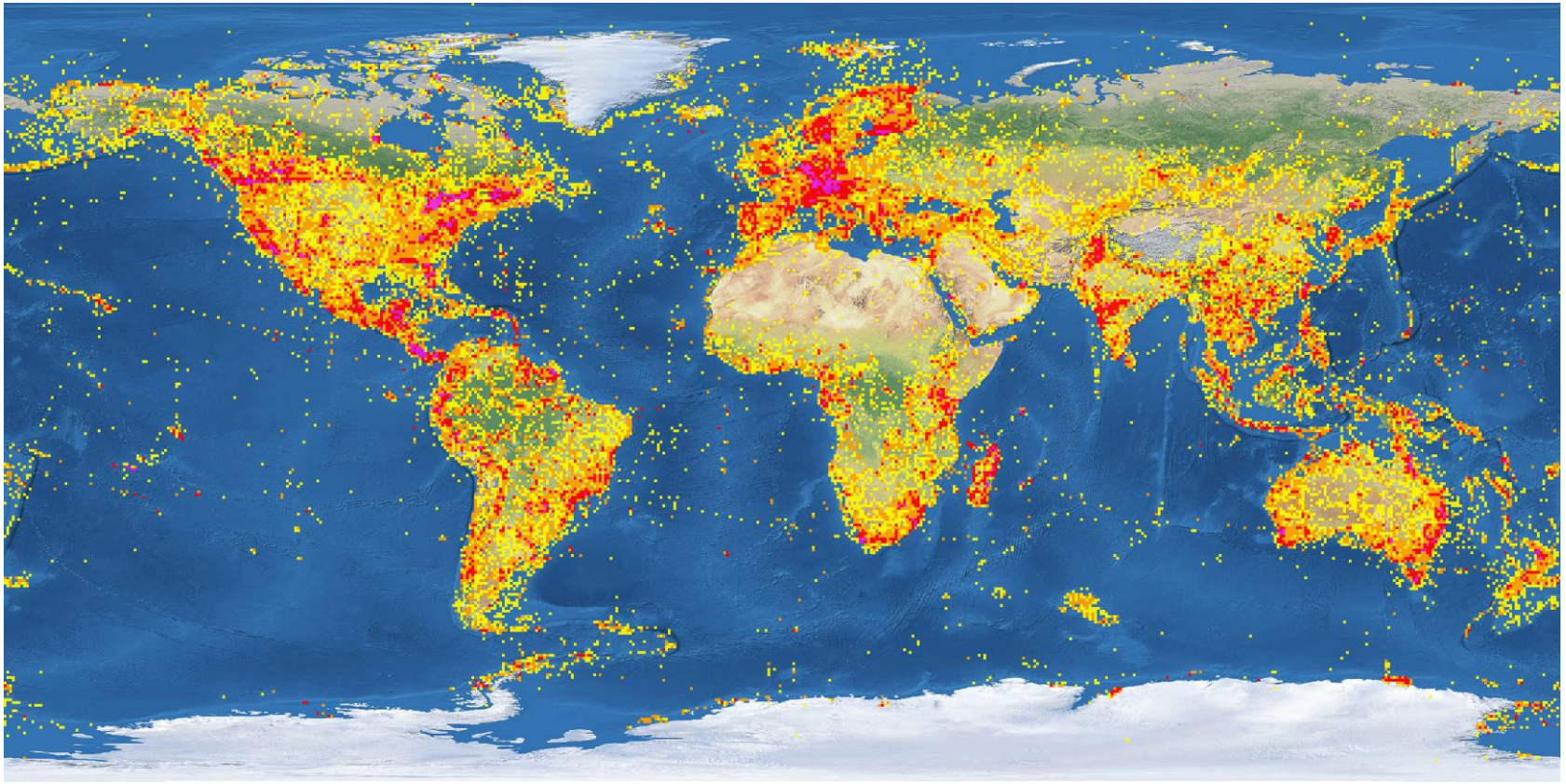
From writing to reading the encyclopedia of life

Paul D. N. Hebert[1], Peter M. Hollingsworth[2] and Mehrdad Hajibabaei[1]


Cost per Genome
$100M
$10M
$1M
$100K
$10K
$1K
Moore's Law
NIH
National Human Genome Research Institute
genome.gov/sequencingcosts
2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015

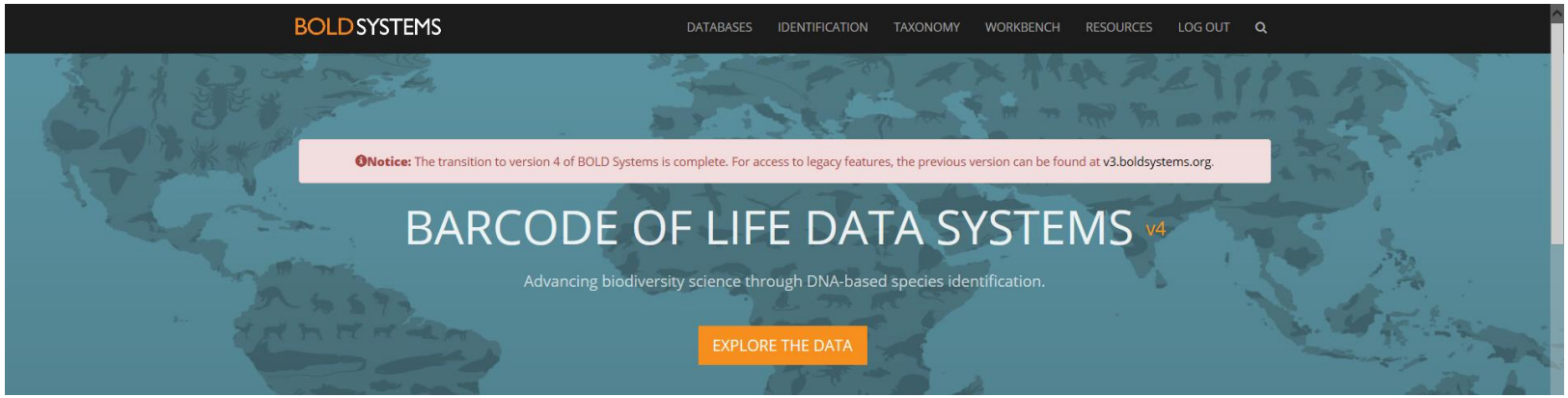
To enable identification by DNA barcodes, we must build a **reference library:**

- International (iBOL) and national (FinBOL) efforts



7,775,324	5,739,959	267,086
Specimen Records	Specimens with Barcodes	Species with Barcodes

The primary storage for DNA barcodes and associated metadata is the BOLD database (www.boldsystems.org)



- BOLD **specimen page** contains full collection and taxonomic data of each record, including photographs of voucher specimens
- BOLD **sequence page** contains full sequence information of each record, including sequences, trace files and laboratory information report

Finnish Barcode of Life and FinBIF

- Launch 2011
- Several funders
  - Finnish Cultural Foundation
  - Kone foundation
  - University of Oulu
  - Ministry of the Environment
  - International Barcode of Life project
  - **At present: Academy of Finland/FinBIF**

SUOMEN AKATEMIA

SUOMEN KULTTUURIRAHASTO

KONEEN SÄÄTIÖ

Ympäristöministeriö
Miljöministeriet
Ministry of the Environment

international BARCODE OF LIFE

UNIVERSITY OF OULU

Overview of barcoding progress in Finland (numbers based on collected in Finland or stored in Finnish Institutions)

- Specimens: **104,438**
- Specimens with Sequences: **90,597**
- Specimens with BINs: **75,097**
- Distinct BINs: **16,799**



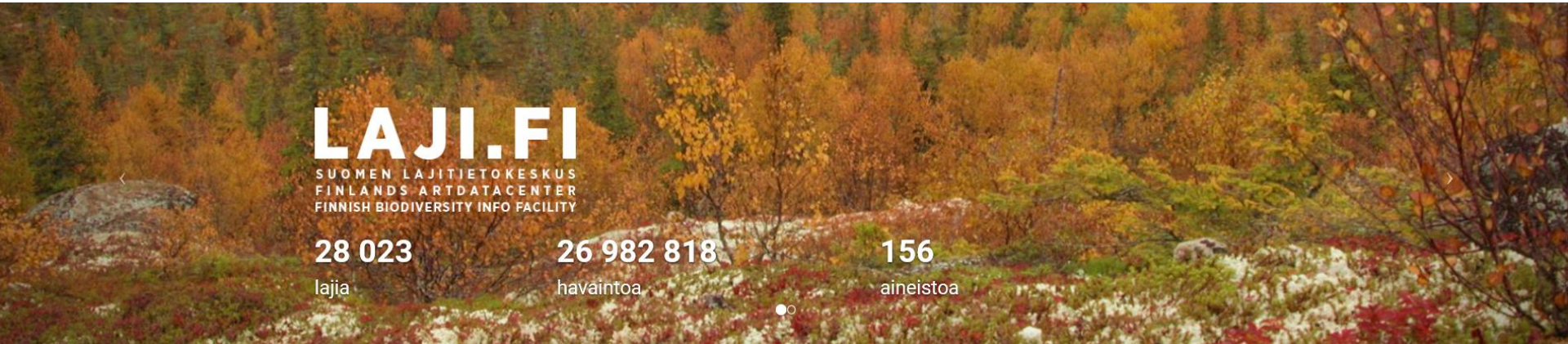



DNA barcoding and FinBIF

- Each species page in FinBIF will include data of associated Finnish (and foreign?) DNA barcodes

- FinBOL data will be uploaded to Kotka. Records on Kotka database will include links to the associated BOLD records

- A tool to search for DNA barcoding data (available in BOLD) of Finnish species (and higher categories?)



Imagine...

a world in which you can know the name of

This is the world that iBOL will build

iBOL *International Barcode of Life Project*
Assembling the DNA barcode library of life