



Barcode Long Island

DNA Barcoding and Biodiversity

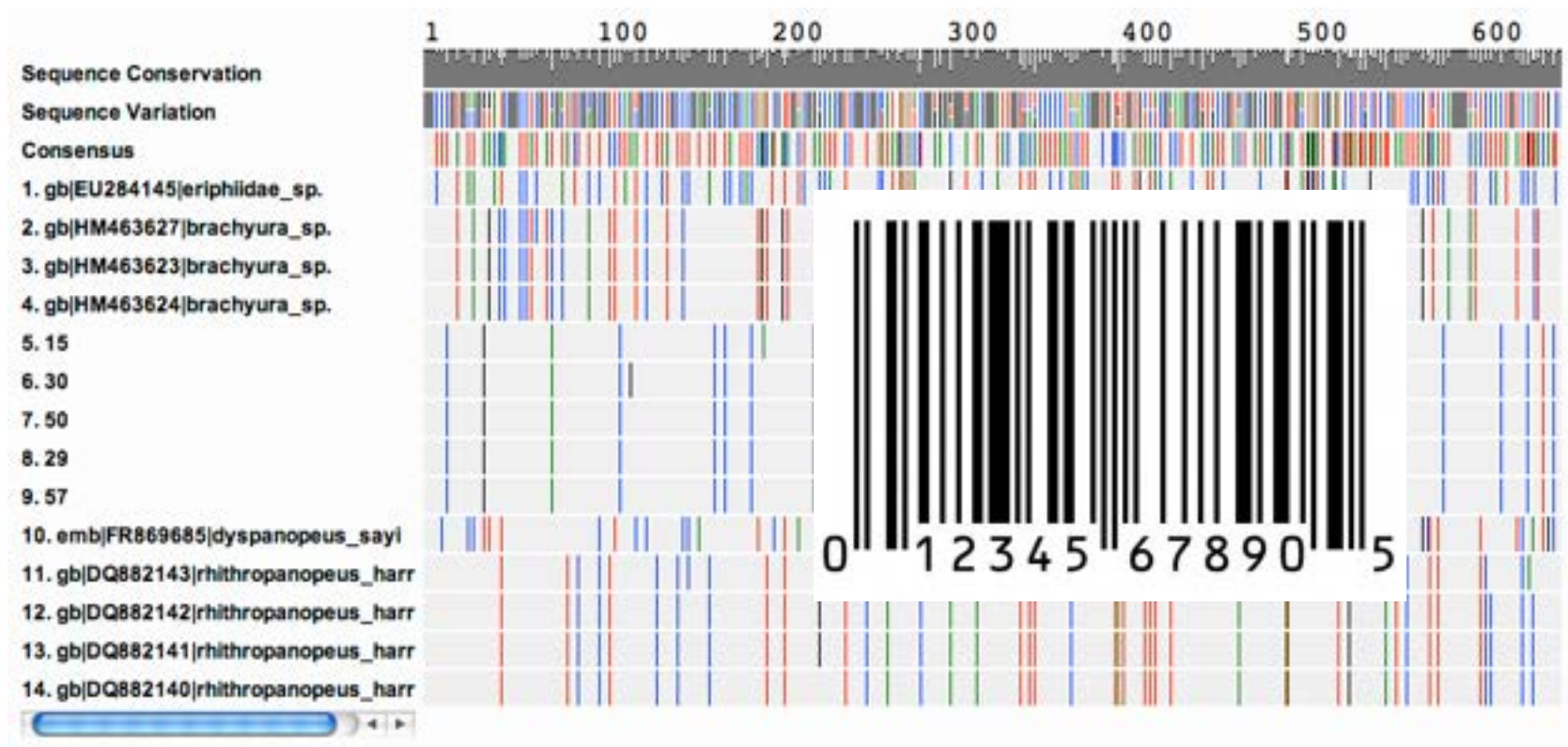
Campaigns and Independent Projects

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DNA Barcoding

- DNA barcoding allows for identification of organisms using their DNA.





DNA barcoding lends itself to studies involving

biodiversity and species identification

Biodiversity

- The variety of living things in a given area or environment



Biodiversity

- **What is species diversity?**
 - Describes the number of different kinds of organisms within a community or ecosystem.
- **How many species are there?**
 - Currently 1.7 million species identified
 - Estimates range between 3-50 million
 - Recent data support an estimate of 4 to 6 million insect species alone.
 - Invertebrates make up 65% of all known species, and probably most of yet to be discovered species.

Benefits of Biodiversity

- **Ecological Benefits**
 - Soil formation
 - Waste disposal
 - Air and water purification
 - Nutrient cycling
 - Solar energy absorption
- We do not fully understand biological communities. *Loss of a seemingly insignificant species can be damaging.*

Benefits of Biodiversity

- **Food**
 - Wild plants could provide new sources of food or more genetic diversity for existing crops
- **Drugs and Medicines**
 - More than half of all modern medicines contain some natural product from a wild species
 - Pharmaceutical companies actively prospect tropical countries for products
 - \$30 billion/year!

Accelerating Extinction Rates

- We are currently in the 6th extinction
 - Worst species die-off since the dinosaurs 65 million years ago
 - 99% of currently threatened species are at risk from human activities

TABLE 5.1 | Estimated Number of Species

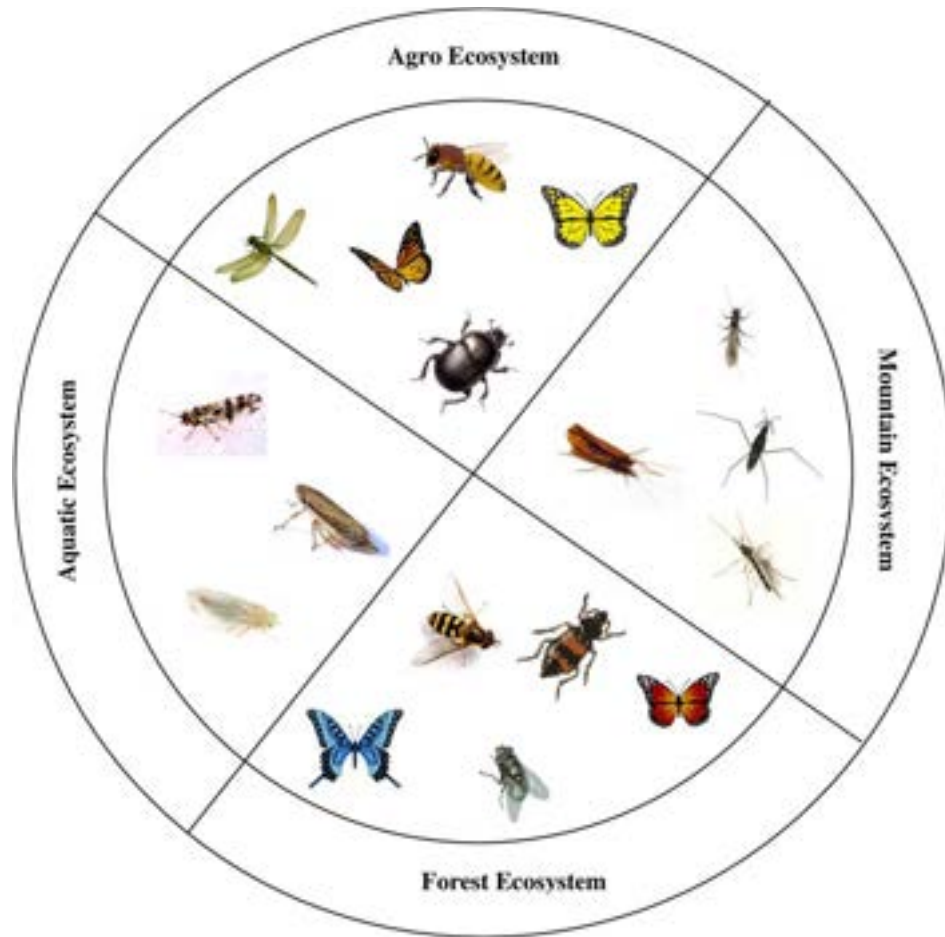
CLASS	NUMBER DESCRIBED	NOT YET EVALUATED ¹	PERCENTAGE THREATENED ²
Mammals	5,491	0%	21%
Birds	9,998	0%	12%
Reptiles	9,084	82%	28%
Amphibians	6,433	2%	30%
Fishes	31,300	86%	32%
Insects	1,000,000	100%	27%
Mollusks	85,000	97%	45%
Crustaceans	47,000	96%	35%
Other invertebrates	173,250	99%	30%
Mosses	16,236	99%	86%
Ferns and Allies	12,000	98%	66%
Gymnosperms	1,021	11%	35%
Flowering Plants	281,821	96%	73%
Fungi, Lichens, Protists	51,563	100%	50%

¹Evaluated by IUCN for threatened status.

²Number of species as a percentage of those evaluated. Includes IUCN categories critically endangered, endangered, or vulnerable.

SOURCE: IUCN Red List, 2012

Insects as Bioindicators



Bioindicators – organisms whose presence or absence can inform us about ecosystem health

Species Identification

Identification of living things is not trivial...

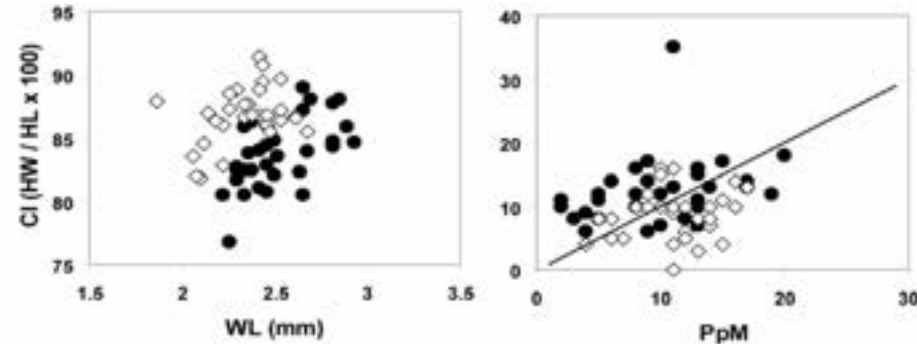
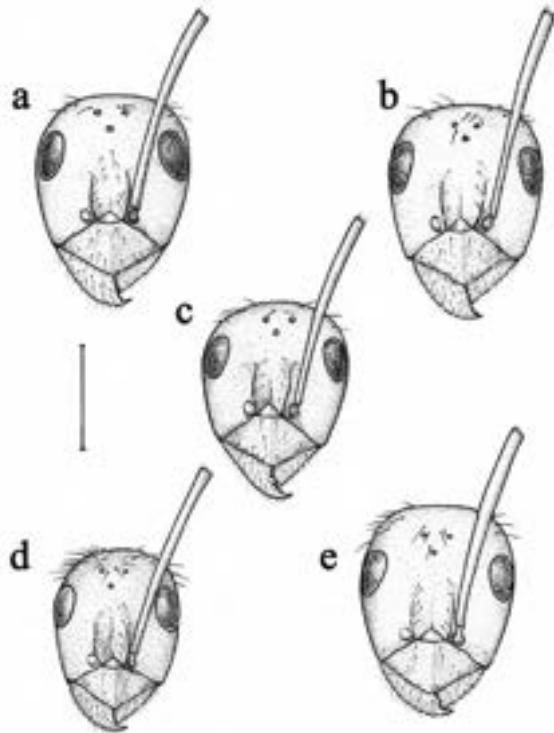
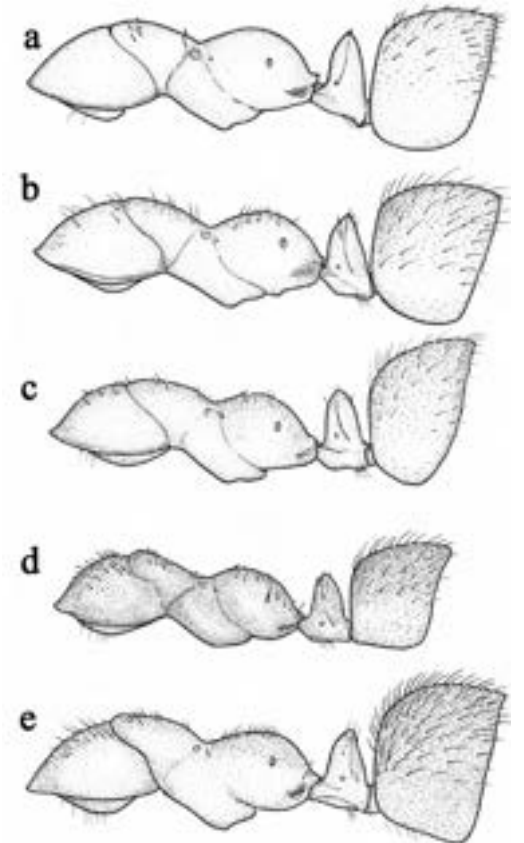


Figure 2. Morphological differences between *F. biophilica* and *F. incerta*: a) *F. biophilica* (closed circles) generally has a longer mesosoma (WL) relative to head proportions than *F. incerta* (open diamonds). b) Whereas *F. biophilica* rarely has more macrochaetae on the propodeum than the pronotum (12 of 32 specimens), this is more often the case for the *F. incerta* (22 of 31). The line indicates the relationship $PnM = PpM$.



Adding to the complexity: *immature, damaged, or incomplete specimen may make identification impossible.*

Species Identification

Complex terminology!

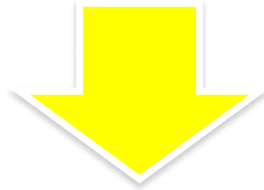
Take this family diagnosis:



The body form ranges from hemispherical (e.g., *Cleidostethus*) to elongate oval (e.g., *Clypastraea*) to latridiid-like (e.g., *Foadia*). Corylophids are typically dull brown, but some species have contrasting yellowish-brown patches on the pronotum or elytra. The integument is often densely punctured and may be glabrous or bear short, fine recumbent setae. Most corylophid adults can be diagnosed using the following morphological features: Maxilla with single apical lobe; Mesotrochanter short and strongly oblique; Head usually covered by pronotum; Frontoclypeal suture absent; Antennae elongate with 3-segmented club; Procoxal cavities closed externally; Tarsal formula 4-4-4; Pygidium exposed

Diagnosis: *an articulated list of characters that defines a particular taxonomic group*

Leaves alternate proximally, opposite and ultimately decussate distally, 6–16 × 4–13 cm; petiole ca. as long as blade, winged, base clasping, basal lobes stipulate, growing as extensions of wings, less than 1 mm wide; blade 5–7-veined, ovate, glabrous, base typically sagittate, margins entire, apex acute to acuminate. Staminate inflorescences axillary, 1–2 per axil, paniculate, fasciculate; panicles bearing flowers singly, bracteolate, in a zigzag pattern along rachis, internodes less than 2 mm; rachis to 25 cm, secondary axes 1–3(–6), fasciculate, less than 3 cm, each subtended by deltate-ovate bracteole shorter than 1 mm. Pistillate inflorescences solitary, 4–8(–20)-flowered, 6–35 cm, internodes ca. 1 cm



>Dioscorea alata (matK) gene, partial

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ATTTAAATTATGTGTCAGATATATTAATACCCCATCCCATCCATCTGGAAATCCTGGTTCAAATACTTCAATGCTGGACTCAAGATGTTTCCTCTT  
GCATTTATTGCGATTCTTTCTCCACGAATATCATAATTCGAATAGTTTCATTACTCCGAAAAACCTATTTACGTGATTTCAATTTCAAAGAAAAAT  
AAAAGATTTTTTCGATTCCTATATAAATCCTATGTATTTGAATGTGAATTTGTATTAGTTTTTTTTTCATAAGCAATCCTCTTATTTACGATCAAGGTC  
CTCTGGAGTCTTTCTTGAGCGAACACATTTCTATGGAAAAATGGGGCATTTTTTAGTAGTGTGTTGAATTATTTTCAGAAGACCCAATGGTCTT  
CAAAGATCCTTTCTGCATTATGTTGATATCAAGGAAAAGCAATCTGGTGTCAAAGGGAACCTCGTCTTTTGATGAGGAAATGGAGATCTTACC  
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ATTTGGATATTATTCATCGATTTGGTTGGATATGTAGAA
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Complex and somewhat objective

Simple (A,T,G, or C) and more objective

DNA Barcoding Workflow



Organism is sampled



DNA is extracted



“Barcode” amplified

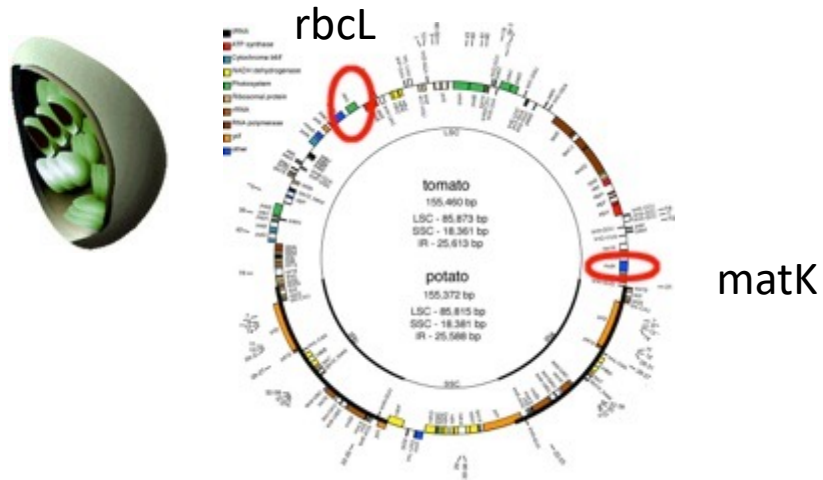
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ACGAGTCGGTAGCTGCCCTCTGACTGCAT  
CGAATTGCTCCCCTACTACGTGCTATATGC  
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GCTGCTAGCTGCTCCCTTATTCGATAACTA  
GCTCGATTATAGCTACGATG
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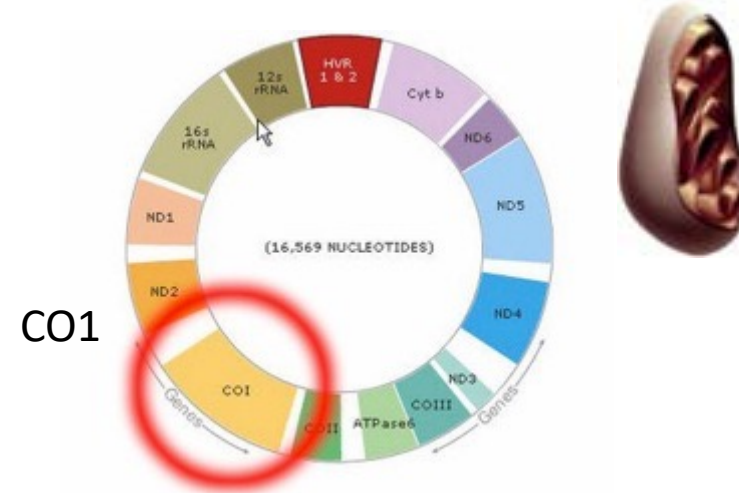
Sequenced DNA is compared with a barcode database

Genes with the right number of differences

Plants: Chloroplast

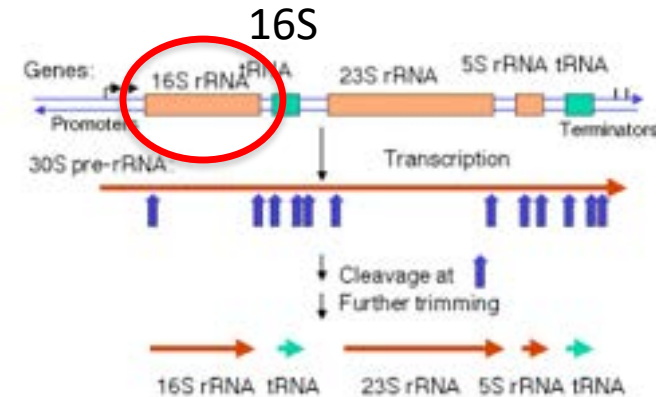


Animals: Mitochondrion



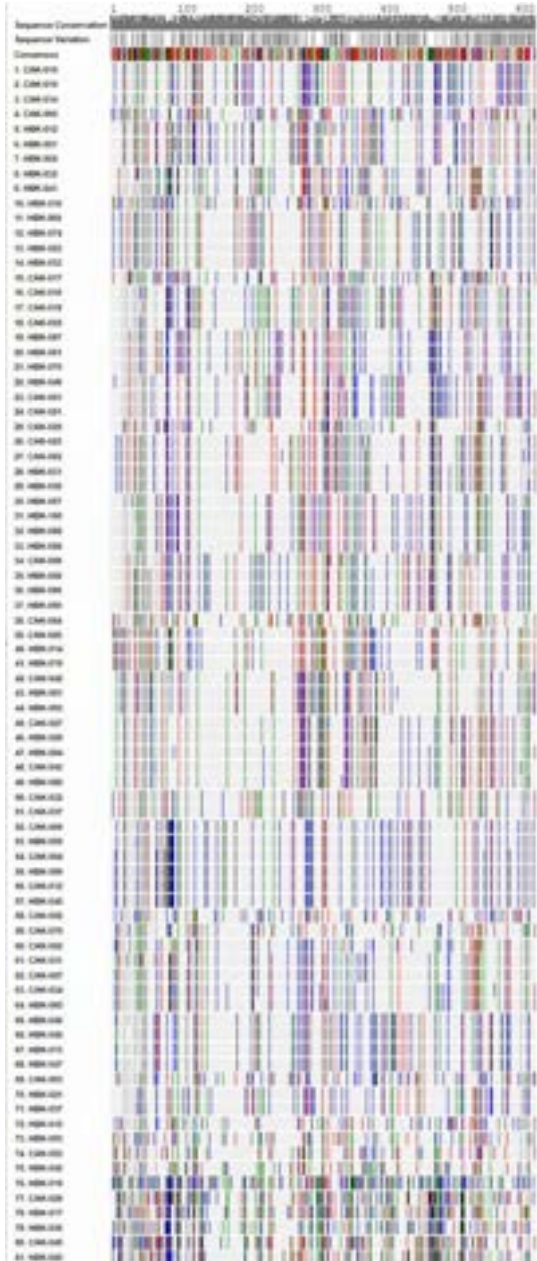
Fungi, Bacteria: Nucleus

Fungal ribosomal RNA transcribed unit



Species Identification

DNA Barcoding is a way quicker way to identify the species living in an area and just about anyone can do it, almost anywhere!



Species Diversity vs. Genetic Diversity

While we are ultimately using variation in DNA to ID a species, BLI projects should focus on **species diversity**

Linking an environmental mutagen to mutation (leading to variation in DNA) is difficult and should not be the focus of BLI studies

AKA: ***avoid genetic diversity*** studies...

Species Abundance vs. Species Diversity

Species abundance – the population size of a species in an area

Out of 20 samples, finding that half of the barcodes match one species *is not* a strong measure of *abundance*

Focus on **species diversity** – abundance can be measured through observation or other means