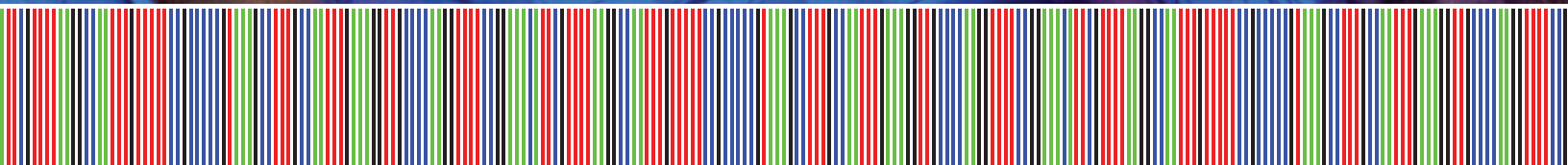


Barcoding life





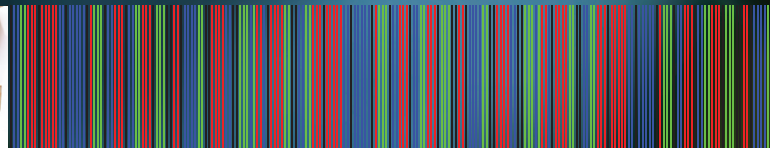
Highlights 2015

We envision a world where anyone can identify any species, on the spot, in an instant, anywhere on the planet. Yet scientists estimate that at least 80 per cent of living species are still unknown. Many of our Earth's species are at risk of extinction unless decisive actions are taken. The question is: how can we preserve what we don't know?

All around the world, the DNA barcode research community is generating a network that will offer the capability to examine entire biotic systems. Together, scientists are creating innovative and exciting achievements that also have socio-economic implications.

This report highlights the efforts of ongoing international DNA barcoding research from iBOL participant countries that are revolutionizing our capacity to monitor and understand the world's biodiversity.

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DNA barcoding



Technology

Seafood identification assay: A portable probe technology using DNA barcoding offers a fast, accurate and easy method to verify seafood samples. Developed by PhD student Amanda Naaum, the InstantID Blue Crab test has been commercialized through the University of Guelph-InstantLabs partnership as a portable seafood identification assay. Based on the Hunter® system (which targets DNA to detect and analyze a wide variety of food samples), suppliers, distributors and others will use this portable technology to help fight against seafood fraud and misidentification.

Transforming human health: Misidentified cell lines cost the American economy up to \$25 billion annually and have continuously troubled the scientific community. In response, the ATCC Standard Development Organization is moving forward with DNA barcoding as the standard method for identifying cell lines. The draft will be available for public review in September to October for 45 days. To obtain a copy of the draft when it comes out for public review, contact standards@atcc.org.

Herbal product assay: Herbal products are often mislabeled, inadvertently or purposefully. To eliminate guesswork, a novel DNA mini-barcode assay, developed at the New York Botanical Garden, has been created to validate the authenticity of a popular herbal product, ginkgo biloba (*G. biloba*). Ginkgo is a dietary herbal supplement that is sold to consumers to allegedly boost cognitive capacity. Using the assay, researchers were able to confirm that nearly 84 per cent of ginkgo supplements were properly labelled.

Education

Student-friendly BOLD: The University of California, San Diego, offers students curriculum that will allow them to barcode species found in San Diego County. Funded by the National Science Foundation and in collaboration with the Biodiversity Institute of Ontario, the project aims to engage students in providing new information to the Barcode of Life Data System (BOLD). One project included barcoding the abundant bloodworm species found on the Scripps Coastal Reserve, to determine how many species there were. Surprisingly, the results showed that they all belonged to one species, *Thoracophelia mucronata*.

Engaging youth: The School Malaise Trap program is a national program in Canada that engages students and educators, giving them a glimpse into the work of biologists using DNA barcoding. Participating schools receive various educational materials, including a malaise trap to collect insects in their schoolyard. Since its inception in 2013, the School Malaise Trap program has worked with over 230 schools and has collected nearly 10,000 species. Using BOLD's BIN analysis, BIO determined that of that 10,000 species collected, 1041 were previously undiscovered.

DIY barcoding: Community-supported DNA barcoding workshops are growing around the world. In the UK, the Manchester Digital Laboratory's MadLab provides workshops to citizen scientists on the science behind DNA barcoding, offering procedures such as the "Mystery Meat Experiment" that teach them how to conduct PCR and gel electrophoresis analyses to investigate food fraud. In Amsterdam, the Waag Wetlab workshops offer simplified DNA barcoding experiments, teaching those who attend the basic concepts behind molecular biology.

DNA barcoding—rapid, efficient, and digital—is changing the way we see the world. It's a new frontier in scientific discovery.



Publication

New to the game: Handheld DNA barcoding devices have arrived just in time to fight food fraud. Kapa Biosystems, a life science reagent supplier based in Massachusetts, has developed enhanced DNA polymerases and technologies that eliminate time-consuming DNA purification and speed up PCR protocols. The company has also gained attention for its \$100,000 Foodborne Pathogen Genome Project, which aims to create the world's largest public database of foodborne pathogen genomes.

Identifying black-marketed CITES species: Illegal trade of Convention on International Trade in Endangered Species (CITES) species could be curtailed with DNA barcoding. A recent CITES case report released from Pakistan shows researchers using DNA barcoding to determine a smuggled turtle species, *Lissemys punctate* (Indian flap-shelled turtle). In Nepal, the National Trust for Nature Conservation and government are coordinating to introduce DNA barcoding to help investigate and convict illegal wildlife traders, with the help of funding by the Smithsonian Institute in the United States.

Rapid food identification: Using DNA barcoding, researchers in the UK found three new kinds of mushrooms that had never been officially labeled in science – in a London grocery store. The researchers extracted the DNA and employed molecular-based “turbo-taxonomy” to identify the species, using a combination of modern tools and approaches. The three species of mushroom in question came from a commercial packet of dried Chinese porcini. Their discovery of the new species suggests that mushrooms are much more diverse than previously believed.

Community

Cooperative species observation: The Norwegian Biodiversity Information Centre launched The Species Observation reporting system in 2008, utilizing the unique cooperation of NGOs, government agencies, and volunteers. Open to professionals and amateur citizen scientists, the service has an average of 5,000 new entries each day. The system is based on a Swedish system called Artportalen. In early 2014, the system recorded its 10-millionth sighting, making it the third largest of its kind in the world.

Global collaboration: The Centre for Synthesis and Analysis on Biodiversity, run by the French Foundation for Research on Biodiversity, promotes research advancements in biodiversity. The program has recently won a three-year grant for a consortium, including 12 scientists from five countries (UK, Switzerland, Canada, USA and France), to carry out a global-scale macroecology analysis of Wild Silkmoths (Saturniidae) and Hawkmoths (Sphingidae), including creating a DNA barcode database.

World forests: The Center for Tropical Forest Science's Forest Global Earth Observatory is a global network of forest research plots and scientists dedicated to tropical and temperate forest research. It consists of 61 forests across the Americas, Asia and Europe. A new study published revealed that 28 of their sites are utilizing DNA barcoding to help identify plants and animal species.

To protect and understand the diversity of life, we must be able to identify and understand the species and ecosystems upon which humans, our industry and our lifestyle depend.



Discovery and Advancements

Barcode library advancements: Building open access barcode libraries of species around the world has become one of the main activities of the DNA barcoding community. German researchers have provided the largest DNA barcoding library for Coleoptera (beetles) in the world, adding more than 3,500 identified species to BOLD. In Europe, researchers have built a DNA barcode library of over 1,000 species of European Lepidoptera (moths and butterflies). In Malaysia, researchers are currently building a DNA barcode library of Lepidoptera found in the Peninsula Malaysia.

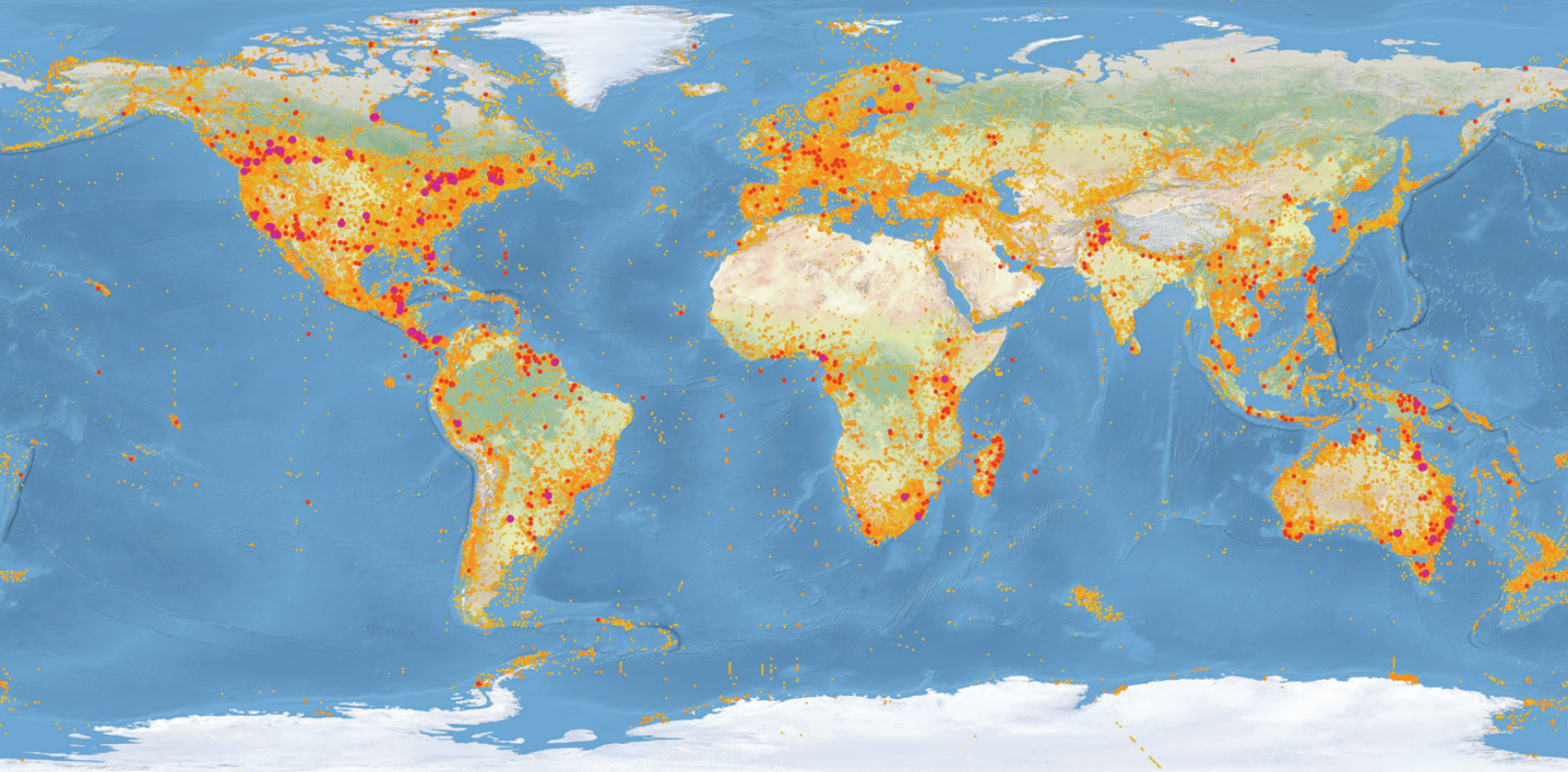
Can of worms? Scientists have raised eyebrows in the ecotoxicological community, as a recent study conducted in Germany shows earthworms commonly used in ecotoxicological testing are much more diverse than previously thought. An international consortium of five DNA barcoding laboratories examined what was thought to be the earthworm species *Eisenia fetida*, used at 28 ecotoxicological labs in 15 different countries across four continents. The results showed that only 17 of the 28 laboratories were actually working with the genus *Eisenia*.

The future of DNA sequencing: Deep sequencing — that is, DNA sequencing without prior polymerase chain reactions (PCR) — is producing data with fewer errors than PCR-based barcoding. In a study using deep sequencing, Chinese researchers developed a next-generation sequencing system without PCR amplifications, producing fewer false positives. In a similar study, Chinese and UK researchers compared the results of a mitogenomics (sequencing of the entire mitochondrial sequence) system without PCR, to that of PCR-based metabarcoding, which combines DNA identification with high-throughput sequencing. Their results showed that PCR-based metabarcoding is more error prone, suggesting that mitogenomics could reduce laboratory workload, sequencing errors and possible contamination risks of PCR-based methods.

Uncovering secrets of extinct animals: The extinct moa, an iconic flightless New Zealand bird, has challenged researchers for over 100 years. With minimal morphological, physiological or behavioral information to work with, it's difficult to understand this elusive creature. Australian researchers using DNA barcoding techniques have determined that two species of the six genera comprising the moa were likely part of the genus *Eurapteryx*, with possibly some subspecies. Their results support the proposition that the two species may have existed during the Holocene era.

Follow the buzz: Honey bees are proving to be great research assistants. A new study conducted by The Ohio State University shows using DNA metabarcoding provides innovative pollen DNA analyses. Their methodology has resulted in higher sensitivity and resolution, and identified twice as many plant families as the traditional microscopic analysis of the same pollen samples. This technology allows opportunities in pollination biology, authentication of apicultural products and insights into bee foraging behaviour.

Invasive alien species: Euphresco, a network of UK organizations that organize research projects in phytosanitary measures, is creating an analytical European and Mediterranean Plant Protection Organization DNA barcoding protocol that will identify plant pests and invasive alien species. Recent collaboration between the United Nation's Convention on Biological Diversity (CBD) and the University of Guelph has trained invasive alien species experts worldwide. CBD funded 20 participants for an online training course, of which 10 were selected for hands-on training at BIO.



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The International Barcode of Life (iBOL), launched in 2010, is the world's largest biodiversity genomics project. iBOL's main mission is to expand upon a barcode reference library—Barcode of Life Data Systems (BOLD)—that will provide a geographic and taxonomic coverage of all known species on Earth. With wide-ranging implications and an international research alliance, iBOL's aim is to have built a reference library of five million standardized DNA sequences, which will be able to identify 500,000 species, by 2016.

Funding organizations

Action transversal du Museum, France
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 Bayerisches Staatsministerium für Wissenschaft, Forschung und Kunst, Germany
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 Canada Foundation for Innovation, Canada
 Chinese Academy of Sciences, China
 CONABIO (Comisión Nacional Para El Conocimiento y Uso de la Biodiversidad), Mexico
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