CONSORTIUM FOR THE BARCODE OF LIFE

Barcode of Life Initiative

http://barcoding.si.edu www.dnabarcodes.org

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Conference organizers and other experts are available for advance interviews. High-resolution photos, together with abstracts of research to be presented, are online for media preview at http://staging.enilsson.com/medres/default/. The conference, at Academia Sinica, Taipei, takes place Sept. 18-20; for details: www.dnabarcodes2007.org

DNA Barcodes:

Burgeoning Field Seen Offering Major Advances in Public Health, Species Protection, Agriculture, Environmental Quality, More

Consumer Protection, Food Safety, Disease-Bearing Insects Among Top Concerns as Global Experts Meet in Taipei

About 350 DNA barcoding experts from 46 nations will converge in Taipei amid spiralling interest from health officials, government agencies and others beginning to realize potential applications in a range of areas – from consumer protection and food safety to disease prevention and better environmental monitoring.

Specifically, this burgeoning three-year-old scientific field could, among many other things, help get illegal fish and timber out of global markets, slow the spread of invasive pests, reduce bird-plane collisions, and uncover the hideouts of medically-important species of mosquito.

Government agencies, particularly in North America but elsewhere as well, are expanding investments in applications for the new technologies that identify and distinguish known and unknown species ever more quickly, cheaply, easily and accurately based on snippets of DNA code.

The science has grown from a single research paper in 2003 to a burgeoning global enterprise in 2007, led by the Consortium for the Barcode of Life (CBOL) with 160 member organizations from 50 countries (up from 42 member organizations from 18 countries in 2005).

In 2005, there were 33,000 records covering 12,700 species in the Barcode of Life Data Systems (BOLD) at the University of Guelph, Canada. Today over 290,000 records have been banked, representing over 31,000 species, and data accumulate at an accelerating pace (see www.barcodinglife.org/views/taxbrowser_root.php).

During the 2nd International Barcode of Life Conference (Taipei, Sept. 18-20), experts will assess progress and global priorities, share latest insights and techniques among the swelling ranks of interested scientists and officials, and air views on a host of questions swirling around the new scientific field.

Says conference organizer David Schindel, Executive Secretary of the CBOL, based at the Smithsonian Institution, Washington, D.C.: "Taxonomists have documented a small portion of the world's plant and animal species over the past 300 years; DNA barcoding adds a fast, objective and repeatable approach to this enormous task that can shift the enterprise into a higher gear."

"Barcodes can document and confirm known species while uncovering lots of hidden variation, some of which may lead to the description of new species."

"Presenters at the Taipei conference will show how barcoding is expanding our knowledge of nature and is simultaneously providing tangible, specific and significant benefits to society. The good science coming out of the barcoding community is helping governments to produce wise policies and well-informed regulations."

Hot Topics Include Consumer Protection

Hot topics for the barcode researchers, policy-makers and government regulators involve consumer, agricultural, health and environmental protection.

For example, researchers will report having DNA barcoded all 689 species listed in *World Economic Plants: A Standard Reference*, a prelude to testing the identity and purity of plant-based medicines and herbals.

Government agencies are seizing the potential of barcoding for improved regulation. In the USA alone, for example:

□ The National Oceanic and Atmospheric Administration envisions several potential barcode data uses, such as:

- More reliable identification of catch and by-catch on commercial vessels and at the dock;
- Better understanding of the food chain through analysis of gut contents; and
- Improved fish stock assessments, based on identification of larvae as well as juveniles and adults;

□ The Food and Drug Administration (FDA) has been working with CBOL to generate barcodes for economically relevant and potentially hazardous fish species. CBOL has provided samples of authenticated fish specimens that are in the FDA Regulatory Fish Encyclopedia (RFE) (www.cfsan.fda.gov/~frf/rfe0.html), and barcodes have now been generated for most of these samples. An accurate barcoding method would improve species identification, which is essential in determining associated hazards, addressing economic fraud issues, and aiding in food-borne illness outbreak investigations.

"Says Dr. Schindel: "Substituted, mislabeled fish offered fraudulently in supermarkets and restaurants may be endangered species or can result in health problems – toxic pufferfish sold as something else, for example, or aqua-cultured species that might contain high loads of controlled chemicals. Barcoding could help close important markets to fish illegally caught and marketed."

□ The Environmental Protection Agency is testing barcoding to identify insects and other invertebrates in rivers and streams, critical indicators of environmental quality.

□ The Department of Agriculture is helping develop a global database of DNA barcodes for fruit flies, an important agricultural pest. Without an objective way to identify and exclude potential pests, decisions made by port inspectors could be challenged and lead to strained trade relations.

Trade of endangered timber species may also be halted by using barcodes to identify processed wood and lumber products.

Among those most excited about barcoding technology are researchers concerned with biosecurity and agricultural quarantine issues.

□ In the medical field, a European leech used in some modern surgical procedures has been approved by the Food and Drug Administration as a prescription medical device. Accurate knowledge and labelling of the bioactive compounds involved relies on precise species determination. But DNA barcoding shows some leeches marketed as *Hirudo medicinalis* are in fact other leech species, findings that impact regulatory statutes and raise concerns for the conservation status of European medicinal leeches.

□ The U.S. Federal Aviation Authority and U.S. Air Force are supporting bird barcoding as it may help reduce bird-aircraft collisions.

According to Carla Dove of the Smithsonian Institution: "Knowing which birds are most often struck, and the timing, altitude and routes of their migrations, could avert some of the thousands of annual collisions between birds and aircraft, military and civilian."

All birds of North America are now barcoded, and progress on the birds of other regions will be presented in Taipei.

Barcoding mosquitoes

Prominent human health-related efforts include barcoding several thousand species of mosquito – including insects responsible for up to 500 million human malarial infections and 1 million deaths each year. As well as malaria, mosquitoes transmit many other devastating diseases as well, such as West Nile and Dengue, and worms.

"Key to disease management is vector control," says scientist Yvonne-Marie Linton of The Natural History Museum, London, and leader of the Mosquito Barcoding Initiative (MBI). However, control efforts are consistently undermined by species misidentification, and DNA barcoding can tremendously assist the world's remaining expert mosquito taxonomists struggling to keep up with new species discoveries, she adds.

Mosquitoes: Anopheles gambiae, the world's worst malaria vector. Obtain photo and others in high-res at *http://staging.enilsson.com/medres/default/*

The MBI was created to provide freely accessible, high quality DNA sequence data to inform and facilitate systematic studies. Its goal: to sequence within two years about 2,800 – some 80% – of the almost 3,500 recognized mosquito species.

Researchers elsewhere worldwide are focused on barcoding other

biting insects – blood-sucking pests to birds, to people and other mammals alike – causing diseases, stress and allergic reactions. To date, barcodes have been completed for some 1,600 specimens of black flies from all over the world, revealing 154 species. Other biting insects being barcoded include deer flies, horse flies, stable flies, tsetse flies, midges and sand flies.

Fungi / Mushrooms

Though known to be essential for life on Earth, scientists say some 90-99% of fungi remain undocumented – a diversity that could be revealed through DNA barcoding. Potential projects include identifying airborne fungi, including mycotoxin producers, global trade-related fungi travelers, boreal forest fungi and medically important fungi.

Biodiversity

A standardized library of barcodes will enable more people to identify species -- whether abundant or rare, native or invasive – engendering appreciation of biodiversity locally and globally.

Researchers at the Taipei conference will show how barcoding can illuminate local and global biodiversity. Moorea, an island in French Polynesia, has become a laboratory where a French – U.S. collaboration is building a barcode library for all terrestrial and marine species. Sphingid moths are found around the world, and the first global barcode survey of the group will be presented in Taipei.

"The importance of this work to conservation is particularly critical to developing strategies to preserve highly different genetic entities or species -- to enable the species identification of eggs, larvae and tissues," noted conference chair Kwang-Tsao Shao, from the Academia Sinica.

"Asia is a region of high diversity but relatively poor documentation of that diversity," he added. "Barcoding is a perfect collaboration between molecular techniques and traditional taxonomy, and practical, cost-effective way to both study this under-explored region and protect its biodiversity. That's why Asians were proud to host this conference and eager to attend."

Barcoding the extinct

Questions and research to be aired by presenters at the conference also include:

- How well might barcoding work with tiny, damaged, old and even ancient specimens? DNA barcoding is expected to identify illegally-obtained wildlife species and wildlife-derived products based on fragments and poorly preserved samples. Researchers will describe DNA barcoding species thought to be extinct, (e.g. moas, an extinct bird species from New Zealand). To enable such identifications, other researchers will report on a new 7-enzyme cocktail that repairs DNA damaged by ultra-violet light, oxidation, heat and other factors.

- What should be the balance between building the reference library of barcodes of species already known to science and using barcoding to discover possible new species?

- What insights into evolution might arise as the barcode database grows toward a million barcode records, expected within a few years? What patterns might we discern that will help us to understand exactly how evolution and speciation occur at the molecular level?

The Astonishing Growth of a New Species of Science

The 2nd International Barcode of Life Conference in Taipei will reveal remarkable progress by the Barcode of Life Initiative since the first such conference, at the Natural History Museum, London, in February, 2005.

Barcodes are in hand for about 20% of the world's estimated 10,000 bird species, and about 10% of the estimated 35,000 marine and freshwater fishes. An emerging international research network plans barcode coverage of more than 500,000 species of all kinds within five years.

Technologies and processes available today can identify a species through its DNA within a few hours at a cost of less than US $2. Scientists believe that process will soon be shaved to mere minutes and a few pennies using new, highly-portable technologies such as DNA microchips, massively parallel sequencers and microfluidic systems.

Two North American "barcode factories" (at the Smithsonian Institution, Washington D.C., USA, and the University of Guelph, Canada) are now able to produce hundreds of thousands of barcodes per year. Meanwhile, a new network of 17 "Leading Labs" has been created to share and disseminate barcoding information and offer training.

Outreach meetings have been organized in southern and eastern Africa, and in South/Central America. CBOL has also worked to build collaboration with marine scientists, evolution and bioinformatics researchers and others.

Barcoding has important connections to major initiatives in biodiversity research. A regular flow of academic papers document the expanding the use of DNA barcodes in taxonomy, ecology, biogeography, and applications such as forensics.

Presenters in Taipei will predict new science and technology that experts expect to see at the 3rd International Barcode Conference, planned for 2009.

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Taipei presentation abstracts in the spotlight
(please see http://staging.enilsson.com/medres/default for full abstract texts):

- Tom Evans, USA: repairing DNA with chemical cocktails
- Dan Faith, Australia: using DNA distances for systematic conservation planning;
- David Lambert, New Zealand: DNA barcoding extinct birds of New Zealand, Sacred Ibis mummies from Egypt;
- Si-Min Lin, Taiwan: Applying barcodes to improve conservation in the tropical fish trade (e.g. armored catfish);
- Charlie Chang Liu, Hong Kong: DNA barcoding Chinese medicinal plants;
- Santiago Madrinan, Colombia: DNA barcoding a large, complex plant group (Lauraceae, Laurels, including cinnamon, avocado, and sassafras);
- Tadeusz Malewski, Poland: DNA barcoding carrion fly-maggots, police forensics
- Robert Anderson: extending DNA barcoding into single-celled organism research.

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Barcode of Life Initiative (BoLI) is an international movement of researchers, research organizations, and users who are dedicated to developing DNA barcoding as a global standard for species identification. BOLI is:

- Creating a global reference library of diagnostic barcode sequences for identifying species;

- Engaging with government agencies, private companies, and other potential users of DNA barcode data to launch new barcoding projects;
- Creating tools for a cost-effective, rapid system of species identification that can be used by non-specialists;
- Adding 21st century diagnostic molecular data to the defining characteristics (morphology, ecology, behavior, geography) now used to identify biological species; and
- Expanding the toolkit used by taxonomic researchers as they improve our understanding of global biodiversity.

For more information: (www.dnabarcodes.org)

The **Consortium for the Barcode of Life (CBOL)** is an international initiative hosted by the Smithsonian Institution in Washington, DC. CBOL is the principal organizer of the Second International Barcode of Life Conference in Taipei and is supporting the development of DNA barcoding by promoting:

- Global standards for DNA barcode data and the laboratory protocols used to obtain barcode data;
- Participation of all countries in BOLI, especially biodiversity rich but under-resourced developing countries;
- Rapid compilation of high-quality DNA barcode records in a public library of DNA sequences;
- Opportunities to apply barcoding and barcode data to new areas of biological research;
- Development of new instruments and processes that will make barcoding cheaper, faster, and more portable;
- Formation of partnerships and networks of researchers and potential users, and
- The use of DNA barcoding for the benefit of science and society.

For more information: (http://www.barcoding.si.edu)