



DNA Barcoding: A New Tool for Identifying Biological Specimens and Managing Species Diversity

DNA barcoding has inspired a global initiative dedicated to:

- Creating a library of new knowledge about species diversity,
- Making that knowledge accessible, and
- Applying that knowledge to create tangible benefits.

www.dnabarcodes.org



■ Conservation and Development Rely on Knowledge of Biodiversity

The biological diversity of each country is a valuable and vulnerable natural resource. Sampling, identifying, and studying biological specimens are among the first steps toward protecting and benefiting from biodiversity. Knowledge about biodiversity and the ability to identify organisms that comes with it, are global public goods. That is, this knowledge can create benefits for all countries - benefits that no one country can create by itself.

“Each Contracting Party shall, as far as possible and as appropriate, in particular for the purposes of [conservation and sustainable use]:

- Identify components of biological diversity...
- Monitor, through sampling and other techniques...
- Maintain and organize, by any mechanism, data derived from identification and monitoring activities...”

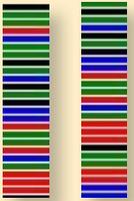
- 1993 Convention on Biological Diversity (CBD), Article 7

“Taxonomic research as specified in the Global Taxonomy Initiative, should not be prevented, and providers should facilitate acquisition of material for systematic use and users should make available all the information associated with the specimens thus obtained.”

- 2002 Bonn Guidelines of the CBD, created to provide guidance to countries in the development of access and benefits sharing regimes



■ DNA Barcoding: Documenting Biodiversity with a Gene Sequence



“DNA barcoding” is an exciting new tool for taxonomic research. The DNA barcode is a very short, standardized DNA sequence in a well-known gene. It provides a way to identify the species to which a plant, animal or fungus belongs. The Consortium for the Barcode of Life (CBOL) is promoting international partnerships that will enable people in all countries to better understand and protect their biodiversity.

■ A Global Library of DNA Barcodes

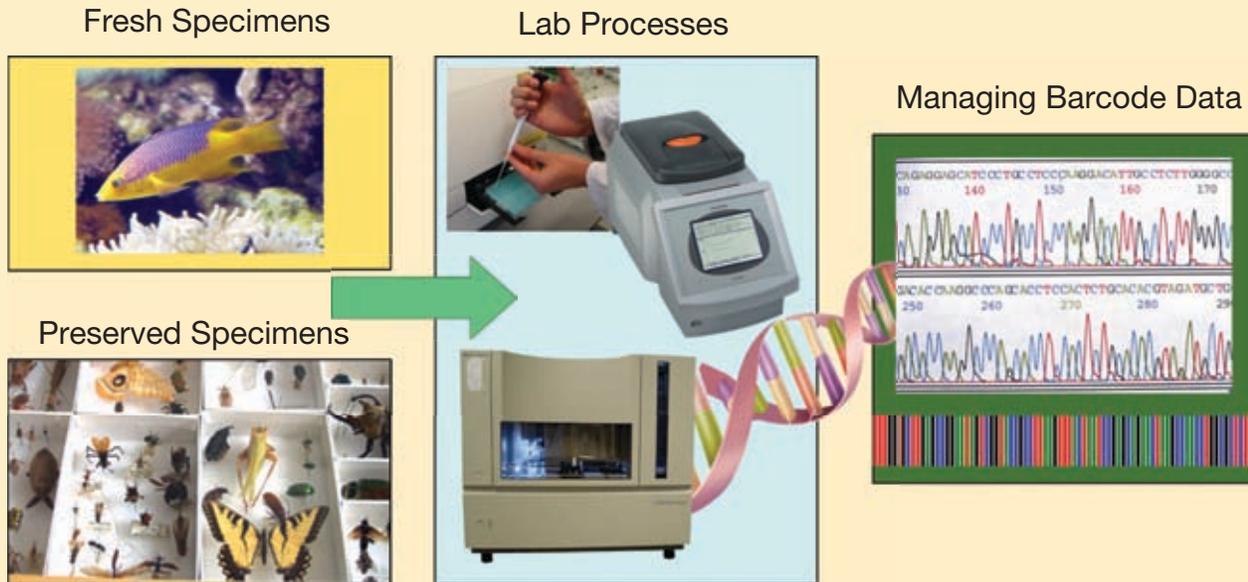
Barcoding is generating a global, open access library of reference barcode sequences which enables non-taxonomists to identify specimens. The barcode of an unidentified specimen can be compared with the reference barcodes to find the matching species.

Barcoding projects have already generated hundreds of thousands of reference barcodes for tens of thousands of species. These species have been selected because they are of special interest to users who need the ability to identify species of scientific, economic, or social importance. The Consortium for the Barcode of Life is creating partnerships among government agencies, local researchers, and NGOs that design and implement the highest priority barcoding projects.

■ How is DNA barcoding done?

The DNA barcode of an unidentified specimen can be read using standard gene sequencing techniques. DNA barcoding includes three types of activities:

- Working with organisms: Collecting, identifying, and preserving voucher specimens in secure repositories
- Laboratory procedures: Sampling and processing tissue from specimens to obtain DNA barcode gene sequences
- Managing data: Sharing the DNA barcode sequence and data about its voucher specimen in a public database



■ How much of the total genome of an organism is in a DNA barcode?

The DNA barcode sequence includes about 650 DNA “base-pairs” (represented by the letters A, C, G and T). That’s a tiny portion of the billions of base pairs that make up the entire genome of many organisms. Barcoding is done with a well-known gene, not a newly discovered gene. It is used for identifying specimens, not for biomedical purposes such as developing pharmaceuticals.



■ How much does it cost to barcode a specimen? How long does it take?

The laboratory process costs between US\$2 and \$5 in most well-equipped labs, and less than US\$2 in some cases. It takes a few hours in most laboratories and can now be done in as little as 90 minutes. The costs are constantly decreasing and the barcoding process is getting faster. In the coming years, barcoding will probably cost pennies and take only minutes.

■ Uses and Global Benefits of DNA Barcoding

DNA barcoding can help to achieve many of the Millennium Development Goals (MDGs) and reach the objectives of the Convention on Biological Diversity.

Controlling Agricultural Pests: Lessening Poverty and Hunger (MDG 1)

Pest damage to agriculture costs farmers the equivalent of billions of US dollars each year. DNA barcoding can identify pests in any life stage, making it easier to control them. The global Tephritid Barcoding Initiative will contribute to the management of fruitflies and will provide border inspectors with tools to identify and stop fruitflies at the border. Ensuring pest-free trade will guarantee better access to global markets.



Identifying Disease Vectors: Combating Diseases (MDG 6)

Many of the most serious human and animal infectious diseases such as malaria are transmitted through vector species. DNA barcoding enables non-taxonomists to identify these vectors, thereby helping to understand and curb disease-carrying pests and pathogens. A global Mosquito Barcoding Initiative is building a reference barcode library that can assist public health officials to control this important disease vector more effectively and with less reliance on insecticides.

Environmental Sustainability (MDG 7 and CBD Objective):

Sustaining Natural Resources

Over-harvesting of natural resources such as fish and hardwood trees is leading to species depletion, extinction and the economic collapse of industries that rely on them. Natural resource managers and regulators can monitor the illegal trade of processed products using barcoding. Reference barcode libraries are being constructed for fish (FISH-BOL) and hardwood trees (TreeBOL), with the goal of improving the management and conservation of these natural resources.



Protecting Endangered Species

Hunting for bushmeat has reduced primate populations by 90% in some parts of Africa. Law enforcement can use DNA barcoding to distinguish bushmeat in local markets obtained from endangered species, thereby contributing to the conservation of biological diversity. A DNA barcoding initiative for conservation has recently been launched, with the goal of creating a barcode library for critically endangered species.

Monitoring Water Quality

Drinking water is rapidly becoming a precious resource. The health of lakes, rivers and streams is often measured by studying the organisms living in them. DNA barcoding is being used to document these indicator species that can otherwise be difficult to identify. Environmental agencies can use barcoding to improve their water quality assessments, and to create and enforce better policies that ensure sustainable supply of safe drinking water.



■ Frequently Asked Questions

What benefits would my country gain from DNA barcoding?

- The ability to identify specimens quickly and cheaply,
- Better ability to control the movement of species across national borders,
- Opportunities for training of local students and researchers,
- Involvement of local researchers in global networks and biodiversity initiatives, and
- Opportunities to improve the national research infrastructure of specimen collections, molecular biology labs, and biodiversity databases.

What is a voucher specimen and why is it necessary to keep them long-term?

The voucher specimen provides the DNA from which the barcode is determined. It is the critical link between the reference barcode sequence and the name of that species, so identifying it correctly is critical. It is often necessary to go back to the voucher specimen to check the identification, and for that reason voucher specimens need to be stored in museums, herbaria, culture collections, and other secure repositories.

What kinds of lab equipment are required to do DNA barcoding?

Most of the equipment needed for the barcoding process is widely available. New barcoding facilities are being established around the world for less than US\$50,000 each. The final step in the process, DNA sequencing, requires larger, more expensive equipment. As equipment costs continue to fall, access to facilities is becoming very easy.

What if we want to do barcoding but do not have the necessary facilities?

The Consortium for the Barcode of Life (CBOL) is helping researchers without access to the necessary equipment to develop partnerships with research institutes that have these facilities. CBOL is also assisting some researchers establish new in-country barcoding facilities.

Can we conduct a barcoding project if we do not have taxonomic experts or collections of voucher specimens?

No single country has all the necessary taxonomic expertise and reference collections. They are distributed around the world and every country depends on experts and specimens in other countries for research. Barcoding operates the same way. CBOL is dedicated to organizing barcoding initiatives around the world, and virtually all of them involve international partnerships.

How can we participate in DNA barcoding initiatives?

CBOL has already launched a variety of barcoding projects and continues to assist in planning new initiatives. New participants are welcome to join at any time. All that's needed is a willingness to collaborate in an international research network and share barcode data. Information on these initiatives is available on the CBOL website (www.barcoding.si.edu). CBOL projects adhere to national laws concerning prior informed consent and mutually agreed terms for the collection and movement of biological specimens.



www.dnabarcodes.org

BOLI is a global initiative with many partners and supporters, among them



Working in support of the Global Taxonomy Initiative of the Convention on Biological Diversity



Convention on
Biological Diversity

Relevant Resources on DNA Barcoding

BOLD website: www.Boldsystems.org

Consortium of the Barcode of Life: www.barcoding.si.edu

FISH-BOL: www.fishbol.org

Tephritid Fruitfly Initiative: <http://www.barcoding.si.edu/tbi.html>

Relevant Resources on Access and Benefits Sharing

CBD website (Bonn Guidelines and the CBD, GTI, and ABS National Focal Points): www.cbd.int/
Swiss Academy of Sciences: Access and Benefit Sharing - Good Practice for Academic Research:
<http://abs.scnat.ch>

For more information please contact:

Consortium for the Barcode of Life Secretariat Office

CBOL is an international initiative hosted by the Smithsonian Institution and supported by the Alfred P. Sloan Foundation. As of early 2008, CBOL had over 170 Member Organization from more than 50 countries.

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