DNA BARCODING AND THE CONSORTIUM FOR THE BARCODE OF LIFE

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INTRODUCTION

Approximately three years ago, "DNA barcoding" was proposed as a rapid and cost-effective method for identifying species using a very short gene sequence from a standardized position in the genome (Hebert et al., 2003). The "barcode region" would have to evolve at a rate that would distinguish species from each other while remaining more or less identical for all members of the same species. It would also have to be flanked by conserved regions so as to make polymerase chain reaction (PCR) amplification practical, and would have to be relatively free of insertions and deletions for easy alignment. The mitochondrial gene cytochrome c oxidase 1 (COI) seems to meet these criteria extremely well for most eukaryotic animals. Kress et al., (2005) have proposed two barcode regions for plants, and there are efforts underway to find a barcode region (or regions) that will work across all land plants.

DNA BARCODING IN TAXONOMIC RESEARCH AND BIODIVERSITY STUDIES

DNA barcodes is proving to be a valuable tool that complements and enhances traditional taxonomic research in three ways. First, most species descriptions rely on adult morphology. Diagnoses can be extremely difficult for immature life stages. In highly dimorphic species it is difficult to associate the males and females of the same species. Since DNA barcoding requires only a small amount of DNA, all the life stages and sexual morphs of a species can be united under a comprehensive species concept.

Second, DNA barcoding provides a lens through which hidden variation is being found. Barcode data is uncovering new and cryptic species that were overlooked or were only suspected on the basis of morphological characters. Using COI data, Hebert et al. (2004a) found suggestions of 10 cryptic species within what had been considered a single widespread species of skipper butterfly. Caterpillar coloration, host plant preferences and other ecological data proved to be consistent with the species delimitations suggested by DNA barcode data. Hebert et al. (2004b) used COI data to uncover previously overlooked cryptic species of North American birds.

Third, barcode data are proving useful in the search for new species in poorly known taxonomic groups, especially those that lack distinctive morphological traits (Blaxter et al., 2005). By using barcode data for the preliminary sorting of specimens, taxonomists can begin to make sense of difficult groups. Taxonomists are using different data types sequentially, in different orders, with the goal of constructing integrative species descriptions that rely on a variety of data types (e.g., genetic, morphologic, ecologic).

APPLYING DNA BARCODING TO SOCIETAL PROBLEMS

DNA barcodes can be invaluable in situations where rapid, accurate and cost-effective specimen identification is needed for regulatory or legal reasons. Border control agents often encounter eggs, larvae, damaged or incomplete specimens, and processed products which are difficult or impossible to identify using traditional taxonomic procedures. For example, barcoding can support efforts to protect endangered species (e.g., primates and other protected species endangered by bushmeat hunting), and control invasive and pest species (Armstrong and Ball 2005) and disease vectors.

THE CONSORTIUM FOR THE BARCODE OF LIFE

The Alfred P. Sloan Foundation has granted $669,000 to the Smithsonian Institution to establish the Consortium for the Barcode of Life (CBOL), an international initiative devoted to promoting the growth and use of DNA barcoding. CBOL's Secretariat is located in the National Museum of Natural History in Washington, DC. Since CBOL's launch in May 2004, more than 80 institutions have become Member Organizations by signing a Memorandum of Cooperation and agreeing to deposit their barcode data in a public repository. The members include museums, herbaria, zoos, biodiversity research institutes, universities, conservation organizations, government agencies and private companies. CBOL has held one international conference and supports several Working Groups that improve the scientific and technological basis for barcoding. Several regional meetings in South America, Africa and Asia are being planned to increase the participation of developing countries in DNA barcoding activities.

SUMMARY: THE DEMOCRATIZATION OF TAXONOMY THROUGH DNA BARCODING

The Global Taxonomy Initiative works to overcome "the taxonomic impediment" — the lack of data concerning Earth's biodiversity which limits our ability to manage living resources in a sustainable and responsible manner. The shortage of trained taxonomists and access to the essential information resources (especially museum and herbarium collections, taxonomic publications, databases on the Web) are most acute in developing countries where biodiversity is highest. DNA barcoding has the potential to increase access to taxonomic knowledge in all regions of the world. Databases of reference barcodes are connecting specimens to their correct species names, providing a direct route to species information associated with those names. CBOL is working with GenBank and its partner DNA repositories (European Molecular Biology Laboratory (EMBL) and DNA Data Bank of Japan (DDBJ)) to construct a global library of reference barcode sequences. Each barcode record is linked to a voucher specimen in a collection, a valid species name, and the associated taxonomic literature. Connections are being built to the Global Biodiversity Information Facility (GBIF) and other biodiversity data portals. Through these efforts, an integrated information infrastructure for taxonomy is growing rapidly.

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