DNA barcoding as an example of applications of molecular biology in sustainable agriculture[1]

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Abstract

Getting species concepts and identifications correct is vital to the success of many agricultural activities, especially the management of pest and beneficial organisms in agricultural systems. Biological control programs and risk assessment of new invasive pests rely on accurate species identifications. Examples include single pest species that turn out to be complexes of closely related species, and the converse in which several supposedly different species are actually one species. Even if species concepts are clear, the ability to identify immature stages (fruit fly larvae) and parts (filets in fish markets) is increasingly important in today's global economy.

DNA barcoding is a technique for assigning biological specimens to known species using a short diagnostic gene sequence from a standardized position in the genome. Barcoding can be thought of as "horizontal genomics" – the use of short gene sequences across many species and individuals. This broad but shallow sampling supports comparative taxonomic and evolutionary research and offers great opportunities for applied research in fields such as sustainable agriculture. Barcoding is distinct from “vertical genomics” that focuses on deep information (typically entire genome sequences) on samples of one or a few individuals from a few important exemplar species (e.g., humans, mouse, rice, corn) ("vertical genomics").

For most animal groups, the 648 base-pair mitochondrial “Folmer” region of the cytochrome c oxidase I gene (COI) is proving highly effective as a barcode region. Barcoding starts with the construction of reference databases of short sequences taken from well-identified voucher specimens. Using this reference library, the barcode sequence can be used as a proxy for morphological keys. This allows non-taxonomists to identify organisms, even juveniles, larvae, and damaged specimens that can often confound experts. Barcode data are also being used by an increasing number of taxonomists as an independent line of evidence for testing and refining species delimitations. DNA barcodes link, in turn, to a variety of new web-based bioinformatics tools allowing access to relevant taxonomic and biological information.

DNA barcoding both relies on, and enhances, biodiversity collections such as those held by many CGIAR centers. The non-plant collections of the CGIAR are currently being surveyed under the Global Public Goods Project, and connection with DNA barcoding activities offers an opportunity to bring value to both.

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