DNA 'barcoding' of plants

DNA 'barcodes' promise rapid identification of plants

By W. JOHN KRESS

"I am standing in a Costa Rican rainforest", writes tropical ecologist and conservationist Dan Janzen. "There are a thousand species of plants within a long stone's throw. Nearly every one of them is a described species with a proper scientific name, a handle that you can plug into Google and come up with something. Nearly all of these species or their near relatives have been studied, sampled, thought about and are in the literature. And I cannot identify a single species. Imagine ... if you could walk up to any plant anywhere – seedling, sapling, 40 m tree, grass, root, pressed leaf, or fallen log – and know in a few seconds its scientific name ... That capacity would transform far more than the science of plant biology, the conservation of plants, and the superficial ways we currently make use of the incredible diversity of form, physiology, genetics and chemistry of plants. It would be to plants what the printing press was to stories, education, science, law, medicine and communication."

Well, Dr Janzen, the future is almost here! A rapid and accurate method is now being developed for the quick identification of plant species based on extracting DNA from a tiny tissue sample of a leaf, flower or fruit. Appropriately called 'DNA barcoding', referring to the coded labels on many products, DNA barcodes are a short sequence of DNA between 400 and 800 base pairs long that can be easily extracted and characterized for all species on the planet. These genetic barcodes could then be accessed through a digital library and used to identify unknown plants in the field, garden or market. Once fully developed, DNA barcoding has the potential to completely revolutionize our knowledge of plant diversity and our relationship to Nature. People will be able to quickly and cheaply recognize known species and retrieve information about them. Barcoding could be a vital new tool for appreciating and managing the Earth's immense and changing biodiversity.

The use of short DNA sequences for biological identifications was first proposed by Paul Herbert and colleagues several years ago at the University of Guelph. Their aim was quick and reliable identification of species across all forms of life including animals, plants and micro-organisms. Although the value of such approaches has long been accepted for identifying micro-organisms where morphological data is lacking, so far this concept has been applied most successfully to animals. Plants have been notably absent in the early stages of barcoding – despite the formation of the Consortium for the Barcode of Life to drive the process forward and build the digital library.

Despite the delayed start, DNA barcodes have now been successfully achieved for flowering plants. In a recent paper, colleagues and myself at the Smithsonian Institution describe how we have identified two DNA barcodes. These can now be used to identify plant species whether for biodiversity assessment, life history, ecological studies or forensic analyses.

A successful DNA barcode must be a) short enough to be quickly sequenced, b) easily identified in all plant species, and c) variable enough to provide a unique sequence for each species. The cytochrome c oxidase (CO1) sequence, which is widely used in animal barcoding, is not suitable for plants because of a much slower rate of COI gene evolution in higher plants than in animals. Instead we have identified two other regions: the nuclear Internal Transcribed Spacer (ITS) and the plastid trnH-psbA intergenic spacer. ITS is the one of the most commonly sequenced locus used in plant phylo-genetic investigations at the species level and shows high levels of interspecific divergence. The trnH-psbA spacer, though short in length (~450 base pairs), is the most variable plastid region in angiosperms and is easily amplified across a broad range of land plants. Together, these two DNA regions may unlock the key to DNA barcoding in plants.

The millions of plant specimens in herbaria provide a documented source for building the library of plant barcodes. We found that we could obtain DNA barcodes from plant specimens over 100 years old. Laboratories around the world, including Kew and Edinburgh Botanic Gardens, New York Botanical Gardens and the Natural History Museum in London, have also started trials of barcoding techniques in plants.

Within a few years, Janzen's vision of quick and accurate identification of all species in a Costa Rican forest may become a reality. And in the long run, respect for nature and conservation will increase as well.

Literature cited

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