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DNA Barcoding and Its Applications

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Abstract— DNA barcoding is a system for fast and accurate species identification that makes ecological system more accessible by using short DNA sequence instead of whole genome and is used for eukaryotes. The short DNA sequence is generated from standard region of genome known as marker. This marker is different for various species like CO1 cytochrome c oxidase 1 for animals, matK for plants and Internal Transcribed Spacer (ITS) for fungus. DNA barcoding has many applications in various fields like preserving natural resources, protecting endangered species, controlling agriculture pests, identifying disease vectors, monitoring water quality, authentication of natural health products and identification of medicinal plants.

Keywords— CO1, DNA, DNA Barcode, IBOL, Identification, ITS, Marker.

INTRODUCTION

Biological effects of global climate lead to importance of identification of organisms to preserve species because of increasing habitat destruction. About 5 to 50 million plants and animals are living on earth, out of which less than 2 million have been identified. Extinction of animals and plants is increasing yearly means thousand of them are lost each year and most of them are not identified yet.[1] This destruction and endangerment of ecosystem has lead to an improved system for identifying species. In recent years new ecological approach called DNA barcoding has been proposed to identify species and ecology research. [2][3] DNA barcoding, a system for fast and accurate species identification which will make ecological system more accessible. [4] It first came to attention of the scientific community in 2003 when science research group of Paul Hebert at university of Guelph published a paper titled "biological identifications through DNA bar codes". DNA barcoding is a new tool for identification of species and for taxonomic research. It is not a new concept as Carl Woese used rRNA and molecular markers like rDNA and mtDNA to discover archea i.e. prokaryotes and then for drawing evolutionary tree. But DNA barcoding uses short DNA sequence instead of whole genome and it is used for eukaryotes. The short DNA sequence is taken from standard region of genome to generate DNA barcode. DNA barcode is short DNA sequence made of four nucleotide bases A (Adenine), T (Thymine), C (Cytosine) and G (Guanine). Each base is represented by a unique color in DNA barcode as shown in figure 1. Even non experts can identify species from small, damaged or industrially processed material. [5]

Figure 1. DNA Barcode [11]

The standard region used to generate DNA barcode is known as marker. This marker is different in different species like COI or cox1 (Cytochrome C Oxidase 1) present in mitochondrial gene in animals proposed by Paul Hebert and recognized by International Barcode of Life (IBOL) as official marker for animals, because of its small intra specific and large inter specific differences in animals. It is not suitable for other group of organisms because it is uniform in them. So, ITS (Internal Transcribed Spacer) for fungus and two genes rbcl and matK, from chloroplast genome are recognized as barcode markers for plants by IBOL. [8][9]

The sequence data generated from standardized region is used for identification of organism and to construct a phylogentic tree. In this tree related individuals are clustered together and can provide large amount of information about specie. [7][10]

APPLICATIONS

1) Controlling Agricultural Pest

DNA barcoding can help in identifying pests in any stage of life making easier to control them saving farmers from cost of billion dollars from pest damage. The global tephritid barcoding initiative contributes to management of fruit flies by providing tools to identify and stop fruit flies at border.

2) Identifying Disease Vectors

DNA barcoding allows non ecologists to identify the vector species that can cause serious infectious diseases to animals and humans, to understand these diseases and cure them. A global mosquito barcoding initiative in building a reference barcode library that can help public health officials to control these diseases causing vector species more effectively and with very less use of insecticides.

3) Sustaining Natural Resources

Using DNA barcoding, natural resource managers can monitor illegal trade of products made of natural resources like hardwood trees. Fishbol is reference barcode library for hardwood trees to improve management and conservation of natural resources.

4) Protecting Endangered Species

Primate Population is reduced in Africa by 90% because of bush meat hunting. DNA barcoding can be used by law enforcement to bush meat in local markets which is obtained from bush meat.

5) Monitoring Water Quality

Drinking water is a process resource for living being. By studying organism living in lakes, rivers and streams, their health can be measured or determined. DNA barcoding is used to create a library of these species that can be difficult to identify. Barcoding can be used by environmental agencies to improve determination of quality and to create better policies which can ensure safe supply of drinking water.

6) Routine Authentication of Natural Health Products

Authenticity of natural health products is an important legal, economic, health and conservation issue. Natural health products are often considered as safe because of their natural origin.

7) Identifying of plant leaves even if flowers or fruit are not available

8) Identification of medical plants [13]

PROCEDURE OF DNA BARCODING

The process of DNA barcoding involves two basic steps: First step is to build a barcode library of identified species and second is matching the barcode sequence of the unknown sample with the barcode library (known as sequence alignment) for its identification. The first step requires ecologic expertise in selecting one or several individuals per species as reference samples in the barcode library. Tissue samples can be collected from live specie in field or from specimen in museum for generating. These specimens go through lab processes that are tissue sampling and DNA processing and sequencing to generate DNA barcode in form of chromatogram. Chromatogram is visual representation of DNA sequence produced by sequencer. This barcode can be stored in database for future use or can be used as query sequence to be compared with sequence already present in database. [6]

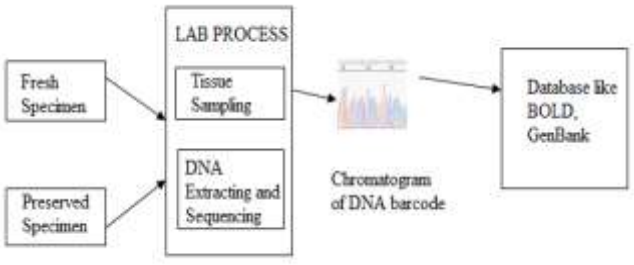

Figure 2. DNA Barcoding Procedure

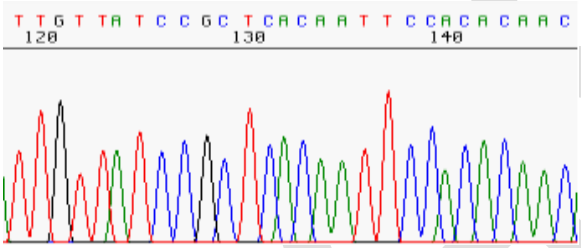

Figure 3. Chromatogram of DNA barcode generated by sequencer [12]

CONCLUSION

DNA barcoding is a system for fast and accurate species identification which will make ecological system more accessible. It has many applications in various fields like controlling agricultural pests, sustaining natural resources, protecting endangered species, monitoring water quality, preserving natural resources, protecting endangered species and identification of medicinal plants.

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