

An International Edition

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VANISHING DIVERSITY

Global threats to flora and fauna

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**SPECIES IDENTIFICATION AND BIODIVERSITY ASSESSMENT
THROUGH DNA BARCODING: A CASE STUDY OF BUTTERFLY**

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ABSTRACT : DNA barcoding has been developed as a revolutionary molecular technique for species identification and biodiversity assessment. Targeting short, standardized stretches of DNA—the most widely used being the mitochondrial cytochrome c oxidase I (COI) gene in animals—it enables quick, reproducible, and economical species identification, including morphologically cryptic taxa. This chapter emphasizes on the concepts, methods, and various applications of DNA barcoding with special reference to butterflies as model organisms. From DNA sequencing, PCR amplification, DNA extraction and specimen sampling to sequencing and bioinformatic analysis, the workflow forms a reliable framework for species discovery and ecological monitoring. Case studies such as the large-scale DNA barcoding of butterflies in Costa Rica revealed unique barcode signature in 98% of the species and uncovered cryptic diversity, demonstrating its effectiveness. Applications include conservation, environmental DNA (eDNA) ecology, food authentication, pest management, and wildlife forensics. It is so immense in potential that even now there are challenges to it, e.g., incomplete reference databases, hybridization problems, funding limitations and legislative barriers. Integrative methods involving the union of barcoding with morphology, ecological data and new tools such as next-generation sequencing and AI-based analyses are defining the future of biodiversity research. Through speeding up species discovery and enhancing conservation planning, DNA barcoding has a major role to play in the global governance of biodiversity against the backdrop of rapid environmental change.

Key words : DNA Barcoding, cryptic species, biodiversity monitoring, phylogenetics, integrative taxonomy.

Introduction

DNA barcoding is a molecular technique for species identification using a short standardized segment of DNA. Hebert *et al* (2003) compared DNA barcoding to retail barcode systems and illustrated in their publication how a short fragment of the mitochondrial cytochrome c oxidase I (COI) gene could be a reliable gene for species identification which has continued to serve as a strong marker for species identification (Hebert *et al*, 2003).

Subsequently, DNA barcoding applications have grown in strength to include taxonomy, ecology, conservation, and biodiversity assessments. Compared to traditional morphological identification (i.e., expert knowledge, whole, edited or juvenile morphology), DNA barcoding