

RESEARCH ARTICLE

# Molecular and Morphological Analyses Reveal Phylogenetic Relationships of Stingrays Focusing on the Family Dasyatidae (Myliobatiformes)

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## Abstract

Elucidating the phylogenetic relationships of the current but problematic Dasyatidae (Order Myliobatiformes) was the first priority of the current study. Here, we studied three molecular gene markers of 43 species (COI gene), 33 species (ND2 gene) and 34 species (RAG1 gene) of stingrays to draft out the phylogenetic tree of the order. Nine character states were identified and used to confirm the molecularly constructed phylogenetic trees. Eight or more clades (at different hierarchical level) were identified for COI, ND2 and RAG1 genes in the Myliobatiformes including four clades containing members of the present Dasyatidae, thus rendering the latter non-monophyletic. The uncorrected p-distance between these four ‘Dasytidae’ clades when compared to the distance between formally known families confirmed that these four clades should be elevated to four separate families. We suggest a revision of the present classification, retaining the Dasyatidae (*Dasyatis* and *Taeniurops* species) but adding three new families namely, Neotrygonidae (*Neotrygon* and *Taeniura* species), Himanturidae (*Himantura* species) and Pastinachidae (*Pastinachus* species). Our result indicated the need to further review the classification of *Dasyatis microps*. By resolving the non-monophyletic problem, the suite of nine character states enables the natural classification of the Myliobatiformes into at least thirteen families based on morphology.

## Introduction

The family Dasyatidae in the Order Myliobatiformes is one of the biggest families of batoid fishes. According to Carpenter & Niem [1], the body of members of the dasyatids is characterized by a large, oval, circular or rhomboidal disc usually covered with denticles, thorns and tubercles on the dorsal surface and sometimes on the tail. Given the large number of species described in the Dasyatidae, the classification and status of the described species are still in flux owing to taxonomic uncertainties especially at the family level. The few comprehensive studies on the classification within the Dasyatidae are based either on morphology, including their