

**DIFFERENTIATION OF TWO TAXA OF *CAULERPA* BASED  
ON *TUFA* MARKER**

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**FACULTY OF SCIENCE  
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ON *TUFA* MARKER**

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## ABSTRACT

The *Caulerpa* is an economical important genus among chlorophyta, which was initially described by Lamouroux in 1809, since then some 70 species of *Caulerpa* have been identified. The *Caulerpa* species have complex morphology that provides some characters that can be used in taxonomy, but extensive plasticity makes species boundaries difficult to be defined. With advancement in the field of molecular biology, it provides some alternatives for better understanding of taxonomy. In this study, PCR-based molecular techniques were used in an attempt to differentiate two taxa of *Caulerpa* based on *tufA* marker.

In this research work, specimens were collected from Pulau Redang, Terengganu, Malaysia. Based on the morphology of the assimilators, specimens were identified into two species namely *Caulerpa serrulata* var. *serrulata* and *Caulerpa serrulata* var. *boryana*.

*Caulerpa* DNA was extracted using DNeasy Plant Mini Kit followed by Polymerase Chain Reaction (PCR), with amplification parameters optimized to obtain reproducible results for gene sequencing.

Based on phylogenetic analyses, it is inferred that *Caulerpa serrulata* var. *serrulata* and *Caulerpa serrulata* var. *boryana* are the same species although different morphological characteristics were observed. Both the Maximum Parsimony (MP) and Bayesian Inference (BI) analyses have shown the two varieties are monophyletic and supported with high bootstrap values.

From this study, *tufA* marker is suitable in resolving the genetic relationship between *Caulerpa serrulata* var. *serrulata* and *Caulerpa serrulata* var. *boryana*.

## ABSTRAK

*Caulerpa* ialah diantara genus kumpulan alga hijau yang penting dari segi ekonomi, yang asalnya digambarkan oleh Lamouroux dalam tahun 1809, sejak dari itu, 70 spesis *Caulerpa* telah dikenalpasti. Spesis *Caulerpa* mempunyai morfologi kompleks yang mempunyai ciri-ciri yang boleh digunakan dalam taksonomi tetapi ciri-ciri yang hampir sama menjadikan spesis ini sukar dibezakan dan dikenali. Dengan kemajuan bidang biologi molekular, ia memberi pelbagai alternatif untuk lebih memahami taksonomi. Dalam kajian ini, berdasarkan teknik molecular PCR, ia digunakan dalam percubaan untuk membezakan dua taksa *Caulerpa* berdasarkan petunjuk *tufA*.

Dalam kajian ini, specimen-spesimen dikutip dari Pulau Redang, Terengganu, Malaysia. Berdasarkan morfologi penyerapan, specimen-spesimen ini dikenali sebagai dua spesis iaitu dinamakan *Caulerpa serrulata* variasi *serrulata* dan *Caulerpa serrulata* variasi *boryana*.

DNA *Caulerpa* diekstrak menggunakan Kit Mini Tumbuhan DNeasy diikuti dengan Reaksi Rantain Polimerase (PCR) dengan parameter amplikasi dioptimumkan bagi mendapatkan keputusan yang boleh diulang untuk turutan gen.

Berdasarkan analisis filogenetik, ia menunjukkan bahawa *Caulerpa serrulata* variasi *serrulata* dan *Caulerpa serrulata* variasi *boryana* adalah sama spesis walaupun berlainan ciri-ciri morfologi diperhatikan. Kedua-dua analisis Parasimoni Maksimum (MP) dan 'Inference Bayesian' menunjukkan terdapat dua variasi adalah monophiletik dan disokong oleh nilai 'bootstrap' yang tinggi. Daripada kajian ini, petunjuk *tufA* adalah sesuai untuk menyelesaikan hubungan genetic diantara *Caulerpa serrulata* variasi *serrulata* dan *Caulerpa serrulata* variasi *boryana*.

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## LIST OF ABBREVIATIONS, SYMBOLS AND UNITS

AFLP	Amplified fragment length polymorphism
AP-PCR	Arbitrary Primed PCR
BI	Bayesian Inference
BP	Bootstrap percentage
cDNA	Complementary DNA
CI	Consistency Index
Cm	Centimeter
DNA	Deoxyribonucleic acid
dNTP	Deoxynucleotide triphosphate
DW	Dry weight
ITS	Internal transcribed spacer
kb	Kilobase
μ	Micro
M	Meter
m	Milli
MgCl <sub>2</sub>	Magnesium chloride
ML	Maximum-likelihood
MP	Maximum-parsimony
NCBI	National Centre for Biotechnology Information
PCR	Polymerase chain reaction
ppm	Parts per million
QTL	Quantitative trait locus
RAPD	Random amplification of polymorphic DNA
rDNA	ribosomal DNA

RFLP	Restriction fragment length polymorphism
RI	Retention Index
RNA	Ribonucleic acid
rpm	revolution per minute
RUBISCO, <i>rbcL</i>	ribulose-1, 5-bisphosphate carboxylase/oxygenase
sp.	Species
spp	Multiple species
TAE	Tris-acetate-EDTA
TBR	Tree bisection reconnection
tRNA	Transfer RNA
<i>tufA</i>	Elongation factor TU