I. INTRODUCTION

1.1 Background

Seaweeds, also known as marine macroalgae, can be classified into three primary groups: Rhodophyta (red algae), Chlorophyta (green algae), and Ochrophyta (brown algae). They exhibit substantial variation in their forms, dimensions, and life cycles (Salido, et al., 2023). Marine macroalgae contain diverse essential nutrients, including polysaccharides, proteins, lipids, vitamins, minerals, pigments, and phenolic compounds (Ganesana, et al., 2019). These components exhibit a wide range of properties including anti-inflammatory, antioxidant, antibacterial, antifungal, anticancer, antiviral, neurotrophic, and antihypertensive effects. Marine macroalgae is acknowledged as a valuable source for the creation of pharmaceuticals, nutraceuticals, cosmetics, and functional food products (Biris-Dorhoi, et al., 2020).

Marine macroalgae offer many kinds of ecological benefits, significantly contributing to the balance and health of marine ecosystems. Marine macroalgae provide essential habitats and breeding grounds for a diverse range of aquatic organisms (Troell, et al., 2023), thus enhancing biodiversity in coastal areas. Marine macroalgae absorb carbon dioxide through photosynthesis, acting as carbon sinks and reducing greenhouse gas levels in the atmosphere (Ortega, et al., 2019). Various species of marine macroalgae can mitigate ocean acidification by sequestering excess carbon dioxide, thereby maintaining a stable pH level in the surrounding waters (Duarte, et al., 2017). Prior research has concentrated on the biodiversity and ecological functions of macroalgae in different parts of the world. Research conducted in both tropical and temperate locations has emphasized the ecological significance and economic possibilities of these areas.

Several studies have investigated the diversity and distribution of macroalgae throughout Southeast Asia, including Malaysia. These studies have provided useful information, although they frequently lack full

molecular data. There is a shortage of information regarding Malaysia's marine macroalgae. Although there has been some taxonomic research, there is a lack of thorough and up-to-date molecular data. Efforts have recently begun to address this deficiency, with programs specifically aimed at documenting species variety and employing molecular tools to ensure precise identification. Nevertheless, there is an urgent need for more comprehensive and methodical investigations. Greater utilization of molecular techniques, such as DNA barcoding, is necessary to improve species identification and deepen our understanding of evolutionary relationships.

DNA barcoding is a technique for identifying species by using distinct DNA sequences as distinctive markers that differentiate each organism (Udhaya, et al., 2019). Marine macroalgae necessitates the use of DNA barcoding as a crucial instrument for more precise and efficient identification of these species. The considerable variety and frequent similarities in physical structure among different types of marine macroalgae can create difficulties when trying to identify them manually. DNA barcoding overcomes these limitations by offering a specialized and dependable method for determining the genetic identity of each species (Bartolo, et al., 2020). The interrelated advantages of marine macroalgae, encompassing ecological, economic, and nutritional merits, emphasize the significance of DNA barcoding.

Precise species identification is crucial when considering the sustainable utilization of marine resources and the preservation of marine biodiversity. By utilizing DNA barcoding, we can enhance our comprehension and effectively utilize the diversity of marine macroalgae, thereby promoting the equilibrium of marine ecosystems and sustainably contributing to human welfare. This research seeks to investigate the genetic patterns within the marine macroalgae community at University Malaysia Terengganu (UMT) Beach, Kuala Terengganu, Malaysia by combining DNA barcoding and phylogenetic analysis. The acquisition of knowledge will not only enhance our scientific understanding of marine macroalgae,

but also provide a foundation for informed conservation practices and the sustainable management of coastal ecosystems. The results of this study could be significant for future investigations in the fields of marine biology and environmental conservation.

1.2 Research Question

1.1.1 What species of macroalgae found in UMT Beach, Kuala Terengganu, Malaysia based on the rbcL and 18S primers DNA barcoding?

1.1.2 What phylogenetic relationships among macroalgae species from UMT beach, Kuala Terengganu, Malaysia?

1.3 Research Aims

1.3.1 Discover the accurate identification of macroalgae species collected from UMT Beach, Kuala Terengganu, Malaysia through DNA barcoding protocols.

1.3.2 Assess and elucidate the phylogenetic relationships among macroalgae species from UMT Beach, Kuala Terengganu, Malaysia, using DNA barcoding techniques.