(Form 7-2)

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(Abstract of Dissertation)

General Introduction:

Diatoms are vital to primary production, forming the base of aquatic food webs. However, invasive species like *Cymbella janischii* disrupt ecosystems by forming thick mats which consist of "stalk" made by extracellular polymeric substance, altering habitats and outcompeting native species. These mats influence microbial interactions, nutrient cycling, and diatom growth. Diatoms also show promise for biofuel production, with lipid yields influenced by different environmental factors. This study investigates *C. janischii* blooms using DNA metabarcoding, explores bacterial interactions affecting its growth, and examines nutrient limitation effects on lipid yield in *Cylindrotheca* sp. and *Trieres chinensis* for biodiesel applications.

Chapter 1: Decoding Microbiome Diversity to Understand the Impact of *Cymbella janischii* Blooms on Microbial Communities: Insights from DNA Metabarcoding of the Invasive Diatom Species.

Metabarcoding analysis of *C. janischii* blooms showed significant impacts on microbial diversity in river ecosystems, with bacterial and diatom communities exhibiting reduced diversity, while fungal communities remained stable. The abundance of *Flavobacterium*

spp. highlighted their role in nutrient cycling and promoting diatom growth. Co-occurrence network analyses indicated mutualistic relationships between *C. janischii* and specific bacteria, particularly *Flavobacterium*, which contributed to enhanced bloom formation. These findings emphasize the cooperative dynamics in diatom-bacterial interactions and their ecological implications for *C. janischii* blooms.

Chapter 2: Physiological Insights into Growth Promotion and Stalk Degradation by Diverse Bacterial Strains Associated with *Cymbella janischii*, an Invasive Diatom Species

The role of bacterial communities in modulating *C. janischii* growth was further explored through co-culturing experiments. Results showed that several bacteria significantly enhanced *C. janischii* growth such as *Flavobacterium* and *Pseudomonas*. In contrast, members of Proteobacteria like *Aeromonas* and *Janthinobacterium* inhibited diatom growth. Stalk-degrading bacteria, such as *Duganella* spp., destabilized *C. janischii* colonies by degrading stalks. This structural disruption may influence nutrient release and diatom dispersal, offering insights into potential biocontrol strategies targeting stalk integrity.

Chapter 3: Performance Characteristics of Marine Diatoms *Cylindrotheca* sp. and *Trieres chinensis* Under Nutrient Limitation and their Potency as Feedstock for Biodiesel Production

The potential of *Cylindrotheca* sp. and *T. chinensis* as biodiesel feedstocks was assessed under nutrient-limited conditions, showing lipid productivity rates of 73.46 mg L^{-1} day^{-1} for *Cylindrotheca* sp. and 68.1 mg L^{-1} day^{-1} for *T. chinensis*, surpassing other industrial microalgae like *Phaeodactylum tricornutum* and *Chaetoceros muelleri*. Optimizing nutrient levels was key to balancing lipid productivity and biomass yield, with diluted synthetic media proving cost-effective for cultivating marine diatoms. Comparative analyses highlighted the competitive potential of these species for large-scale biodiesel production, with FAME profile analysis confirming biodiesel compatibility with international standards. This research emphasizes the significance of diatom in biofuel production, presenting a sustainable solution to global energy challenges.

General Discussion:

Metabarcoding analysis showed important findings into the microbial interactions that may influence *C. janischii* and *Didymosphenia geminata* blooms. The enrichment of specific bacteria like *Flavobacterium* and members of Comamonadaceae suggests their role in bloom formation of *C. janischii*, with these taxa potentially influencing *D. geminata* blooms as well. Previous studies have documented *Flavobacterium* dominance in *D. geminata* mats, supporting the idea of its role in diatom bloom dynamics. In addition, co-culture experiments proved the role of *Flavobacterium* in promoting diatom growth and proliferation while *Aeromonas* and *Janthinobacterium* inhibit growth. Additionally, stalk-degrading bacteria such as *Duganella* spp. contribute to diatom mat disintegration, suggesting that microbial interactions could also impact *D. geminata* bloom persistence or collapse.

These findings aid in deepening our understanding of diatom bloom ecology and microbial interactions, particularly in *C. janischii* and *D. geminata* invasions in river ecosystems. Specific bacterial species may either promote bloom formation or contribute to bloom collapse through antagonistic interactions, offering insights for future biocontrol strategies. Targeting bacterial species that suppress or destabilize invasive diatom blooms could provide environmentally sustainable alternatives to chemical or mechanical control measures, enabling more effective management of invasive diatom outbreaks while minimizing ecological disruptions.

The studies presented provide valuable insights into diatom ecology and their potential as sustainable bioenergy resources, offering a framework for understanding their ecological roles. These findings help address challenges in ecosystem management and renewable energy, paving the way for future innovations.