Molecular and physiologial insights into diatom ecology : enviromental risks and potential applications

(Form 7-3)

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（Summary of Examination Report）

This doctoral dissertation explores the ecology and growth responses of invasive freshwater and marine diatoms through molecular and physiological investigations.

This study can be highly evaluated based on following aspects:

1. Metabarcoding analysis quantitatively demonstrated how the presence of invasive diatom, *Cymbella janischii,* affects the diversity of co-occurring diatoms, bacteria, and fungi. Co-occurrence network analysis identified bacterial species associated with the presence of mucilage mats, while pathway analysis of bacterial communities revealed an enhancement of functions such as plant hormone production. These findings suggest that certain bacterial species may facilitate the massive proliferation of the stalk-forming diatom *C. janischii.*
2. The effect of bacterial strains isolated and cultured from mucilage mat communities on the growth of *C. janischii* was experimentally examined. The results showed that seven bacterial strains promoted the growth of the diatom, whereas four had no effect, and one strain inhibited its growth. Additionally, two strains were found to degrade the mucilage stalks produced by *C. janischii*, suggesting potential implications for future research and application.

The spread of the invasive diatom *Didymosphenia geminata*

(commonly known as Didymo) has raised significant concerns worldwide about its ecological impact, particularly on biodiversity and ecosystem functions. Despite being recognized as a major global threat for a long time, efforts to better understand its physiological characteristics have been hindered by the fact that this species is unculturable. In this study, clonal cultures of *C. janischii*, the closest sister species of Didymo, were successfully established. Growth characteristics were examined under different conditions, including the presence or absence of bacteria, as well as interactions with various bacterial species. The study also discovered bacterial clones which digest stalks of *C. janischii.* This has a great potential for application to utilize this function to suppress Didymo bloom as well. Thus, this research not only sheds light on the physiology of *C. janischii* but also has the potential to be a breakthrough in addressing the Didymo issue on a global scale.

3. The lipid production capacity of two diatom strains isolated from Obama Bay was investigated. By reducing nutrient concentrations by half, cell numbers decreased to some extent, but lipid recovery was maximized. Furthermore, lipid composition analysis showed that both strains met the standards for biofuel production (EN14214 and ASTM D6751), indicating their potential as valuable biofuel sources.

For these reasons, this dissertation can be considered to meet the

criteria for a Doctorate in Bioscience and Biotechnology.

Based on the results of the degree examination on 2025/2/12 regarding this dissertation and the related research areas, the Examination Committee has approved that the Applicant is qualified for a Doctor of Bioscience and Biotechnology conferral.