The 1st Knowing-to-Growing Duckweed Application Awards: winner and runner-up of 2017

Preface

The "Knowing to Growing Duckweed Application Award" was organized by the International Lemna Association (ILA) as an expression of gratitude for the excellent duckweed research being done around the world. We sought to recognize the academic papers that are progressing the duckweed industry the most. Journal articles written in 2017 were nominated, and then voted on by a panel of industry judges comprised of duckweed company leaders. There were many fine papers and judging proved to be a challenge. We were happy to announce that the winning team was Dr. Ishizawa, Dr. Kuroda, Professor Morikawa, and Professor Ike with their study, "Environmental bacterial community, a factor strongly affecting duckweed growth", Runner-up was Dr. Appenroth and team, "Nutritional value of duckweeds (Lemnaceae) as human food." (Appenroth et al., 2017) As a direct result of running this competition, duckweed companies were very appreciative to learn of new discoveries that they may have not have prior knowledge of. The ILA wishes to thank Paul Fourounjian for spearheading this competition and Tsipi Shoham for announcing the winners at the recent ICDRA in India.–Tamra Fakhoorian, Executive Director of the *ILA*.

Environmental bacterial community, a factor strongly affecting duckweed growth

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It is indeed a great honor to receive the "Knowing to Growing Duckweed Application Award" for our paper entitled "Evaluation of environmental bacterial communities as a factor affecting the growth of duckweed *Lemna minor*" in *Biotechnology for Biofuels*. We would like to express our sincere gratitude to the members of ILA and those who recognized and voted for our publication.

Our study was conducted to explore the possibility of enhanced duckweed production by utilizing co-existing bacteria. It is widely recognized that land plants harbor specific and diverse bacterial communities in their rhizosphere and phyllosphere, which can play very important roles in determining the growth rate of host plants. Recently, some bacterial strains were found to accelerate the growth of duckweed under certain environmental context as the first examples for aquatic plants (Yamaga et al., 2010; Tang et al., 2015). Our research project is thus an attempt to utilize such beneficial bacteria in duckweed hydroculture for increased biomass production and water treatment

performance. In this study we particularly focused on how and which bacteria affect the growth of duckweed in both the community-scale and individual strain-scale, to better understand the application of beneficial bacteria in practical environments.

Here, we reported that bacterial communities in freshwater environments can affect the growth of *Lemna minor* similarly to other environmental factors such as light and nutrient conditions (see Figure). By characterizing each member of bacterial communities formed on the surface of *L. minor*, we also found the common existence of both plant growth-promoting bacteria (PGPB) and plant growth-inhibiting bacteria (PGIB), which may cooperatively or competitively determine the effects on the host plant's growth properties. Similar studies also examined duckweed growth promotion/inhibition by bacteria from genomic and physiological aspects (Ishizawa et al., 2017a,b). Although these studies just scratched the surface of the complex plant-bacterial interactions, the results suggested that natural bacterial community often function as a comprehensive growth-regulating factor of duckweed.

Appearance of *Lemna minor* co-cultivated for 7 days with the most promotive (left) and inhibitory (right) bacterial communities.

Currently, we are trying to establish the methodology to manipulate the bacterial consortium co-existing with duckweed. Since the bacterial community associated with a plant possess far richer genetic and functional diversity than the plant itself, we believe designing this “plant secondary genome” would enable us to invest useful functions to duckweed hydroculture, such as enhanced growth, improved biomass composition, and degradation of recalcitrant compounds in wastewater (e.g. Toyama et al., 2017; Kristanti et al., 2014). We hope our studies contribute to such future technologies, and offer useful insight for further development of duckweed research and applications.

References

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