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Preventing Styrofoam in Marine Environment through Eco-friendly, Durable Bivalve Buoys of Reduced Impact through Structural Modification

Jungyeon Wi, Korea International School, Jeju Campus, Gyeonggi-do Republic of Korea

TITLE: Preventing Styrofoam in Marine Environment through Eco-friendly, Durable Bivalve Buoys of Reduced Impact through Structural Modification

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Styrofoam buoys, commonly used in South Korea in the aquaculture industry (e.g., oysters, mussel production) and fishing, are one of the dominant sources of marine plastic debris in Korea. The Ministry of Environment estimates that 990,000 styrofoam buoys are lost or disposed of annually, accounting for 72% of the total used buoys1. Styrofoam, made out of Expanded Polystyrene (EPS), is easily broken down into microplastics by waves and UV from sunlight, which marine organisms can ingest. According to the Ministry of Oceans and Fisheries, hazardous chemicals and additives in styrofoam, including HBCD, can be transferred to aquatic organisms, which deteriorates their physiological functions and health and potentially affect the health of seafood consumers.

To prevent styrofoam waste in the marine environment, The Ministry of Oceans and Fisheries announced the policy to replace all styrofoam buoys with eco-friendly ones by 20252. However, due to the lack of standards and qualifications for "eco-friendly buoys," the ministry has approved most buoys that are broken down into plastic debris slower than styrofoam buoys as eco-friendly buoys. As a result, 95% of approved eco-friendly buoys are still made of plastic and not recycled, becoming another plastic waste in the ocean. The recycling of the plastic buoys is to be determined, whereas some of the styrofoam buoys are recycled. This indicates the contradictory national policy of promoting eco-friendly plastic buoys to reduce the creation of plastic waste in marine environments. The plastic buoys are also easily split when water flows inside. While there are buoys made out of eco-friendly materials, such as aluminum, seaweed sludge, and wood powder, the buoys are 2~5 times heavier than styrofoam ones or not resistant enough to outside impact. To effectively prevent plastic debris in marine environments, a more durable buoy made of a biodegradable material should be created.

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A new eco-friendly buoy will be designed to improve weight, material, and durability to impact. The spider-web structured partition made of polycarbonate will add more structural rigidity than other eco-friendly buoys with lattice partition to withstand winds and waves while maintaining the lightweight as styrofoam buoys'. Additionally, the buoy will experience 20% less impact due to the presence of a water channel, thus more resistant to potential split commonly shown in current plastic buoys. The product lifespan will be two years longer than other plastic buoys by reducing the impact. Its cost-effectiveness and longer lifespan will encourage the aquaculture community to replace styrofoam buoys since the high cost and poor durability of current eco-friendly buoys have been the primary reasons to continue using styrofoam ones. The outer structure is made from biodegradable material, which does not produce microplastic, unlike other eco-friendly buoys.

As styrofoam buoys are not well-known to the public as a significant cause of microplastic issues in South Korea, several campaigns should be held to increase awareness. First, we will introduce the prototypes to local bivalve farms and collect feedback for further refinement while informing the aquaculture community about the microplastic issue. To raise students' awareness, we will organize an annual engineering competition at four Jeju international schools to design eco-friendly buoys and other products often made of styrofoam and launch a blog3 and social media. Additionally, we will collaborate with community service clubs and launch fundraising to organize the competitions and financially support the fishing community to encourage replacing styrofoam buoys with eco-friendly ones.

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