**Ballooning Up from the Deep**

**Zareena, Mookayi and Mari**

Zareena, Mookayi, and Mari stood by the railing of the research ship ***RV Sindhu Sadhana***. The ocean near Hawaii sparkled under the bright sun. The girls were thrilled to be there. Mooks couldn’t contain her excitement. “We’re actually at sea! On a ship full of researchers!”

Mari’s mother, Usha, a biologist leading the expedition, had arranged for them to join. Even better, **Manu Prakash**, the inventor of the ***Foldscope***—a low-cost paper microscope—was on board too! They had first used the Foldscope in a **Tamil Nadu Science Forum** workshop. Their friend **Mo Pandiarajan** had shown them how to use it. Now, they were surrounded by scientists on a high-tech ship.

**BOX on Mo Pandiarajan**

Mo Pandiarajan works as a teacher at a small primary school in the village of Muthupatti in Tamil Nadu, India. In the early 1990s, the Indian government started a literacy movement. Mo joined the movement and founded the *Eden Science Club*, a group for school-going and drop-out students in Muthupatti that organizes events and lectures to promote scientific exploration for all. When Eden Resource Club received its first Foldscope in 2015, they took an ant as their first sample. From the moment Mo took a closer look at the microscopic world, he felt like he had unlocked the secrets beyond the naked eye. Today, Mo continues to share the excitement of the microscopic world by providing Foldscope trainings for over 100,000 people and counting. This includes Mo’s own son and daughter, who he says “eagerly use their Foldscopes every day!”

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Mari pointed to the cabin. “Look, there’s Amma—she’s leading the biology team! She’s at the microscope!”

Zar gasped. “And that’s Manu Prakash! Remember how we used his Foldscope to study mosquito larvae in the workshop?”

Mooks nodded. “I remember the green algae we saw!”

Just then, Usha walked over, holding a small vial that glowed faintly blue. "Would you like to see something amazing?" she asked. “This is *Pyrocystis noctiluca*—a tiny marine **plankton**. It lives in warm oceans. It glows. It does not swim.”

Zar peered at it. “It lights up? Like underwater fireflies?”

Manu Prakash joined them and smiled. “Exactly. It’s *bioluminescent*. When waves or fish disturb it, it flashes like a tiny beacon.

**BOX What are plankton?**

Plankton are organisms that live in water. They cannot swim but simply drift with the currents (flow of the water). There are plant-like plankton (**phytoplankton**) that perform photosynthesis, using sunlight to produce energy and releasing oxygen. In fact, they are an important part of the food chain in the sea. There are also animal-like plankton (**zooplankton**) that feed on other plankton, including phytoplankton. Both varieties form a critical part of healthy water-based ecosystems. Not only are they the food source for many larger marine animals, they also produce a large part of the Earth's oxygen.

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Mari squinted at the vial. “Is it really just one cell?”

Usha nodded. “Yes—and it’s huge for a single cell. It’s usually 250-400 micrometers wide, but it can inflate to six times its size. Big enough to see with your eyes!”

Mooks whistled. “That’s almost a millimeter!”

Zar laughed. “That’s gigantic for a cell!”

Manu took out a Foldscope. “Under magnification, you’d see something cool. The outside looks smooth, but inside, *plastids* cling to thin threads. Most of the cell is just a giant *vacuole*—like an empty balloon—with the nucleus tucked at the edge.”

BOX Plastids

Plastids are tiny structures inside the cell which serve different functions. The most well-known are chloroplasts, which contain chlorophyll and are responsible for photosynthesis. Chromoplasts are plastids that give the colour to fruit and flowers.

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Mari’s eyes lit up. “So the vacuole helps it float?”

Manu explained, “*P. noctiluca* is denser than seawater and should sink. But early in its life, it swells up, making it lighter so it rises. They make a once-in-a-lifetime trip from about 125 meters deep to about 50 meters, where there’s more of the sunlight that they need to photosynthesize. At the end of its seven-day life cycle, the cell then starts to divide into two daughter cells as it sinks. When the division is completed, the two newborn cells now inflate by filling up with seawater. And the cycle begins again.”

Usha added, “The cell fills its vacuole with low-density water, using special molecules called *aquaporins* to filter out denser salt. Aquaporins are like the plumbing system of a cell. This inflation acts like a slingshot, pushing the cell upward. It’s like a helium balloon—but underwater! The large size also protects them from predators and allows for more photosynthesis.”

(The picture shows the 3D structure of **aquaporin Z**. You can see the 'hourglass'-shaped water channel that cuts through the center of the protein. Itis just wide enough to allow water molecules to go through, but does not allow salts inside. So the salt in the seawater remains outside and the vacuole fills with pure water that is less dense than the outside sea water, allowing the organism to float.)

Manu continued, “It can swell six times its size in just 10 minutes. If it doesn’t, it sinks too deep, where there’s no light—a ‘gravitational trap’ it can’t escape.”

Mooks gasped. “So it’s a race against time!”

Zar turned to Usha. “Are there other creatures like this?”

Manu nodded. “Yes! Take **cranchiid squids**—they store **ammonium** **ions** in their tissues, which are lighter than seawater, so they float easily.” (See the next article for the fascinating story of these squids.)

Zar frowned. “But ammonia is toxic, right?”

Usha agreed. “They’ve evolved low *blood pH* to neutralize it. There are also the **Chiroteuthis squids**. It relies on the *buoyancy* provided by ammonium ions dissolved in their tissues.”

Mooks thought for a moment. “So plankton and squids solved the same problem… just differently.”

Manu grinned. “That’s **convergent evolution**—life finds clever ways to reach the same solution from different starting points!”

As the sun set, the girls looked down. The ocean began to glow.

Zar gasped. “The *Pyrocystis*—it’s lighting up the waves!”

Mari whispered, “Like stars … all ballooning up.”

Together, they called out, “Have a good night, ballooning friends of the deep!”

Mooks clapped her hands. “Let’s try an experiment back home! A density jar—layering honey, soap, water, and oil to see how things float.”

Zareena added, “And we’ll take Foldscopes to the pond to find plankton!”

**BOX: A density jar experiment**

Typically, liquids like honey, dish soap, water, oil, and rubbing alcohol are used. Optionally, add food coloring to each liquid to enhance the visual effect; this creates a visual “rainbow” effect. Carefully pour the liquids into the jar, one at a time, starting with the densest (usually honey) and ending with the least dense (usually rubbing alcohol). Allow the liquids to settle and observe the distinct layers. Then, drop in various objects and see where they float or sink in the layered liquids. They will settle in one of the layers based on their own densities.

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***References:*** *“Cell biology: Wanderers that balloon towards light” Clotilde Cadart in Current Biology 34, R1137–R1157, November 18, 2024;*

*“Inflation-induced motility for long-distance vertical migration” Larson and others in Current Biology 34, 5149–5163, November 18, 2024*