THE P FACTOR

In the challenge of keeping our seas clean, plastics FAIL. And yet, during the last decade, we produced more of it than in the last 100 years combined. ***Dr Adam Gauci*** *writes about his team's efforts to categorise the microplastics from Malta's beaches and how those efforts will contribute towards the war on plastic.*

Plastic is convenient. It's cheap, versatile, and useful. The trouble is that it never goes away. While plastic is recyclable and can be reused in the form of lesser quality plastic, it can never be completely eliminated. Instead, it breaks down into smaller and smaller fragments, called microplastics, that stay in the sea. The only way they are ever removed is if fish eat them—coloured ones look especially tasty—or if they enter some orifice of ours while we're enjoying our summer sun on the beach. Next time you're sunbathing, sift your hand through the first five centimetres of sand and count all the small, smooth, rounded plastic fragments you pick up—that's the stuff we're talking about.

A whole movement has started taking shape in recent years, raising awareness about the damage plastics are causing. If you've never received a Facebook invite to join a clean-up campaign, you're following the wrong friends. However, there are so many questions that need answers.

What's the source of these fragments, the land or the sea? Are there more fragments closer to the waterline? At which depth in the sand and water will you stop finding them? What can their number, size, shape, and colour tell us about the way they move through the environment? All this informs our understanding of microplastics. With this information, we can identify whether their prevalence increases or decreases on a seasonal or yearly basis. It also helps target campaigns, since some areas need cleaning more urgently than others.

Characterisation of plastic is an important first step in this journey. We need to extract and define parameters for the microplastics found within specific volumes of sand from specific beach locations. Needless to say, the going is slow. So far, there is no universal methodology researchers follow for analysing isolated microplastics. When classifying pieces of plastic based on colour, something as simple as lighting can affect results. Subjectivity also plays a big role—what appears red to one person can be pink to another. There is a high bias from the interpretation of human observers, which needs to be resolved. Reducing human bias is where computers and image processing techniques come in.

Using cameras, we capture high-resolution images of the particles and submit them to computers, which run image processing techniques to automatically characterise the plastic pieces. Not only does this save time, it removes the subjectivity, allowing us to make accurate spatial and temporal comparisons.

Our shovels, sieves, hats, and flip-flops were out from August to November. We collected samples from Riviera Bay, Golden Bay, Għadira Bay, and Pretty Bay. Apart from being our favourite beaches, these locations also cover the four corners of Malta. They are exposed to wind and waves from different directions, which means that we can correlate the total number of extracted microplastics with the meteorological and sea conditions before and on the days of fieldwork to determine how natural phenomena affect the concentration of microplastic particles.

We visited each beach eight times. At every location, we sampled six different stations by sifting a consistent volume of sand to extract microplastics and other debris. We recorded GPS

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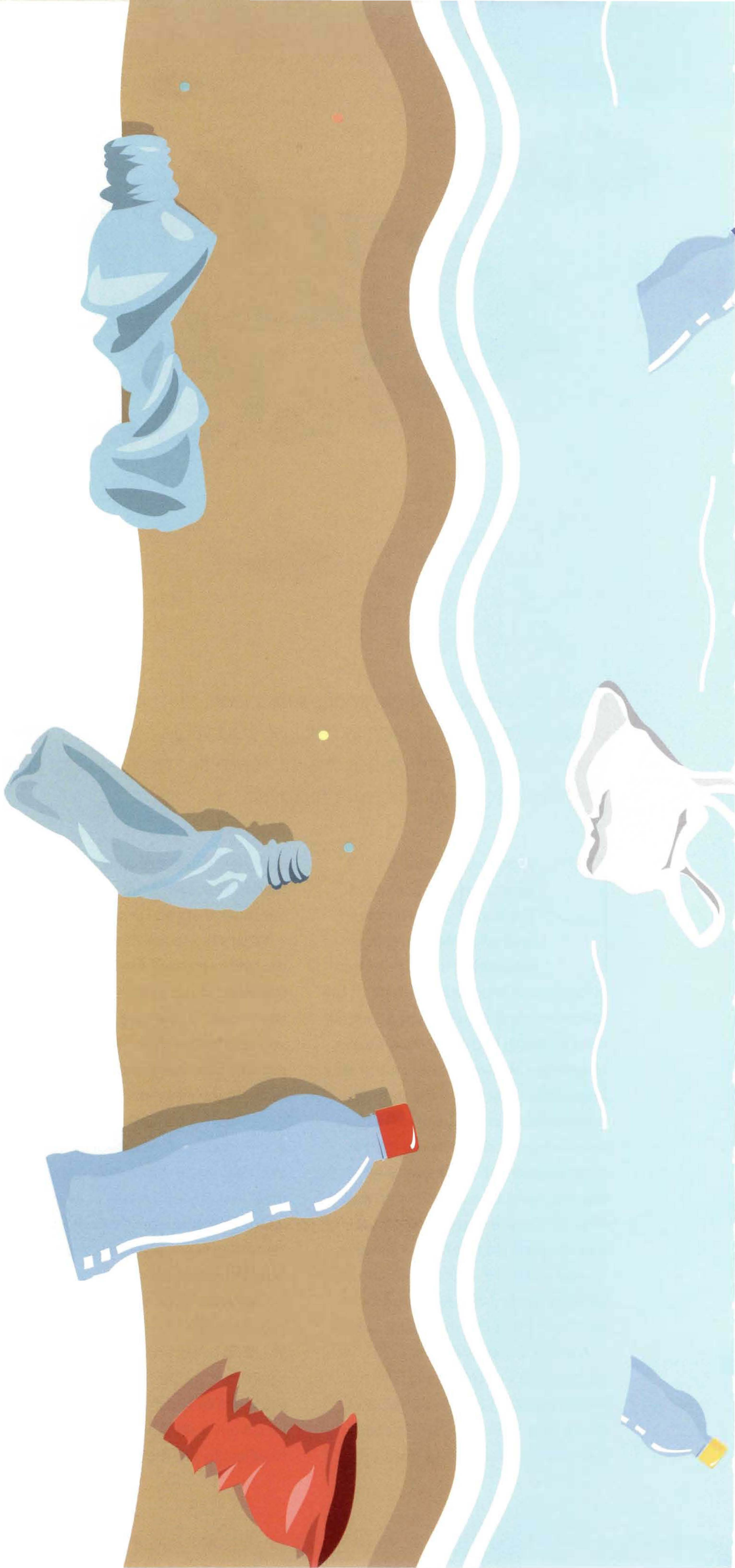
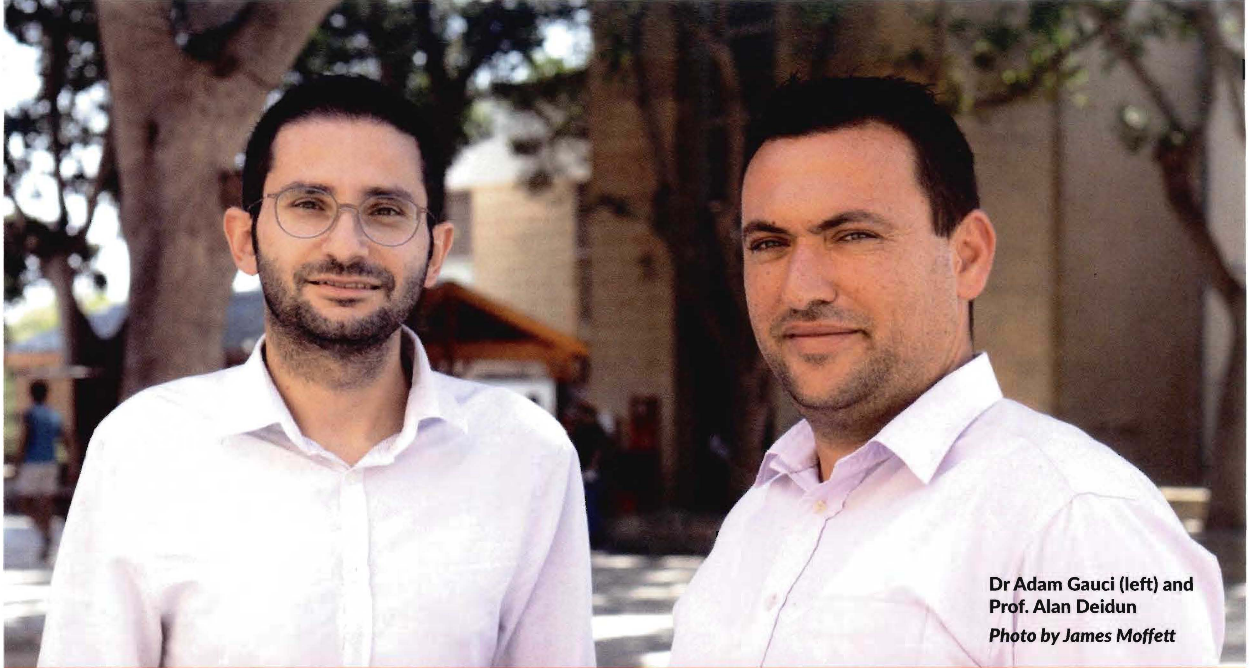
coordinates to ensure that data was collected from the exact same spot each time and soon learned that asking tourists to reposition their sunburnt selves out of the way is really uncomfortable. Asking a local, even more so. A few awkward encounters later, we shifted our sampling schedule to very early in the morning, before swimmers arrived and prior to beach cleaning by the authorities.

In the lab, a calcium chloride based solution helped us separate the microplastics from other debris. Once dry, we could scan the samples at high resolution. Following hours of coding, we created an algorithm that could run on all the data collected. We designed





Dr Adam Gauci (left) and Prof. Alan Deidun
Photo by James Moffett

THE TEAM

There is no fairy tale behind the setting up of the team. People with different backgrounds, research interests, and (allegedly) superpowers got together to improve the way we parameterise microplastics. I, Dr Adam Gauci (Physical Oceanography Research Group, Department of Geosciences), discussed the topic with John Montebello (Institute of Earth Systems). Prof. Alan Deidun was roped in because of his previous experience on a similar project some months before. Dr John Abela (Department of Computer Information Systems, Faculty of ICT) helped with developing the algorithm. Prof. Victor Axiaq (Biology Department) was also involved for his long-standing work on the same thematic. The inclusion of Prof. Francois Galgani from IFREMER *(Institut Français de Recherche pour l'Exploitation de la Mer)* was sacrosanct in view of his research profile on microplastics.

the programme to automatically generate charts for our interpretation.

The implemented software is about as intelligent as a three-year-old. An adaptive thresholding method gives us a binary image. Morphological methods then fill in the gaps to create a solid image. The programme basically mimics human paint-by-numbers. The second step is like a connect-the-dots exercise, identifying and drawing rubber bands (i.e. outlines) around each particle. With this, the algorithm builds a mathematical model of each microplastic particle, from which it can compute roughness as well as the lengths of its major and minor axes. The red, green, and blue intensities of the pixels enclosed within each boundary are compared against a table to determine whether the particle is black, blue, brown, green, grey, orange, pink, purple, red, white, or yellow.

We already know that the algorithm performs very well compared to the output emerging from human observation, but a more comprehensive validation process is underway.

As it stands, what we know is that the most polluted beaches are Riviera Bay and Golden Bay. Both have a north-west aspect, which matches the direction of the prevailing winds reaching the Maltese Islands. Preliminary results suggest that high microplastic counts in these locations could be due to these locations being exposed to a lot of wind and wave action. However, contribution from human visitors cannot be discounted. The results clearly indicate that 66.63% of the isolated particles (that is, a total of 7133 microplastic fragments) are smooth and either grey or white. This might mean that most of the particles collected from the four beaches are pre-production pellets (nurdles which have not yet been moulded into a plastic item). These pellets are occasionally lost from industrial facilities during the production process or from carriers during transit and are highly mobile given their small size, easily transported from land into the sea.

As a team, we are on a journey that will serve to quantify Malta's microplastic problem as well as highlight how dangerous and widespread microplastics are. This study adds to the movement attempting to claw us out of the hole we've dug ourselves into and reverse the damage plastic has been wreaking on our natural habitat for the last decades. We hope that next time you're on a beach running your fingers through the sand (and, inevitably, the microplastics in it) you will also remember your role in all this. At that point, ask yourself: What will my contribution to the solution be?