Pure water and extraordinary research in the Negev

The research of Prof. Sharon Walker of California examines how bacteria and other particles adhere to surfaces, brought her to the Zuckerberg Institute for Water Research to investigate these effects at Sde Boker.

By Eithan Karian

Prof. Sharon Walker, from the University of California, Riverside, is smiling as a response to the common question I ask her, and repeats and agrees that the water in Israel are of a very high standard and that she fearlessly drinks water from the tap. "The scientists and the engineers in Israel are among the best in the world in the field of water quality and desalination." This is the precise reason for her being in Israel on her sabbatical year as a part of an American Fulbright program for researchers and students exchange (Israeli participation in the program is managed by the Israeli-American education fund). According to prof. Walker, Israel is one of the leaders in the field, along with the Netherlands, Sweden and the United States.

In her research, Walker is focusing on the physiological, chemical and biological processes affecting natural and human source particles attachment to surfaces, a very important issue when it comes to treating water by removing those particles. Her research deals mainly with pathogenic bacteria, such as *Salmonella* and *E. coli*, which are under constant supervision by water authorities. The adhesion processes determine whether the particle will stay in water or adhere to a surface.

Biological polymers covering the cell allow them to adhere to surfaces; the adhesion capacity of bacteria is affected by several criteria. The bacteria are pretty smart, says Walker, and sometimes they are capable of choosing whether to stick to the surface or not by the nutrients available in the water, however as it appears later in the conversation, the choice is not always in their hands.

From the physical point of view, it is important to determine the affect of such factors as flow velocity, turbidity and the roughness of the surface. Of course the chemistry of the surface has a major impact on the adhesion, bacteria tend to bind to specific chemical groups, such as oxides found on the surfaces of minerals. Also, the composition of the suspended ions is very important. Different concentrations of calcium, nitrogen, chloride and additional ions contribute to the interactions of bacteria with the surface. Walker stresses out that from her point of view, it doesn't matter if a certain parameter improves adhesion or a repulsion of the bacteria from the surface. What is important is the fact of understanding of those parameters, an understanding that will improve our ability to remove the bacteria.

Designing new materials that allow absorption of bacteria is the study area of a few researchers in Zuckerberg institute for Water Research, because membranes have primary role in water desalination. The researchers are interested in preventing the attachment of bacteria, as much as possible; to prevent biofouling that clogs the membranes. This activity, taking place in the Zuckerberg institutes, is an example of implementation of Walker's research. Indeed, one study she took part in Israel was recently published in the prestigious *Langmuir* journal, which focuses on surface research, deals with adhesion prevention by a surface-attached molecule which alters the chemistry of the surface, making them uncharged and hydrophobic. Dr. Moshe Herzberg, Israeli colleague and academic host, says that not only does this compound

prevent adhesion; it interferes with the quorum sensing pathways and prevents biofilm formation.

This article underlines the main conclusion that stems from Walker's research: The most important factors to affect bacterial adhesion are not biological, but physico-chemical, specially, electrostatic forces. The bacteria are covered by protein polymers, explains Walker, that under the chemical conditions of water are almost always have a negative charge. These bacteria will be attracted towards surfaces that are positively charged. Those forces grow as the ionic strength of the water increase. At freshwater conditions, the most significant forces will be the repelling forces. This conclusion is contrary to a popular opinion claiming that microbes attach to surfaces to obtain more nutritious compounds. "But sometimes the electrostatic forces are so strong; they force the bacteria to attract or to repel just because those are the active forces. Just like we stick to the Earth, whether we want to or not".

As aforesaid, recently Walker begun to investigate new particles, non-biological nano-particles, which poisonous effects are not known and the medical community is worried about them. Walker reached the conclusion that the factors affecting their adherence are not significantly different from those affecting bacteria. The reason the research on this topic begun only recently, explains Walker, is the constant increase in nano-particles in water due to their infusion into consumer products such as toothpastes, and the growing concern regarding their effect. Additionally, just recently the tools allowing investigation of the nano particles were developed. Walker tags the particles, bacteria or nano-particles with fluorescent marker, and observes them under the microscope under different conditions, such as a parallel flow cell, to determine quantitatively the rate of adhesion to surfaces.

Though Sharon Walker’s research is primarily basic research, the practical implementations are clear. She collaborates with the experts from U.S. Department of Agriculture (USDA) at their pilot plants to consider how to improve water quality. During her stay in Sede Boqer Walker succeeded to initiate and approve of cooperative plan between Ben Gurion University in the Negev, USDA and University of California, Riverside for a researchers exchange.

At this point of our meeting, a baby’s cry interrupts the conversation. This is Ma'ayan, the new Sabra (term for a child born in Israel) of the Walker family, who was born here during her sabbatical year. As Sharon's husband calms the baby down, we transfer to a more personal talk. As an answer for my question on how the family fit in to Sede Boqer, she fills with enthusiasm. "Zuckerberg Institute for Water Research is an excellent institute", she says, and adds that never before she worked in a place where the cooperation between researchers from different fields was as fruitful. She praises the quality of life in Sede Boqer campus of Ben Gurion University of the Negev. "It is a special place with a social, cultural, academic an intellectual atmosphere which promotes research. Everybody here are concerned about environment and it is a small place that allows us to integrate socially. Moshe Herzberg approves all the above and adds that beyond the academic achievements, Walker won the appreciation of students as a lecturer. Walker explains that the students in Sede Boqer are highly evolved and very bright. "They are also more mature, and it was a pleasure to teach students who are actually my age" she says.

For Sharon Walker it is highly important to encourage teenagers, especially girls, to study science and engineering. She is active in several organizations in the U.S. that act to increase the relative proportion of women in research. Each year, 500-1000 young girls arrive to Riverside University, from first grade to high school, to break the stereotype and see that engineering in not an exclusive profession for boys. "I'm very

worried that in the future there will be shortage of engineers" sais Walker. "Therefore it is very important to direct effort to encourage girls to study this profession". We conclude our talk with a question that Walker uses to challenge with the children she meets with: "Can you think of anything you did today that didn't include the work of a scientist and engineer?"

Under her picture: Sharon Walker, who investigates how bacteria and other harmful particles in water adhere to surfaces, found a second home in Sede Boqer, a place where the climate is very much similar to the one at her home university in Riverside, South California.