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**Science by the sea: how nanoengineering met mechanobiology in
Camogli**

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A late summer evening of four years ago I was sitting on a small, stony beach in Camogli, a few kilometers east of Genova, on the coast of the Ligurian Sea. A line of stairs had led me to that corner of paradise through the narrow space between two tall and lightly colored buildings. Facing the sea.

Lingering under the last rays of sun, I looked up above. Large windows on a wall were framing what appeared to be a small conference room. I could see a man at the far side of it. From his gestures I realized he was giving a seminar, the audience hidden to me. After few minutes, I distinguished a handclapping and more people came in sight. A man and a woman, attracted like I was by the sunset in front of us, appeared on the front terrace, directly hanging on the sea. Light faded, and the streets behind claimed me back to the village. A few days later I left Camogli, the sea and that summer. The image of the conference and the pair on the terrace very vivid in my memory.

Later that year, at a dinner in Zurich, I was introduced to Massimo Vassalli, friend of a friend and fellow scientist visiting from Genova. Our shared research interests became immediately evident. We both were leading groups that developed engineering technologies for the application to biological and medical investigations. Mechanobiology was our common field. How we never met at a conference?

At the time Massimo was applying advanced Atomic Force Microscopy methods to the study of membrane mechanosensors (Soattin et al. 2016) while I was excited about the development of a nanoprinting technology to generate a novel Traction Force Microscopy platform (Bergert et al. 2016). So, Force Microscopy was for both, yet a single foreword divided our two scientific communities. We realized that technology developers, i.e. the engineers, and their adopters, the biologists and medical doctors, had very little occasions to meet and discuss at international congresses. Each category attended specialized meetings, where different scientific languages are spoken, further marking the divide.

Based on that dinner chat, Massimo had the brilliant idea of creating a venue where researchers in nanoengineering with interest in biological applications and biologists open to innovative technologies could meet, discuss and develop new ideas.

- *Yes – said I – but where?*
- *We have some facilities in Camogli. – Massimo replied.*

The couple on the terrace was now smiling at me.

A year later Aldo Ferrari and Massimo Vassalli made it real. At the verge of Spring 2016 the picturesque venue of the fishermen village was ready to open its doors to the first Nanoengineering for Mechanobiology (N4M) symposium. A nascent community of more than 40 scientists, interested in advanced technologies to study the role of forces and mechanics in biology, gathered to Camogli.

Since those early days, the atmosphere of the conference was maintained very informal, fostering interactions and leaving much space for questions and plenary discussions. In keeping with this philosophy, N4M evolved from the first pioneering experience to a broader event. In March 2017 it was organized in collaboration with the European project NICHOID (ERC Consolidator Grand led by Maria Teresa Raimondi at Politecnico di Milano) with the participation of 26 speakers and 60 attendees from more than 10 different countries. In 2018 and 2019 the N4M symposium further expanded, counting 70 and 80 attendees; respectively.

Each event left us with a feeling of scientific enthusiasm, already looking forward to the next edition. We were not alone. In these years, several participants returned to Camogli. Their attendance to multiple editions contributed to set what is now a traditional scientific event. At the end of March, Nanoengineering for Mechanobiology will happen in Camogli.

Among the N4M enthusiasts is Boris Martinac from the Victor Chang Cardiac Research Institute of Sydney. He attended to the last three editions of the meeting.

My link to the N4M symposia in Camogli is Massimo Vassalli, who as an Endeavour Research Fellow (funded by the Australian Government) spent two months in 2016 working on a mechanobiology pilot project in my laboratory. The project focused on specialized cellular proteins involved in the process of mechanotransduction. By turning into a success, the project offered a great opportunity for establishing a long-term collaboration between Massimo's and my laboratory. When Massimo told me about the Camogli N4M symposia and asked me if I would consider giving a presentation at the symposium in the following year, I happily accepted his invitation. Since my first attendance and participation at the N4M in 2017 I got hooked on both, the symposium and Camogli. The unique combination of engineering and biological sciences, the quality of presentations, the camaraderie between participants as well as the atmosphere and beauty of Camogli have all contributed to a wonderful experience I have had at the N4M symposia since the first time I went there.

Industrial interests grew with the years. In all, the 2016-2019 editions of N4M hosted more than 20 companies to present their products and services, encompassing Light microscopy and spectroscopy (Olympus 2019; Phiab 2019; Light Machinery 2019; Advanced Technologies 2019), scanning probe microscopy (Nanosurf 2019; Cytosurge 2019; JPK Instruments 2019; Elbatech 2019), force spectroscopy (Optics11 2019; Lumicks 2019), optical and mechanical components (Mad City Lab 2019; Physik Instrumente 2019), advanced materials and processing (Alveole 2019; Hylomorph 2019) and systems integration (Biofotonica 2019; Schaefer Italy 2019; FABCrea 2019).

A key ingredient of the symposium, a blow of fresh air at every new meeting, is the collaboration with a guest organizer. Together with Aldo Ferrari and Massimo Vassalli, the yearly renewed N4M organizing committee sets to embrace new aspects of technology and

mechanobiology. In 2019 Marco Capitanio from the University of Florence joined as guest organizer.

My first interaction with N4M was in 2018, thanks to Massimo Vassalli who intrigued me with his description of the conference and invited me there to give a talk. The format of the meeting immediately captured me, gathering in the same room researchers with very different backgrounds from biology to physics and engineering, leaving long time slots for discussion in an informal atmosphere, which stimulated new ideas and interactions. I soon realized that several research groups from my institute (LENS - the European Laboratory for Non-linear Spectroscopy in Florence), including mine, were working on developing optical tools for mechanobiology, so I happily proposed to co-organize the following N4M meeting together with my colleagues Leonardo Sacconi and Riccardo Cicchi. The N4M meeting was the perfect location to invite researchers interested in our field, discuss with them what the future directions might be, and it turned out to be a great opportunity to start new collaborations.

This special Biophysical Reviews issue features manuscripts from scientists attending one –or more - of the past N4M editions. The collection reflects the multidisciplinary interests of our audience.

Contributions on innovative devices and technologies for force measurement include the review on optical tweezers by Arbore et al., tracing the history of their development up to the current applications in single molecule mechanics and cell mechanobiology. Rollo et al, provide an overview on the technological and fabrication challenges towards the use of Field Effect Transistors (FET) for biological sensing.

Much attention is given to advanced optical methods and their application to force detection in biological specimens. The reviews on Traction Force Microscopy (Ferrari), high-speed force spectroscopy (Valotteau et al.), and Super-Resolution Microscopy (Magrassi et al.)

highlight the most recent improvements in temporal and spatial resolution required for force measurements and the study of cell mechanosensors at different length scales.

Fundamental subjects of such investigations are the transmembrane receptors through which cells sense and interact with their local environment. In this direction, comprehensive reviews on Focal Adhesion mechanobiology (Citi) and the role of Piezo1 mechanosensitive channels (Ridone et al.) introduce to the related cellular responses. Examples are given for mechanotransduction in neuronal cells (Chighizola et al.), in skeletal cells as response to flow (Alfieri et al.), and in mesenchymal stem cells (MSCs) during the phases of nucleo-cytoplasmic mass transfer (Boeri et al.). Topics that are further extended to cell collectives, at the tissue level (Vishwakarma and Di Russo) and in full organoid systems (Bayir et al.) leading to their application for regenerative medicine and the development of active biomaterials (De Masi et al.).

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