



**Miquel Alcaraz
 (1945-2022)**

Si em mor,
 que el cant siga ja realitat,
 Si em mor,
 que les esperances siguen fets
 i que d'altres continuen
 el que nosaltres continuem.

(Raimon, 1964)

If I die,
 may the song be a reality,
 If I die,
 may hopes be fulfilled
 and may others continue with
 the work we continue.

(Raimon, 1964)

Prof. Miquel Alcaraz passed away on 30 April 2022. He was a world-renowned marine zooplanktologist. We first met on the tram that we often took together on our way to the University of Barcelona. Suddenly, one day around October 1964, we started talking and I have the impression that we kept talking until, a few days before his death, he called me to say goodbye.

Alcaraz was born in Barcelona in 1945 in a family of nine siblings. He had to take on a variety of jobs from the age of 14 to contribute to his family's income. This probably helped him to obtain a close perspective on everyday reality and people's problems. He was a

great conversationalist, and this was a very important aspect of his life, because it led him to connect with people and to make friends everywhere. His facility for communication generated a positive environment around him.

We studied Biology together at the University of Barcelona from 1964 to 1969. Alcaraz had excellent scientific mentors. He learned zooplankton taxonomy with Francisco Vives at the Institute of Fisheries Research (IIP) in Barcelona. Under the direction of Ramon Margalef at the IIP and the University of Barcelona, he completed his doctorate on the species-spe-

cific segregation of copepods of the genus *Acartia* in estuarine environments with strong hydrographic gradients (Alcaraz 1977). Margalef was, I am sure, a fertile source of research suggestions for him, and Alcaraz undoubtedly played out Margalef's ideas to perfection when they were working together at the IIP in Barcelona. While working on his PhD, Alcaraz learned regional and chemical oceanography at the IIP in Vigo, where he spent almost four years, mainly interacting with Fernando Fraga. Later on, as a tenured researcher at the IIP in Barcelona, he made a major contribution to several studies on feeding, nutrition, movement and energetics of copepods with Rudy Strickler from the University of Wisconsin and Gustav Paffenhöfer from the Skidaway Institute of Oceanography (Alcaraz et al. 1980, Paffenhöfer et al. 1982, Alcaraz and Strickler 1988). Miquel and his colleagues had fun tethering copepods to a dynamometer using a dog's hair and filming their movement while taking physiological measurements. These copepods and the dog, of course, became film stars in a famous experiment that amazed the scientific community of copepodologists.

Influenced by his brother Félix, who was a sculptor, Miquel also developed great artistic skills that surprised those of us who knew him. In his research work and in his paintings, he showed three essential characteristics in approaching his objects of study and interest. Firstly, he was extremely curious. Secondly, when he observed, he did so with depth, with attention to detail. Thirdly, he was able to retain in his memory everything he had seen, heard and felt. He had a systemic scientific approach to thinking based on his great ability to classify the facts that he observed, to relate these facts to cause-effect relationships, and to compare different facts and processes until he was able to reach a synthetic insight. He then tested this vision with experimental designs that were usually innovative, imaginative and surprising. With these principles of action, formulating hypotheses to promote future research seemed to be easy and immediate. His critical capacity was subtle and thorough. I shall mention one of his studies, namely the criticism of the Metabolic Theory of Ecology and its limitation when it was applied to the study of processes such as respiration and excretion of nitrogen and phosphorus in high-latitude planktonic crustaceans (Alcaraz 2016), an excellent study that I recommend for educational purposes in basic research.

In my view, Alcaraz showed a dual preference when choosing research topics. First, I presume Miquel was influenced by the literature of adventure and great expeditions: the ocean seen as the best scenario for infinite adventures. He admired Hackel, Humboldt, Banks and Darwin, among many other expeditioners, oceanographers and polar and tropical travellers. During his career he conducted large-scale oceanographic research in the seas he had always read or dreamed about. He worked in the Arctic (Alcaraz et al. 2010, Alcaraz et al. 2013, Duarte et al. 2012), Antarctica and the Southern Ocean (Alcaraz et al. 1998, Alcaraz et al. 2014), and in the Mediterranean (Calbet et al. 1996, Calbet et al. 2001, Alcaraz et al. 2007a, Alcaraz et al. 2016). His adventurous and artistic spirits became almost satiated

during the second Malaspina circumnavigation expedition in 2010, on which he was invited as a scientist and the graphic chronicler of the cruise! Second, Miquel was interested in the small things, and hence the duality in comparison with large-scale oceanography. This interest was related to his main working tool: the stereoscopic microscope. He wanted to see what went on at the scale of individual plankton organisms, the resulting population dynamics and interspecific variability.

In 1997, Alcaraz carried out an assessment of the importance of turbulence in the behaviour of copepods (Alcaraz 1997). This article reviewed a fruitful research line to show the effects of turbulence on small organisms at a time when such studies were not yet mainstream. He and other colleagues developed several methods (Alcaraz et al. 1989, Saiz et al. 1992) for studying the effects of small-scale turbulence in the laboratory. He published papers on the explicit influence of turbulence on grazing behaviour and metabolism (Alcaraz et al. 2007b), on development and growth time (Saiz and Alcaraz 1991), on feeding time related to gross growth efficiency (Alcaraz et al. 1989), and even on the heartbeat frequency of small zooplankton crustaceans (Alcaraz et al. 1994).

With the turn of the century, Alcaraz looked more intently at community level variables, namely production, respiration and stoichiometry changes within the biogeochemical cycles of nitrogen and phosphorus (Alcaraz et al. 2002, Alcaraz et al. 2010). At that time of his career, a scientific cycle was completed. Alcaraz's research had evolved through three phases: an early, mainly descriptive phase in which he carried out extensive research in various geographical areas; then a mainly experimental phase in the laboratory; and, closing the loop, a phase of linking the incidence of microscale phenomena to biogeochemistry at the regional level. All these stages were coherently supported by the common concept that turbulence at small scales is key to understanding processes at larger scales.

My impression is that Miquel Alcaraz lived intensely, enjoying the discovery of small things and remembering what he had seen before as if it were the first time he had experienced it. When I was with him, he filled the room with his wit, anecdotes and conversations on research into ecology, cinema, travel and many other topics.

I thank Miquel's wife, Francesca Burgueño ("Paqui"), and Francesc Peters, Enric Saiz, Albert Calbet Celia Marrasé and Marta Estrada for helping me confirm some information. I beg your forgiveness if this obituary ended up too personal. I must confess that I have always felt Miquel's was a parallel life to my own, as a young man, during our lives and especially during this last year, when, together with Paqui and his daughter Marta, he bravely faced his illness with great dedication, despite moments of pain and deep discomfort. Miquel Alcaraz was a unique person with a strong personality characterized by humour and drive, and an unusually extensive knowledge on the most varied subjects. We miss him greatly, but we are fortunate to have his scientific and artistic legacy.

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