Giuseppe Bertani (1923–2015)

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Professor Giuseppe Bertani (Joe to friends) died on the 7th of April 2015 at the age of 91 years in Pasadena, California, USA. As a pioneering microbial geneticist he helped to develop this field of research into one of the precursors of the molecular biology of to-day. He was born in Como, Italy, on the 23rd of October 1923 but grew up in Milan with his mother, father, sister and brother. He was in his mid-teens when the shadow of the upcoming war spread across Europe. After finishing elementary school he attended the University of Milan. In 1945 he obtained a Laureat in Natural Science (DSc. Zoology). His professors were Silvio Ranzi in zoology and Claudio Barigozzi in genetics. Silvio Ranzi got him a fellowship at the Zoological station in Naples for two years and afterwards Claudio Barigozzi arranged for him to do genetic research with Ernst Hadorn at the University of Zürich, Switzerland. Here he studied developmental problems in *Drosophila melanogaster* such as induction of male pigmentation in somatic cells of *Drosophila* ovaries.¹

In October 1948 he arrived at the Cold Spring Harbour Laboratory (CSHL) on Long Island, N.Y. as Carnegie Fellow to work in Milislav Demerec's group. Rather soon he decided to shift from *Drosophila* genetics to the then very new microbial genetics and it did not take long before he was off measuring reverse mutation rates in a streptomycin dependent mutant strain of *E. coli* after exposure of

agents such as radiation or chemicals,² in fact much like the Ames test that was developed later. Here he met Gus Doermann, his first American friend.³ Gus was working on phage T4 at that time. It was on his petri dishes Joe saw phage plaques for the first time, and it was from Gus that Joe learned about The Phage Group. In early 1949, still at CSHL, he encountered lysogeny for the first time.⁴

Joe attended Max Delbrück's phage course at CSHL in 1949, and in the fall that same year he joined Salvador Luria at Indiana University in Bloomington as a research associate. Here he proposed for Salvador Luria to study lysogeny. At first Salvador Luria was somewhat reluctant, but provided Joe with the lysogenic *E. coli* Lisbonne strain and a *Shigella* strain so he could start working on lysogeny. Using, what he called, a modified single burst technique in combination with a streptomycin resistant *Shigella* mutant indicator he had isolated, he could demonstrate that phage production by a lysogen was discontinuous involving rare, large bursts of phage.⁵ Now a range of questions appeared about lysogeny, such as the establishment and state of the prophage, what about superinfection immunity, is there a substance that blocks the development of superinfecting phage? As it turned out the Lisbonne strain produced 3 different phage, that he named P1, P2 and P3 respectively, but P2, the non-inducible phage, was to become his primary phage of study. In these studies⁵ he had composed the LB medium which later has been referred to as Luria broth, Lennox broth or Luria-Bertani medium. For the historical record, Joe has pointed out, that the abbreviation LB was intended to stand for "lysogeny" broth.⁴ Outside lysogeny his discovery of "host controlled variation" together with Jean Weigle represents an important contribution published in 1953,⁶ but it should take more than 15 years before the phenomenon was understood and led to discovery of restriction enzymes. Joe remained as Salvador Luria's research associate also after Salvador Luria, in 1950, moved

his laboratory to the university of Illinois, Urbana-Champaign. His tenure with Luria lasted for almost 5 years.⁷ Having met already at phage meetings at Ann Arbor and Cold Spring Harbour, it was in Urbana Joe and Elizabeth (Betty to friends) Teegarden met and got married. Betty was then a first year graduate student at the university in Urbana.

In 1954 Joe joined the laboratory of Max Delbrück at Caltech who hired him as a senior research fellow. He had briefly visited Caltech some time before working with Jean Weigle.⁶ It was at Caltech Erich Six started to work with Joe on phage P2. The plan had been that Erich Six should work with Max Delbrück, but being on sabbatical at the time Joe was asked to take care of Erich Six.

In 1957 Joe took up a professorship in the medical school at University of Southern California (USC), Los Angeles. Werner Arber joined Joe at USC as a research associate 1958-59. He has commented on the stay and generosity of Joe in a short recording called Bacteriophage P1.⁸ Werner Arber was awarded the Nobel prize in Physiology and Medicine (jointly with Daniel Nathans and Hamilton Smith) in 1978 for the discovery of restriction enzymes and their application in molecular genetics, a discovery with roots in the Bertani-Weigle paper of 1953.⁶ At this time Martha Chase had become Joe's Ph.D. student but as things developed she came to finish her thesis in Stockholm, Sweden, as his tenure at USC was to be short.

In 1948 Joe visited Stockholm while attending the International Genetics Congress. He is listed as an affiliate of the Cold Spring Harbor Laboratory in the congress material, although he was still with Ernst Hadorn in Switzerland at that time. His next visit to Stockholm was in the late fifties, when he attended a smaller meeting on microbial genetics. During that meeting Joe was asked, informally, if he could imagine to come to the Karolinska Institute to promote research in microbial genetics. So he did, joined by his

wife Betty Bertani, first as a visiting scientist, but in the early sixties appointed professor in microbial genetics at the Karolinska Institute by an act of the Swedish Riksdag (Parliament). From now on, studies of phage P2 became the focus of the Bertani lab. In these years a steady stream of post-doctoral fellows filled his laboratory in addition to his students and many distinguished visitors passed by his laboratory, such as his friend James Watson, when he received the Nobel Prize in 1962. One of us (BHL) can remember a pleasant evening in Joe's and Betty's apartment in Stockholm in the company of Gus Doermann during his visit to Stockholm around 1968. That year Erich Six spent the fall in Joe's lab. Erich Six had brought satellite phage P4, discovered by him a few years earlier, to Stockholm. The P4 dependence of P2 as a helper phage greatly enhanced the P2 studies. In addition to his obligations at the Karolinska Institute Joe was also responsible for the advanced teaching of microbiology at the University of Stockholm while the undergraduate teaching was in the charge of a university reader. One of us (EHL) has a vivid memory of the first meeting with Joe. Taking the microbiology course at Stockholm University with BHL as reader, we had to take an oral examination for Joe who we never had met, in English, which we feared. However, we were met by a very friendly man who clearly enjoyed discussing science rather than asking about the facts in the textbook. His influence on the scientific community in Sweden grew gradually and pioneered the development of the "new biology" in Sweden. His pioneering work was recognized by Uppsala University where he received a honorary doctorate (Hedersdoktor) in 1982. During this time he participated in establishing the European

Molecular Biology Organization (EMBO) and he was often called upon as a specialist when professorships, most often in microbiology, were to be filled. By 1981, after more than 20 years in Sweden, he resigned from his professorship to take up a position at the Jet Propulsion Laboratory (JPL) in Pasadena, California.

At JPL he started to study genetics of methanogenic bacteria and described a curious phenomenon of transduction. In a paper from 1999 one can read the following summary. "The methanogenic archaeobacterium *Methanococcus voltae* (strain PS) is known to produce a filterable, DNase-resistant agent (called VTA, for *voltae* transfer agent), which carries very small fragments (4400 bp) of bacterial DNA and is able to transduce bacterial genes between derivatives of the strain. Examination by electron microscopy of 2 preparations of VTA that were concentrated and partially purified by different methods showed virus-like particles with isometric heads, about 40 nm in diameter, and with 61 nm long tails."⁹ After his retirement from JPL in 1991, Joe continued as a voluntary scientist in the division of Biology at Caltech, that very same institution he had joined in 1954. In 2005 he was elected Foreign Member of the Istituto Lombardo Academy of Science and Letters, based in Milano, Italy.

Through the years, scientists and students interested in phage P2 and related phages and the satellite phage P4 got together at informal meetings organized by members of the P2-P4 community to exchange ideas, new findings and planning collaborations and joint publications. The P2-P4 community was never large but spread over the world, which made these meetings important to encourage collaborations rather than competitions.

Joe was highly critical but generous when it came to publishing. He rarely put his name on his students work when they were ready to publish their results, which is also confirmed by Werner Arber in his recording.⁸ Joe was an outstanding scientist with a philosophical touch, belonging to that dwindling group of pioneers in microbial genetics with roots in the legendary Phage Group. We thank him for taking us on a marvelous journey in science, with him as our guide, and for his friendship. Our thoughts are with Betty Bertani and their 2 sons, Christofer and Niklas with families including the whole Bertani family.

Disclosure of Potential Conflicts of Interest

No potential conflicts of interest were disclosed.

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