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Lourens G. M. Baas Becking (1895–1963), Inspirator for many (micro)biologists

The town of Delft, in the Netherlands, may be proud of having been the habitat of three outstanding founders of modern microbiology: Anthony van Leeuwenhoek in the 16th century, Martinus W. Beijerinck at the end of the 19th century and later in this century his successor in the chair of

microbiology Albert J. Kluyver. Lourens G. M. Baas Becking might have become a fourth name in this honourable series had he continued his studies at the technical university in Delft. But early in his career he switched to biology at the University of Utrecht, where he became an assistant professor at the Plant Physiology Department, under the famous plant physiologist F. A. F. C. Went. Becking's scientific interest was heavily influenced and inspired by the great microbiologists from Delft, especially by the work of Beijerinck. It was Beijerinck's application of the use of selective nutrient media which became the base for Baas Becking's general view of the role of bacteria in the cycle of nutrients in the biosphere and the interactions between life and earth. Long before Lovelock's Gaia hypothesis, Becking introduced the concept of Gaia for these mutual interactions in his inaugural address "Gaia or Life and Earth" as professor of general botany at the University of Leiden in 1931 [2].

Lourens Baas Becking was born in Deventer on January 4th, 1895. After his final examination in biology in Utrecht he moved to the USA, where he worked at the laboratory of the renowned geneticist T. H. Morgan. His thesis after his return to Utrecht, "Radiation and Vital Phenomena", was based mainly on work done in the USA. In 1923 he was appointed professor at Stanford University in Palo Alto, California, USA, where he taught economic botany and plant physiology. There he became fascinated with life under extreme environmental conditions, like those in salt-lakes, and soon his main interest turned to the interactions between living organisms and their environment. His appointment as director of the Jacques Loeb Marine Laboratory in Pacific Grove gave him the best opportunity for research in this field.

In 1930 an appointment as professor of general botany at the University of Leiden brought him back to the Netherlands. His arrival in Leiden must have been perceived as a thunder-storm in the still conventional atmosphere of



Fig. 1 Lourens G. M. Baas Becking (1895-1963)

the Botanical Laboratory. He introduced new concepts in biology: ecological approaches in both field and laboratory research, and the application of modern developments in physics and chemistry in the realm of experimental biology.

The observations made in the Californian salt lakes formed the base of a new research program. The study of salt lakes all over the world made it clear that certain organisms, which were highly adapted to these types of environment, could be observed in salt lakes widely dispersed geographically. Special research was made on the alga *Dunaliella viridis* [1], and the species of the crustacean *Artemia* [10]. These natural distributions, compared with earlier laboratory observation by Beijerinck (e.g. on *Sarcina ventriculi*), led Becking to formulate Beijerinck's ideas into two general laws. The first law for those organisms, especially micro-organisms, for which no difficult problems of distribution were limiting, stated that "everything is everywhere"; the second: "the environment selects".

These laws, together with their applications to (micro)-organisms with different metabolic characteristics and the consequences for their distribution on earth, formed the basis of the research program at the Leiden Botanical Laboratory. A series of lectures on these topics was given for the scientific society "Diligentia" in the Hague. They were published, unfortunately only in Dutch, under the title "Geobiology" [3]. I translate from the introduction to this book: "*These lectures are an effort to describe the relation between the organisms and the earth. The name "Geobiology" merely expresses this relation. This new word does not want to describe a new discipline. It tries to unite under one point of view, as far as possible, phenomena which already were known in different areas of biology*". The book contained a series of chapters on environment with emphasis on factors such as radiation, temperature, chemical characteristics (pH, carbon dioxide, ion-balance) and especially the role of water. After a description of the cycles of C, N and S, general principles were applied to special types of environment: oligotrophic, eutrophic, oceanic and brine types.

The fundamental importance of photo-radiation for life on earth stimulated further studies on photosynthesis, especially the structure of chlorophyll and its configuration in chloroplast membranes [6]. These studies were inspired by ideas about the structures of biological membranes put forth by his colleague in medical biochemistry, H. G. Bungenberg de Jong.

The unique combination of plant physiology, ecology and microbiology, both in Becking's teaching program and the research in his department, led to several studies by PhD students on symbiotic associations [7, 9]. The results of these studies inspired him to develop a new definition of symbiosis: "*all mutual dependence of vital-units (cells, tissues, organs, organisms) either of a parasitic, mutualistic or commensalistic character*". It might be objected that such a broad definition of symbiosis takes much away from the original definition.

However, the present insight in the role of biochemically related signals in differentiation and morphogenesis, as well as in plant (or animal)-microbe interactions, shows that it can now be considered as a far-seeing view. Unfortunately, the situation at the beginning of World War II prevented Becking from writing a well-documented publication on this universal concept of symbiosis [4, 5]. He did, however, ask me to include a short description of his concept of endosymbiosis in the introduction to my PhD thesis of 1943 [9], which alas has remained its only published form.

Meanwhile his life had taken a new course. His restless mind prevented him from restricting his interest to only one field. Besides the different fields of research which he encouraged in his laboratory, he organized the restoration of the historical botanical garden of Leiden University. Returning from a visit to Australia to study the salt-lakes, he visited the famous Botanical Garden of Buitenzorg (the present Bogor) on the island of Java. The neglected gardens were in a pitiful state. He convinced the authorities that this situation was unacceptable, which led to his appointment as Director of "s Lands Plantentuin" in 1940. With his family already in Java, he returned for a short time to Leiden where he gave his valedictory lecture on April 24th 1940, a few weeks before the attack by the German army. The subsequent five years of German occupation prevented him from going back to his work and his family in Java. His very strong rejection of nazi ideology played a major role in the struggle between the Leiden University with its maxim "Presidium Libertatis" and the occupying forces. He twice tried to escape to England leading to a temporary and a definite imprisonment respectively, the last time nearly leading to his execution. During the last months of the war he spent his time of imprisonment studying the then developing epidemic of typhoid fever in his prison-camp and even found the mental strength to begin, under those circumstances, writing a book on Geobiology. When the war was finally over he learned that his eldest son had died in battle on the Java-sea. The Indonesian Revolution prevented him from starting his plans for the garden in Bogor. In 1948 he was appointed vice-president of the scientific council of the "South Pacific Commission" and moved to New Caledonia. It was there that his wife died in a traffic accident.

He found the possibilities for a normal life again in Australia, where he obtained a post in the "Commonwealth Scientific and Industrial Research Organization", first in the Oceanographic Institute in Cronulla N. S. W., later in Canberra. His influence there was so great that the Bureau of Mineral Resources established a "Baas Becking Geobiological Laboratory", which after his death was continued under the direction of Dr. Ph. Trudinger. Though Baas Becking was of course grateful for this sign of recognition, he had to realize that it had come too late for him. His health declined due to a heart attack which led to his death on January 6th, 1963.

In one of the obituaries after his death, Professor V. J.

Koningsberger, from the University of Utrecht, wrote: “*Baas Becking was without any doubt one of the most gifted biologists of his time. He moreover had great talents, as well, in other sciences and the arts. His ideas were nearly always original and not rarely genius. His spirit, however, was so restless, that in most cases he did not allow himself the time to thoroughly test his ideas and to elaborate them*” [8]. I agree with this statement, but must add that this was compensated by his enormous inspiration and the stimulation of his students and collaborators. From my own personal experience I realize that this inspiration has influenced my whole scientific life. The same can be said of many of his students and collaborators in California, in Leiden and in Australia. They therefore all will regret that, beside the small Dutch book on “Geobiology”, no book or review from his hands is available in a more international language [11].

There exists a manuscript for such a book written around 1950 and discovered in 1976 when his former secretary in the South Pacific Commission, Mrs. L. Dgraffy-de Peski, brought her copy to the attention of some Dutch biologists. It appeared to be the manuscript for the book he started when imprisoned by the Germans. Additions were made in Cronulla in 1950 and it appears to be the extended and internationally published version of his earlier Dutch book on “Geobiology”, which had the same title. The original manuscript of some 750 pages is now kept in the library of the Royal Netherlands Academy of Sciences in Amsterdam. It has been reproduced and copies have been distributed among a few interested biologists and biological libraries in the Netherlands, including the library of the Botanical Laboratory (today in the Clusius Laboratory) of the University of Leiden. Unfortunately, all of the approximately 350 figures are lacking, though a few were recovered during my visit to Dr. Ph. Trudinger in Canberra in December 1981. This lack of essential documentation makes the publication of the manuscript in its present state impossible. Still more important is the fact that the manuscript was finished prior to modern insights in biology thanks to the discoveries in molecular and cellular biology. Many conclusions and considerations in the manuscript certainly should have been re-written by Baas Becking in the light of this later knowledge. Therefore, it is a great pity that only a very limited number of (micro-)biologists were aware of the content of a manuscript which certainly could have had a great influence if published in the early fifties.

When we compare the text of the manuscript with the Dutch book of 1934 we recognize the same concept: chapters on “the earth”, “the organisms”, “milieu”, “water”, “the influence of the organisms on the milieu”. An extensive chapter on “symbiosis”, including the old topic of nutrient cycles, and a final chapter on “Man” are new. Of course, these chapters contain far more up-to-date (in 1952!) data if compared with the older book. There are, however, discrepancies between the chapters.

Many chapters have a text-book character. The chapter

on “water”, however, is a comprehensive monograph. From correspondence with the editor of the “Chronica Botanica Series”, Dr. Frans Verdoorn, we know that the latter suggested publishing this chapter as a separate volume. Baas Becking rejected this proposal, though some papers found in Canberra in 1981 indicate that he was working on a monographic book on this topic during his later years.

In the two new chapters, “Symbiosis” and “Man”, we find much discussion on the relation between life and earth, of evolution and the role of man in the biosphere. The broad concept of symbiosis, best illustrated by a verse from a poem by Shelley: “*nothing in the world is single*”, is extended to man’s place in the biosphere and his dependence on nature. Here again the concept of Gaia is used and extended. “*Man is not alone*” and, as all other organisms, is highly dependent on the other participants of the biosphere. Man is part of a general symbiosis in which he must participate, but where he has made himself responsible for the stimulation of different aspects of dissipation. “*The impact of mankind is no longer solely dependent upon its number, but on its power. A single man, by using all of the modern tools, could create more havoc than the armies of Attila, Gzenghis-Khan and Timur-Lenk combined*”... “*Humanity has become a geochemical factor of importance, it has become a force tending to create its own biocenosis, its own successions... But, being men ourselves, we hesitate to admit that we, by divine right proprietors of this earth, and as such exalted, are equally subject to the laws of nature*”... “*The attitude of man towards the earth is still, on the whole, that of a parasite. For a parasite, nevertheless, the life of the host is of prime importance*”.

Let us not forget that such remarks, now perhaps common in discussions on environmental problems, were highly original in 1952 and, unlike many more recent discussions, were based on a thorough knowledge of existing data on the nature of living organisms, their relations with the environment and their mutual interactions.

Baas Becking’s enormous influence on all who had the fortune to call themselves his students, and many others, was a consequence of his own enthusiasm for the study of life on earth and his awe for its mysteries. This may be illustrated by the words in the last letter he wrote me shortly before his death: “*I think it delightful to have been a naturalist*”.

Notes and references

1. Baas Becking LGM (1930) Salt effects on swarms of *Dunaliella viridis* Teod J Gen Physiol 14:765-763
2. Baas Becking LGM (1931) Gaia of leven en aarde. Oratie gewoon hoogleraar Rijksuniv. Leiden, Mart. Nijhoff’s Gravenhage, 20 pp
3. Baas Becking LGM (1934) Geobiologie of inleiding tot de milieukunde Diligentia Wetensch. Serie 18/19, van Stockum’s Gravenhage, 263 pp
4. Baas Becking LGM (1938) Symbiose, Verslagen Gewone Vergaderingen

- Kon Nederl Acad van Wetensch. Af Natuurkunde 47:67-70
5. Baas Becking LGM, Quispel A (1945) Symbiose als stofwisseling Verslagen Gewone Vergaderingen Kon Nederl Acad van Wetensch. Amsterdam Jaarboek 1962/1963, pp 369-375
 6. Hanson EA, Meeuse ADJ, Baas Becking LGM (1938) A note on the chlorophyll content of the granum. *Chronica botanica* 4:104-106
 7. Jongh Ph de (1938) On the symbiosis of *Ardisia crispa* (Thunb.) A. DC. *Verhandelingen Kon Ned Akad Wetensch Afd Natuurkunde sectie 2*, part 37, number 6.
 8. Koningsberg VJ (1963) Levensbericht L. G. M. Baas Becking Kon Ned Acad Wetensch. Amsterdam Jaarboek 1962/1963 pp 369-375. See also: Went FW Obituary Dr. LGM Baas Becking *Nature* (London) 198: 134
 9. Quispel A (1943) The mutual relations between algae and fungi in lichens. *Rec Trav Bot Neerl* 40:413-541
 10. Warren H, Kuenen D, Baas Becking LGM (1938) On the relation between internal and external medium in *Artemia salina* (L.) var *principalis* Simon, *Proc Kon Ned Akad Wetensch. A'dam afd natuurkunde* 41:873-878
 11. Westenberg J (1977) A bibliography of the publications of Lourens G. M. Baas Becking, North Holland Publ Comp, Amsterdam, 20 pp (*Most references mentioned above were selected from this comprehensive list of publications*)