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James E. Vanderplank: South African and globally recognised plant pathologist

James Edward Vanderplank, best known to plant pathologists globally simply as 'Vanderplank', is widely regarded as one of the world's most influential plant scientists. This recognition stems from his reputation as the founding father of modern quantitative plant disease epidemiology.[1] Professional plant pathologists and students in the discipline are familiar with Vanderplank's work as it provides a theoretical framework to study disease epidemics and breeding for disease resistance. The United Nations declaration of 2020 as the international Year of Plant Health provides an apt opportunity to reflect on the contributions Vanderplank has made to both plant pathology and plant breeding.

Vanderplank was born in 1908 in Eshowe (KwaZulu-Natal, South Africa). He was the youngest of four children. His father, Walter, was a solicitor and his mother, Agnes, a nurse. Although his name might suggest otherwise, he came from an English background[2], with his surname having been anglicised in the 18th century to Vanderplank. His British ancestors were of Flemish–Belgium descent.[2] His grandfather, John Vanderplank, emigrated to South Africa in 1838 and was responsible for bringing *Acacia mearnsii* (black wattle) seed into South Africa from Australia in 1864, to be used for the production of tannins needed for the leather industry.[3] Vanderplank attended Eshowe Primary School and completed his secondary education at Durban High School for Boys. It is intriguing to know that, prior to his retirement in 1973[1], he used van der Plank, the Dutch form of his surname, but in his subsequent publications, he chose to present his name as Vanderplank. This has led to some confusion in the literature with scientists unsure whether these two names refer to the same person.

After his primary and secondary education, Vanderplank obtained a BSc from the University of Natal in 1927. He completed a MSc in Botany (1928) under the supervision of Prof. J.W. Bews at Natal University College (now the University of KwaZulu-Natal) who taught him plant ecology. Known to be a great admirer of Bews, Vanderplank commented that the knowledge he acquired from Bew's teachings was used in a chapter of his 1975 book *Principles of Plant Infection*.[2]

In 1928, Vanderplank was appointed as a mycologist in the South African Department of Agriculture. He continued his studies and obtained a second MSc in Chemistry (1932) from Rhodes University College where he was taught by Prof. JLB Smith, later to become the famous ichthyologist. Vanderplank suggested jokingly in his autobiographical preface in the *Annual Review of Phytopathology*[2] that Smith probably left chemistry to study fish after the traumatic effect of teaching him. The following year he was awarded an 1851 Exhibition Scholarship to undertake a doctorate in Graz, Austria. However, because Hitler had just assumed power in Germany and Nazi terrorism had begun to destabilise Austria, Vanderplank entered a PhD programme in botany specialising in physiology at Imperial College London. His PhD, awarded in 1935, was supervised by the renowned Prof. Vernon Blackman FRS and focused on plant photosynthesis and the biosynthesis of sugars.

After completing his PhD, he returned to South Africa and to his employment in the Department and met and married Elsa Niemeyer, a botanical artist. He was then transferred to the Low Temperature Laboratories at the Cape Town docks as a biochemist to work on the preservation of fruit for export. While there, he developed a method of bleaching oranges to remove rust spots and this formed the basis of his second doctoral thesis in chemistry, conferred by the University of South Africa in 1944. Vanderplank returned to Pretoria in 1941 and began his research career in plant pathology. In 1958, he became Chief of the Division of Plant Protection. He was appointed director of the newly established Plant Protection Research Institute in 1962 and remained in that position until 1973[1] when he retired.

Much of Vanderplank's career was spent doing what he termed 'down-to-earth' potato breeding.[2] During World War II, seed potatoes were in short supply as they were imported from Scotland. Vanderplank persuaded the South African government to allow him to establish a potato breeding programme. This research was undertaken in greenhouses at Vredehuis, close to the Union Buildings in Pretoria, as well as at the Vaalharts Irrigation Scheme. While in Pretoria he was known to meet his visitors in dirty overalls after planting potatoes. They often mistook him for a labourer and he appeared to delight in this anonymity. One author (MJW) remembers as a young and inexperienced plant pathologist being introduced to Vanderplank during a Vredehuis morning tea break and expressing his delight in having the honour of meeting the famous man. Vanderplank simply answered with the single word 'baloney'. This illustrates his understated nature and his down-to-earth humility.

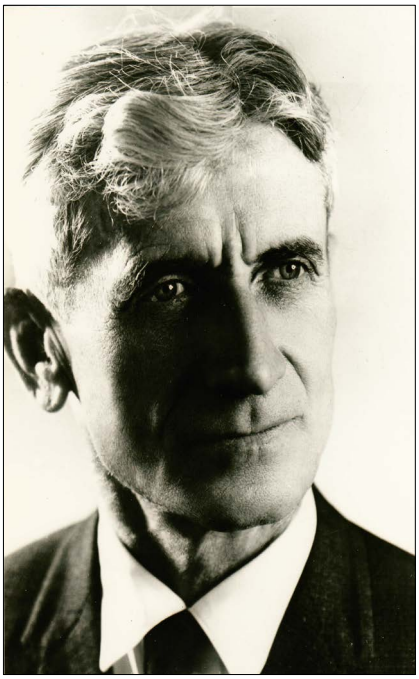
Vanderplank was particularly proud that one of his potato cultivars was named after him. He had predicted that, in the future, 60% of all potatoes grown in South Africa would come from his breeding programme.[2] Although true at the time, owing to substantial subsequent advances in potato breeding, this is no longer the case. Yet the cultivar 'Van Der Plank', known for its excellent eating and processing qualities, remains the most popular early maturing potato variety in South Africa.

While plant breeders and potato growers in South Africa know of Vanderplank for his potato breeding, his global fame rests on introducing a theoretical framework to our understanding of plant disease epidemics and disease resistance. Vanderplank was often heard to say that he had never attended a single course in plant pathology, genetics or plant breeding. To his many followers, this was truly remarkable given his later reputation as one of the world's most highly recognised scientists in all three of these fields. His interest emanated from the work he conducted after formal office hours and during his holidays, analysing the published research work of others. He regarded himself as a 're-viewer of evidence'[2].

Vanderplank's interrogation of previous studies led him to interpret the published data such that he often arrived at conclusions different from those of the original authors. Based on these views, and his alternative hypotheses, his first, and arguably his most famous book, *Plant Diseases: Epidemics and Control*[4], was published in 1963. This book has been reprinted several times and has been cited at least 2800 times. More importantly, it was often used as a textbook, which over the years has introduced scores of plant pathologists and plant breeders to the world of plant disease epidemiology.

Vanderplank's particular contribution in 1963 was that he was the first person to propose a 'unifying' theory on plant disease epidemiology.[3] Essentially, he suggested that epidemiology represents the science of diseases and pathogens in populations. These ideas were not only new and applicable to plant pathology but also to the broader field of epidemiology and across many fields of biology. Importantly, Vanderplank used mathematical models, such as the monomolecular and logistic equations and infection rates, to quantify the relationship between the amount of inoculum and disease progress. Although his descriptions, including the simple and compound interest analogy, were an oversimplification of monocyclic and polycylic development of a disease over time and space, they undoubtedly inspired research on disease dynamics.[5]

Vanderplank established the terms 'vertical resistance' and 'horizontal resistance' in his 1963 book and extended this concept in 1968 in *Disease Resistance in Plants*.[6] These remain fundamental principles of plant pathology and terms crucial to the field of disease resistance breeding. Vertical resistance refers to when a plant variety/cultivar is bred to have complete resistance to particular races or strains of a pathogen which is controlled by a single gene in the host. By contrast, horizontal resistance refers to when a plant variety/cultivar is bred to have a general level of resistance, or incomplete resistance, to many races or strains of a pathogen, which is controlled by multiple host genes. These concepts of horizontal and vertical resistance were debated by many researchers in the fields of plant pathology and plant breeding.



James E. Vanderplank [photo courtesy of Elspeth van Duuren]

Vanderplank's concepts and ideas not only fuelled debate but more importantly forced many researchers to conduct detailed experiments and to consider their data differently. An appropriate example can be found in the landmark paper by Parlevliet and Zadoks[7] who convincingly showed that horizontal and vertical resistance do not represent different forms of resistance but are a continuum. Using more detailed analyses, they showed that horizontal resistance can involve specific multiple additive interactions, but in some cases can also be conferred by a single major gene. They also suggested that the value r (rate of infection), as used by Vanderplank, is an inaccurate measure for quantitative resistance and certainly of no value for breeders because its assessment is quite laborious.[7] A more commonly used method today is to measure the area under the disease progress curve. These examples illustrate how notable plant pathologists utilised and tested Vanderplank's theoretical framework when dealing with host plant resistance, thus substantially advancing the field of plant disease epidemiology.

While Vanderplank's theories and concepts may not be applicable to all pathogen systems, he clearly incited plant pathologists to question his views. However, the challenger needed to be prepared with rigorously analysed data or face Vanderplank's often-used response 'please go and do the experiment and prove your point'.

Vanderplank's 1963 book introduced the 'vertifolia effect' in which horizontal resistance is eroded during breeding for vertical resistance. The story behind this demonstrates his penchant for reading. He is known to have conceived the 'vertifolia effect' during his visits to the library in Wageningen (the Netherlands) during an international potato conference held in that city. Publication of his 1968 book led to intense and heated debates amongst the scientific community, with many researchers intent on proving or disproving his theories regarding plant resistance to disease. He was later shown to be fundamentally incorrect regarding horizontal resistance because it cannot be proven experimentally.[8] The terms 'vertical resistance' and 'horizontal resistance' are used less frequently today but race specificity and race non-specificity remain central concepts in the quest for durable resistance in crops.

By the late 1960s, Vanderplank was globally recognised and widely sought after as guest speaker at international congresses. He preferred not to travel and was known to have declined many opportunities and invitations that could have added to his stature. In addition, the peak of his fame came at the same time as the height of South Africa's apartheid era. The academic boycott led to his being prevented, on at least one occasion, from presenting an invited lecture in the Netherlands. Knowing of his country's pariah status might, in part, have influenced his reticence to speak at international meetings or to receive awards when these were suggested to him.

After 1968, Vanderplank published three additional books: *Principles of Plant Infection* in 1975[9], *Genetics and Molecular Basis for Pathogenicity* in 1978[10] and *Host-pathogen Interactions in Plant Disease* in 1982[11]. In the last of these, he extended and elaborated on some of his earlier basic ideas and re-argued the basis of resistance and the development of epidemics. There were several objections to his ideas and innovative theories. It has been suggested that his later books were less worthy and detracted from the impact of his first two and most important contributions. This seemed not to bother Vanderplank and it certainly did not diminish the 'greatness'[12] of this South African scientist with a remarkable mind.

In 1966, Vanderplank spent 6 months in the Department of Plant Pathology at Pennsylvania State University (USA) working with Prof. C. Wernham. At that time, the Department had just initiated a programme in plant disease epidemiology. He was that University's first distinguished visiting professor, and he found that he had both admirers and adversaries of his theories. He also undertook study leave at Wageningen Agricultural University in the Netherlands, with Prof. J.C. Zadoks in 1968, and with Prof. J. Kranz at the Justus Liebig University, Giessen, Germany in 1979. Zadoks and Kranz were great admirers of Vanderplank's theories on plant disease epidemiology. Zadoks and Schein[1] expressed their admiration for him by stating that 'he changed the faces of two sciences, plant pathology and plant breeding'.

Owing to the general acceptance of his theories on quantitative plant disease epidemiology, Vanderplank received numerous awards, both in South Africa and abroad.[11] Amongst others, they included the Junior and Senior Captain Scott medals (1928 and 1948, respectively) from the South African Biological Society. In 1979, he was awarded the

Christiaan Hendrik Persoon Gold Medal from the South African Society of Plant Pathology and Microbiology. This was the first time that this award, the most prestigious of the Society, was conferred. Given his huge accomplishments, 8 years were to pass before another member of the now Southern African Society of Plant Pathology was considered deserving of this honour! Vanderplank also received the Ruth Allen Award from the American Phytopathological Society in 1978 and was awarded honorary doctorates by the University of Natal (now the University of KwaZulu-Natal) and the Justus Liebig University, Giessen, Germany. To celebrate Vanderplank's 80th birthday in 1988, a special issue of the *international Journal of Plant Diseases and Protection* (Vol. 93), edited by Jűrgen Kranz, was published to honour him.

Vanderplank (middle) at the ceremony in Pretoria where he received the prestigious Stakman Award with Prof. Mike Wingfield (left) and Prof. Mike Martin (right) of the University of KwaZulu-Natal.

Vanderplank was regarded as a 'superb lecturer'[3] even though he tended to come across to his students and staff as shy and claimed not to relish the public spotlight. This was illustrated when one of us (MJW) was tasked with arranging an appropriate ceremony for Vanderplank to receive the prestigious Stakman Award, conferred by the Department of Plant Pathology of the University of Minnesota. Vanderplank had reluctantly agreed to attend the ceremony in Pretoria (not in Minnesota), but he had made it clear that guests on the occasion, which included an emissary (Prof. Chet Mirocha) from the University of Minnesota, should be informed that he would not speak, but merely say 'thank you'. It therefore came as a surprise to everyone present when he spoke at some length, even regaling the audience with anecdotes from his career. One of these included his explaining that as a chemist with the Department of Agriculture during World War II, he was instructed to produce chocolate with a high melting temperature so that it could be shipped to the South African troops fighting in the hot Egyptian desert. He suggested in his address that this might have been his greatest scientific accomplishment, and then joked that it could even have been the origin of chocolate chip cookies!

Zadoks and Schein[1] describe Vanderplank's personality as modest and courteous. He was well aware of his status as a globally recognised scientist, and was considerate of opposing points of view, even when he disagreed with them. James Vanderplank passed away on 2 June 1997 after sustaining fractures after a fall at his home in Pretoria where he had lived all his working life with his wife Elsa and their two children, Elspeth and Adrian. He had a brilliant mind, and his name endures in the plant pathology halls of fame with other great leaders in this field. It is also a fitting tribute to remember him in the International Year of Plant Health.

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In preparing this Commentary, it became evident how little has been recorded of Vanderplank's personal views on matters outside of plant pathology. We were fortunate to make contact with his daughter, Elspeth van Duuren, who provided perspectives regarding his personal life. While we consulted with numerous colleagues and relied on word of mouth and/or on our own experiences, we take full responsibility for any misinterpretation that might have resulted. We are especially grateful to Zakkie Pretorius and Jane Carruthers for suggestions and advice in preparing this Commentary.

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