2019 Alexander von Humboldt Medal, awarded by the International Association for Vegetation Science to Pierre Legendre

By Peter Minchin

Good morning, friends and colleagues. It is my great pleasure to introduce Professor Pierre Legendre, recipient of the 2019 Alexander von Humboldt Award for Excellence in Vegetation Science. This is the highest award that IAVS can bestow on a vegetation scientist in recognition of an outstanding body of work that has made a major contribution to vegetation science. The Award was established in 2011 and is awarded at 2-year intervals. I acknowledge the assistance of two ex-members of Pierre's lab, Miquel de Caceres and Pedro Peres-Neto, in preparing this laudatio. They provided me with some photos and their reflections on Pierre's publications.

I have known Pierre for 31 years. We first met at the IAVS Working Group for Theoretical Vegetation Science symposium in 1988, which was held in Vienna, Austria. This working group, originally known by the much less impressive title of the Working Group for Data Processing, was very active in developing numerical methods for the analysis of vegetation data. At the Vienna symposium, I not only met Pierre but also David Goodall, Jari Oksanen, and Dave Roberts. In 1994, Pierre and his wife Ghislaine Ouellette visited Melbourne, Australia and stayed for a week at my home. I recall that they were model guests and Pierre showed himself to be an excellent cook. I have very fond memories of his kangaroo curry (if I recall correctly, an adaptation of a recipe he had learned in Montreal for venison curry). Pierre and Ghislaine continued on from Australia to his sabbatical in Perpignan in SW France. My wife and I met up with them there for a few days *en route* from Spain to Italy. We explored the local sights, including several wineries around Perpignan and I learned a lot from Pierre about the regional wines - Côtes du Roussillon, Banyuls, Muscat de Rivesaltes, and Maury. Pierre once again excelled in the kitchen, preparing a delicious duck dish and inventing a sauce featuring local peaches from the farmers market and Roussillon wine.

But to get back on topic, Pierre is a very worthy recipient of this award. His research and in numerical ecology, both solo and collaborative, has provided vegetation scientists with many effective tools to analyze plant communities, investigate their patterns of spatial and temporal variation, and identify environmental factors that determine these patterns in space and time.

Pierre obtained a B.A. from Collège Saint-Viateur (affiliated with University of Montréal) in 1965 and then did 2 years of a B.Sc. in biological sciences at the University of Montréal before heading to McGill University to complete a M.Sc. in zoology in 1969. He then obtained his Ph.D. in biology from the University of Colorado (Boulder) in 1971.

Pierre was a Postdoctoral Fellow in the Institute of Genetics at Lund University, Sweden 1971-72 and a Research Associate, Center for Ecological Research, University of Québec in Montréal 1972–73. After positions as Research Director of the Centre for Environmental Research and a Natural Sciences and Engineering Research Council Research Associate, he was appointed a Professor in the Physics Department at the University of Québec in Montréal in 1980. Pierre then moved to the University of Montréal as an Associate Professor in the Department of Biological Sciences in 1980-84, becoming a Full Professor in that department in 1984.

Pierre has previously received many richly deserved awards and distinctions. He was elected Fellow of the Royal Society of Canada in 1992, received the Distinguished Statistical Ecologist Award of the International Congress of Ecology (INTECOL) in 1994, and the Romanowski Medal (environmental science) of the Royal Society of Canada in 1995. In 1999, at the Ninth Lukacs Symposium "Frontiers of Environmental and Ecological Statistics for the 21st Century", Pierre received the Twentieth Century Distinguished Service Award "for outstanding contribution to the synergistic development and direction of statistics, ecology, environment and society".

In 2005, he was awarded the Prix Marie-Victorin, the annual prize of the Government of Québec for highest achievements in research in natural sciences and engineering. He was made an Officer of the National Order of Québec in 2007 and in 2012 he received the Canadian Council of University Biology Chairs Career Achievement Award. In 2013 Pierre was awarded the Canadian Society for Ecology and Evolution President's Award. In 2015, the Canadian Aquatic Resources Section of the American Fisheries Society declared him to be a Legend in Canadian Fisheries Science and Management "in recognition and appreciation of contributions to fisheries science" and French Consulate in Québec City awarded him the Adrien-Pouliot Prize (for scientific cooperation with France).

In 2016 Pierre was elected Corresponding Member of Academia Mexicana de Ciencias (AMC) and in 2019 he was made an Honorary Life Member of the Sociedad Ibérica de Ecología.

Pierre is generally regarded as one of the founders of the field of Numerical Ecology, building on the work of pioneers such as David Goodall, Paul Jaccard, Robert Sokal, and John Gower. Numerical Ecology deals with the analysis of multivariate ecological data, including community composition data (generally with many species) and related environmental data (typically with many variables). Methods have been developed to seek patterns in these types of data, explore correlations between species composition and environment, and test ecological hypotheses. The methods of numerical ecology are widely used by community

ecologists, vegetation scientists, and conservation biologists. Though some methods have been borrowed from other disciplines and adapted to the specific structure of ecological data, in many cases it has been necessary to develop entirely new approaches to answer ecological questions. Much of the standard toolkit of multivariate statistics assumes multivariate normal data and linear correlations among variables, while most ecological variables are not normally distributed and have highly non-linear relationships.

Pierre has an enormous output, including more than 300 journal articles, 11 books, 18 book chapters, and more than 90 versions of software packages in R. Pierre's work is heavily cited. According to the Web of Knowledge, his articles alone have had about 35,000 citations, giving him an H index of 75. In the field of Environment/Ecology, he is one of only four scientists worldwide who have been listed as Web of Science Highly Cited Researchers in all six lists that have so far been published.

Apart from his publications, Pierre's legacy includes the large number of graduate students and postdocs that have worked with him in his lab in Montreal. I could not find an exhaustive list of students and postdocs but just since 2009 he has had 4 MSc students, 5 PhD students, and 7 postdocs.

Pierre's early publications in the 1960's and 70's were mainly in the field of numerical taxonomy but by the 1980's he had come to realize that ecology is much more interesting. I will not attempt the impossible task of documenting all of Pierre's research achievements here but will briefly try to summarize some of his main contributions in the early 21st century.

Since 2000, Pierre's interests have focused on providing methods for the analysis of patterns in community data, including the role environmental factors underlying these patterns and the elucidation of spatial and temporal structures. This mainly arose from collaborations with his long-time colleague Daniel Borcard, which were followed up by post-docs in his lab, especially Pedro Peres-Neto and Stéphane Dray. More about these guys coming up.

One of the key contributions has been the variation partitioning of species data matrices, into fractions attributable to environment, space, time, and their interactions. This research has led to a debate in the literature about the way in which beta diversity should be analyzed.

Many of you (or at least the oldies) may recognize this famous photo, taken in Sun Studio, at 706 Union Avenue in Memphis, Tennessee, in 1957. It shows Elvis Presley, Johnny Cash, Jerry Lee Lewis, and Carl Perkins, all of whom had made their first records with Sam Phillips at Sun Studio and had then gone on to become famous and successful. During an impromptu reunion at the studio, this photo was snapped and became known as "The Million Dollar Quartet". If you are in Memphis, I recommend that you do the tour of Sun Studio, which ends in this studio room, unchanged since the 1950s (the same piano is even there), and they play back the studio tape from the moment that the photo was taken.

Note the similarity with this photo taken in Pierre's lab. It shows Pierre, Daniel Borcard, Pedro Peres-Neto and Stéphane Dray. I think Pierre refers to it as "The Dream Team of 2013" but I like would like to suggest that it be called "The Thousands of Citations Quartet".

More recent contributions on analysis of beta diversity have included reviews of dissimilarity indices and their appropriateness for beta-diversity analyses along with the assessment of local contributions to beta diversity and additional studies about different forms of dissimilarity coefficients and their value to assess beta diversity patterns.

Another important line of methodological contributions has been the spatial analysis of ecological structures, starting with the proposal to use Principal Components of Neighbourhood Matrices (and later generalized to Asymmetric Eigenvector Maps and Moran's Eigenvector Maps) as spatial variables to quantify the importance of spatial structures and their scales.

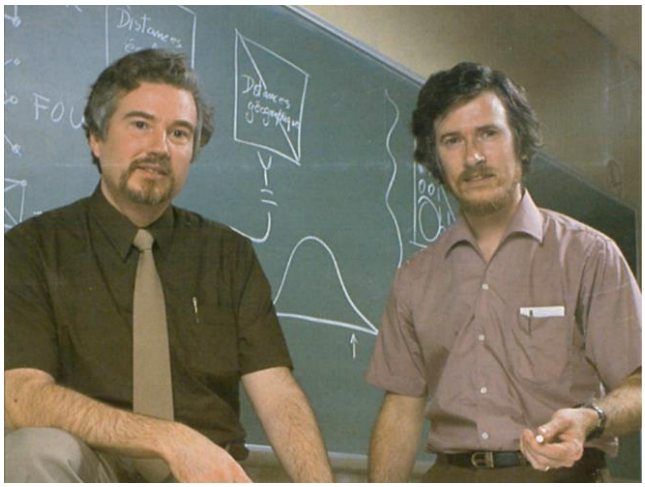
These approaches have had extensions to phylogenetic analysis and multi-scale spatial analyses, research conducted in collaboration with Guillaume Guénard, a PhD student in Pierre's lab.

Pierre has developed ideas about the analysis of temporal and spatio-temporal patterns, the latter also profitting from the Principal Components of Neighbourhood Matrices approach.

In addition to these main lines of research since 2000, Pierre also continued to make important contributions to the use and improvement of existing, classical statistical tools.

This has been just a brief summary of some of Pierre's contributions over the past two decades but I hope it has served to give a taste of his enormous volume of work and its contribution to the tool kit for vegetation science. Apart from his research articles, Pierre has had a major impact on the development of data analysis in ecology through his books.

In 1975, Pierre and his brother Louis Legendre, an oceanographer, were independently invited to attend a 3 day meeting of ecologists to discuss an emerging area in ecology – the application of statistical methods to study multivariate ecological data. On the final evening of the meeting, Pierre and Louis sat out on the terrace of a restaurant overlooking the Mediterranean and wrote a list of topics on a paper place mat.



That list was to become the Table of Contents for a book about this new area of ecology, which was published in two volumes in 1979, written in French, and named Écologie Numérique (Numerical Ecology).

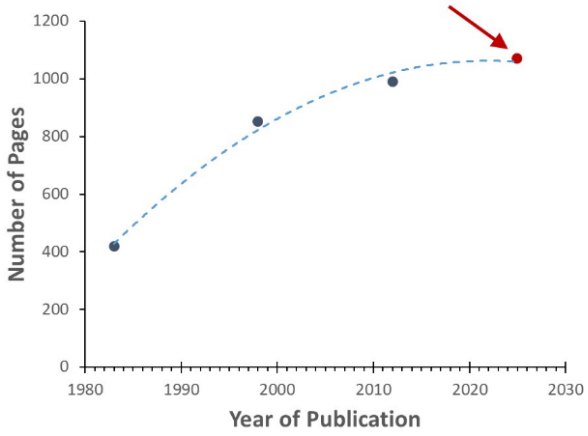
This was followed, in 1983, by the first English edition.

The book was a huge success. I remember how impressed I was to see it for the first time as postdoctoral fellow in the lab of Mike Austin at the CSIRO Division of Water and Land Resources in Canberra, Australia. The book provided a comprehensive and encyclopedic description of methods for multivariate data analysis in ecology, with informative examples showing how to do the calculations. It quickly became a must-have book for community ecologists wanting to understand these methods and apply them to their data.There have since been two more English editions, in 1998 and 2012. This slide shows Pierre and Louis planning the 3rd English edition over a glass or three of wine.

The huge influence this book has had is shown by the fact that, according to Google Scholar, the total number of citations for all editions so far is approaching 20,000.

The first English edition was 419 pages long but this expanded to 853 with the second edition and 990 with the third, as new methods and examples were added.

I could not resist analyzing these data. Committing the sin of extrapolation, I predict that the fourth edition will come out in around 2025 and will be 1070 pages ☺



Cajo ter Braak once told me as we had coffee in a café in the countryside outside Wageningen, in the Netherlands that you can write as many great papers about a method as you like but in the end the best way to ensure that your method becomes widely used is to provide good software. One way to do that is to write a commercial program and sell it. An even better way is to write software that is open source and free to everyone. To this end, Pierre has made many contributions of code to the R project.

The first edition of Numerical Ecology with R was published in 2011, co-authored by Pierre, Daniel Borcard, and François Gillet (University of Franche-Comté). It makes most of the methods discussed in the book accessible to all ecologists via R. The second edition was published in 2018.

Numerical Ecology with R has been translated into both Mandarin and Spanish, further increasing accessibility (since both of these languages are in the top four spoken languages of the world). Now all we need is a Hindi edition.

This leads me to a further aspect of Pierre's global impact on ecology, with is his involvement in teaching short courses on numerical ecology in many different countries.

The red dots show places where Pierre has taught short courses. These include many locations in Europe, North and Central America, China, Japan, and Australia.

Here's Pierre with participants in the course on Numerical Ecology that he taught in Trieste, Italy.

My personal favourite paper by Pierre is this one, in which the method of spatially constrained clustering that he developed with Francois-Joseph Lapointe was applied to the important task of making a regional classification of single malt Scotch whiskies, taking into account data on their colour, aroma, taste, and finish. My only criticism is that the data were compiled from a book on single malts by Michael Jackson (not the singer but a British whisky expert). I would have preferred to see data collected from the field by Pierre and Francois (and had I known, I would have volunteered to be a field assistant).

They found that classifications based on aroma and taste agreed well but both of them differed markedly from a classification based on finish characteristics. It the final paragraph of the paper, they discuss this discordance.

"Only when swallowing an alcoholic product could one totally capture the aftertaste. … Jackson explains that 'some professional blenders work only with their nose, Not finding it necessary to let the whisky pass their lips'; this could be read as an indication that smell is the most important feature to distinguish single malts. However, we are led to believe from our analyses that finish should be equally weighted as a selection criterion. **In any case, single malts must be swallowed."**

I find myself in total agreement.

And so, I figuratively (and perhaps later on literally) raise a toast to you, Pierre, congratulating you and your many career achievements and your huge contributions to community ecology and vegetation science.

Pierre will now present his 2019 von Humboldt Award talk, entitled "Temporal beta diversity: identify sites where species communities have changed in exceptional ways".

Pierre, à ta santé et felicitations!