The Bulletin of BISMiS

Published by Bergey's International Society for Microbial Systematics

Volume 7, part 1 – January 2018

Venue
BISMiS 2018 will be hosted by the University of Pretoria, South Africa from 8 – 11 April 2018. The meeting will be held at the Misty Hills conference center, situated close to both Johannesburg and Pretoria.

The BISMiS conference will directly follow the bi-annual meeting of the South African Society for Microbiology which will also be held at the Misty Hills conference center from 4 - 7 April 2018.

The central location of the conference venue provides many opportunities to explore the rest of the country (http://www.southafrica.net). Cape Town is only a 2 hours flight from Johannesburg with opportunities to explore the beautiful scenery associated with the Cape Floral Region, taste some of the top wines in the world or visit historic sites such as Robben Island.

Travel awards
Bergey's Manual Trust will sponsor five travel awards for students and other young investigators to attend BISMiS 2018 in South Africa. Three of these awards will be for any of the young participants with the other two targeting participants from Africa specifically.

Various sponsorship opportunities are available, also allowing for exhibition space at the venue. For logistic, conference enquiries, contact the organisers

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On the cover

Information For BISMiS 2018 Meeting in South Africa

The Bulletin of BISMiS

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Bulletin Editorial

In this issue of the *Bulletin*, we first look back to BISMiS 2016 held in Pune, India. Kamlesh Jangid provides a vivid report of both the scientific program and cultural events. Accompanying images capture some of the interactions between delegates showcasing the friendly and collegiate nature of the BISMiS family. The second article is a wonderful autobiography by one of the leading taxonomists/ ecologists of our time, James (Jim) Staley. Through this extensive and personal account, we get an insight into his illustrious career and interactions with other leaders in microbial systematics –past and present. This is a very comprehensive essay on his personal and professional career that we have decided to split it into two parts, the first published in this issue with the second installment in the next issue. These autobiographies published in the Bulletin engender much interest, not only from established researchers but also serve as inspirational sources to our younger audience. Personally, I receive many positive comments about these articles that bring an author's name on a paper to life.

The next two articles are from our student body, first from five undergraduate students (Victoria M. Wilson, Jacob R. Miller, Emily A. Carson, Devin C. Frantz, Kyle T. Jacobs) of Jeff Newman's lab (Lycoming College Biology Department). They provide an enthusiastic account of their experiences at BISMiS 2016 that highlights the opportunities that can be realized even if from smaller undergraduate schools. We get a real feel of the excitement of attending an international conference, mingling with scientists whose papers they have read, along with the accompanying travel and experiences of a very different country and the lifestyles found there. Furthermore, one of these students, Jacob Miller received the IJSEM 'Best Taxonomic Student Poster Prize' presented by Aharon Oren.

The next article is by two graduate students (Patricia Benito and Raúl Riesco) under the supervision of Martha Trujillo our BISMiS president and recently appointed new Editor-in-Chief of IJSEM. We get an insight into all aspects of graduate student life and as many of us know these are not always straightforward! These students are immersed in their studies and realize the challenges of modern day taxonomy as discussed at the BISMiS meeting, again the students provide an enthusiastic account of their experiences in Pune.

Finally, we look forward to BISMiS 2018 with conference host and organizer Stephanus (Fanus) Venter. The conference will be held at the Misty Hills conference centre, situated close to both Johannesburg and Pretoria. The meeting is being hosted by the University of Pretoria, established in 1908 and in now the largest residential university in South Africa. Fanus introduces the idea of "indaba. An indaba, in the traditional African culture of Zulu and Xhosa speaking people, is a gathering where people get together to sort out the problems that affect them all. At these gatherings everyone has a voice and an attempt is always made to find common ground and to collectively decide how to go forward." This encapsulates BISMiS in a nutshell, where differing views on the future of taxonomy can lead to robust discussions but in a respectful, professional and friendly environment. Of course, no trip to Africa would be complete without a chance to see the magnificent wildlife and a number of tours and events are offered, I for one are saving my pennies! Again, I look forward to meeting old friends, new friends, and students at what is sure to be a wonderful meeting.

Finally, I wish to encourage readers to submit articles for future publication in the Bulletin, from original articles, reviews, autobiographies and student reports all receive very positive feedback by our readers.

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Report of the 3rd Meeting of Bergey's International Society for Microbial Systematics in Pune, India September 2016

Kamlesh Jangid

BISMiS 2016 was held in the city of Pune, the cultural capital of the state of Maharashtra, India at the Microbial Culture Collection (MCC) during the region's most revered festival, the 10-day Ganeshotsav. With the theme of 'Microbial Systematics and Metagenomics', the meeting was focused on the use of genomic/enviro-genomic data for the description of novel taxa. It was attended by 86 registered participants from 15 different countries. Since this was the first ever meeting of the Bergey's Trust or its Society, in this country, the meeting generated a huge interest among researchers in India, which formed the largest contingent of participants (Figure 1). The report below highlights the key events and sessions that took place during the three and half day long meeting.

Opening Ceremony

The meeting began with a traditional Hindu welcome of all the participants to MCC (now known as the National Centre for Microbial Resource, NCMR). This was followed by a formal welcome of all participants by the BISMiS president, Brian Austin, followed by an overview of things to follow by the Convener of the meeting, Kamlesh Jangid (Figure 2). A brief presentation on the status of microbial systematics in India was then delivered by Yogesh Shouche, the Co-Chair of the Organizing committee.

Due to the very specific nature of the meeting, student participation was limited. With the objective of reaching out to these young researchers in this field, a collection of chapters was put forth leading to the genesis of "BISMiS 2016 - a Souvenir." These were written by the expert speakers specifically for the students and faculty in academia, on topics that they would benefit most from, and those that would generate the curiosity in these young minds and motivate them to learn more about the subject. The Souvenir was released by Brian Austin, Peter Kämpfer and Yogesh Shouche. The Souvenir will act as a ready reference of the current status in this field for students and faculty alike who could not attend the meeting.

This was followed by the Opening Address on "Taxonomy of Prokaryotes - New Challenges in a Global World" by Peter Kämpfer. The discussion following the opening address set the stage for a very successful meeting over the next three days. The opening address was followed by the Welcome mixer for all participants, sponsors and volunteers at the Melange, a rooftop lounge at the Hotel where nearly all BISMiS participants were staying (Figure 3). At the mixer, all delegates were greeted with drinks, bollywood music and a live cricket telecast on the big screen in the background along with a range of delicious Indian cousine.

Scientific Sessions

A total of six scientific sessions were held during the three full days of the meeting. With two sessions held on each day, a total of eight invited keynote talks and 22 oral presentations were delivered (Figure 4). A brief outline of each session is given below.

Session 1 - Genomic/Metagenomic Description of Novel Taxa

- Keynote 1 - Use of Genome Sequence Data in Bacterial Taxonomy: Perspectives from Large Scale Analysis by Jong Sik Chun
- Keynote 2 - Cultivation-Independent Genomics Approaches and Their Relevance to Microbial Taxonomy by Brian Hedlund

In addition to the two keynotes, there were seven oral presentations by David Arahal, Marike Palmer, Martha Trujillo, Maria Figueras, Jeffrey Newman, Boris Vinatzer and Kamlesh Jangid. These talks focused on genomic approaches to resolve the

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taxonomy of difficult taxa, proposal of a single phylogenomic metric for species identification, development of a prototype for genome-based description of taxa and the development of new algorithms for the comparison of microbial communities.

Session 2 - Cultures and Culturing of As-Yet-Uncultivated Microbes

- Keynote 3 - Community Wide Insights into Stressed Niches Using Metagenomic Approach by Rup Lal

The keynote talk was followed by two oral presentations by Monali Rahalkar and Om Prakash who discussed the isolation of methanotrophs from rice fields and the preservation of 'uncultured' in omics era, respectively.

Session 3 - The Role of Cultures in the Twenty First Century

- Keynote 4 - The Value of Cultures to Modern Microbiology by Brian Austin
- Keynote 5 - Megaculturomics of Microbial Biodiversity from Diverse Ecological Niches in India by Yogesh Shouche

The session also included four oral presentations by Svetlana Dedysh, Syed Dastager, S Krishnamurthy and Kumari Richa that were focussed on the taxonomic and biotechnological implications of the characterized diversity of various taxa.

Session 4 - Modern Approaches to Identification/ Diagnosis

- Keynote 6 - Novel Insights into Microbial Systematics Based on Molecular Ecology and Comparative Genomics Approaches by Joerg Overman

Following the keynote, five oral presentations by Paul Lawson, Iain Sutcliffe, Pelin Yilmaz, Wen-Jun Li and Ch. Sasikala were delivered in this session. The topics included a focus on chemotaxonomy, attempts to unite the classification of Bacteria and Archaea, environmental adaptability of Nocardia and metabolomics for taxonomy.

Session 5 - Minimum Standards for the Description of New Taxa

- Keynote 7 - Modest Proposals for Unification of the Nomenclature of Cultured and Uncultured Prokaryotes by William Whitman

Two oral presentations by Stephanus Venter on 'Genealogical Concordance and Other Lines of Evidence for the Recognition and Description of Bacterial Species' and Paras Yadav on 'SMRT sequencing in bacterial genomics' followed the keynote address in this session.

Session 6 - Cyanobacterial Taxonomy

- Keynote 8 - The Current Status of Cyanobacterial Nomenclature Under the "Prokaryotic" and the "Botanical" Code by Aharon Oren

This last session also included talks by Stefano Ventura and Prashant Singh who keenly discussed a unified approach for the taxonomy of Cyanobacteria.

Poster Sessions

A total of 31 posters were displayed throughout the meeting. A team of experts, Chaired by Aharon Oren evaluated the posters for the International Journal for Systematic and Evolutionary Microbiology 'Best Taxonomic Student Poster Prize' that was sponsored by the Microbiology Society.

Cultural Evening

A cultural program showcasing the mesmerising classical music and diverse dance forms of India was held on the evening of the first full day at the National Centre for Cell Science (NCCS) campus (Figure 5). The event was followed by dinner and interactions between participants and NCCS faculty. The following evening was marked by an adventurous industry sponsored visit on the outskirts of Pune.

BISMiS Business Meeting

The BISMiS members meeting was held at 12:20 pm on 15 September 2016 in Raman Hall, at MCC, Pune. The meeting was open to all registered participants as well as BISMiS members. The proceedings began with the BISMiS president, Brian Austin thanking the

organizers and all volunteers at MCC for hosting the meeting. This was followed by a discussions on increasing the member participation and to have regional contacts for increasing the memberships to the Society. The Treasurer, William 'Barny' Whitman presented his annual report on the financial status of the society and expenditure incurred during various events throughout the year. also updated the members about the elections for the two officer positions in BISMiS (see below). A proposal to hold the next meeting in 2018 in South Africa was put forth by Stephanus Venter that was welcomed by the attendees. The members meeting was adjourned after a thank you vote by the new President of BISMiS, Martha Trujillo.

Closing Ceremony

The proceedings of the closing ceremony were initiated by the Convener of the meeting, Kamlesh Jangid who presented a summary of the happenings over the past three days. He began by thanking all who attended the meeting, the Bergey's Manual Trust and other industrial sponsors, and a special thanks to all the volunteers for a very successful BISMiS 2016. Kamlesh also briefed the participants about the different proposals that were presented by various speakers to advance and improve microbial systematics. At the end, he reported that many ideas and the work presented at BISMiS 2016 would be released as a Special Issue of Antonie van Leeuwenhoek as confirmed by Iain Sutcliffe, the Editor-in-Chief of the journal.

Following this, Aharon Oren awarded the IJSEM 'Best Taxonomic Student Poster Prize' to Jacob R Miller for his poster on 'Two Novel *Flavobacteriaceae* Related To *Flavobacterium hydatis* and *Flavobacterium hibernum* Isolated From A Freshwater Creek' (Figure 6).

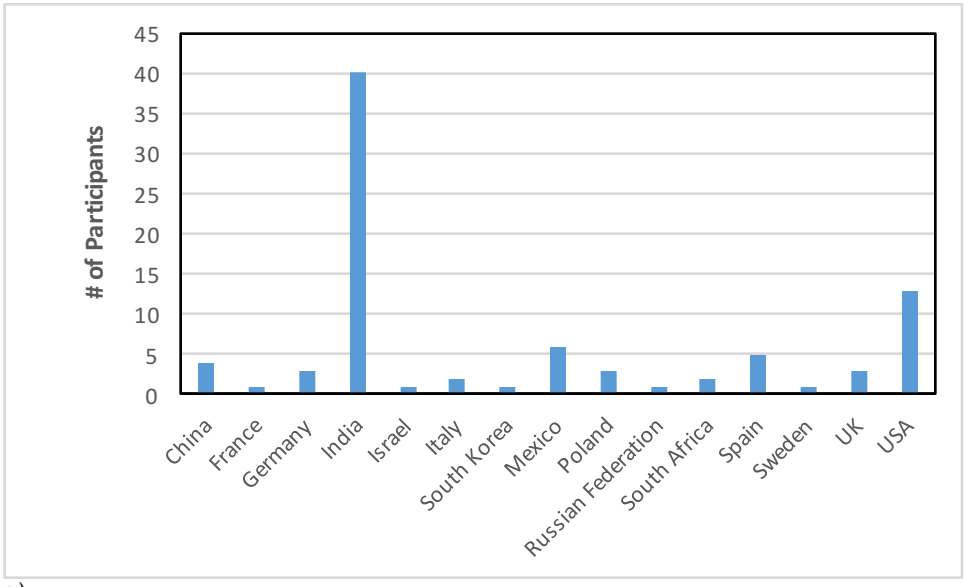
William Whitman then announced the names of the travel award recipients. The two International Travel Awards were given to Nisha Patel and Marike Palmer, while the Local Travel Award was given to Anukool Vaishnav (Figure 7). The awards covered the travel, registration and hotel for the meeting days for each of the recipients.

William Whitman, as the Treasurer and Kamlesh Jangid, as the Secretary of BISMiS, conducted the election of officers for the positions of President-Elect and Secretary of BISMiS. These were held online prior to the meeting. William Whitman reported the results of the vote: Iain Sutcliffe, new President-Elect, and Kamlesh Jangid, Secretary.

On behalf of the Bergey's Trust, William Whitman appreciated the hardwork and effort taken by the organizers. He presented the Bergey's T-shirt to Yogesh Shouche and Kamlesh Jangid for a very successful BISMiS 2016 (Figure 8).
Brian Austin was awarded the Bergey's Medal for his tremendous contribution to bacterial systematics and to the Society. The award was given by Svetlana Dedysh (Figure 9).

On behalf of the entire Society, the new President of BISMiS, Martha Trujillo thanked the outgoing President, Brian Austin for his services to the Society. She handed over a copy of the Engraved Stone Plaque to Brian in recognition of his hard work over the past two years (Figure 10).

The award ceremony was followed by closing remarks from the Co-chairs of BISMiS 2016, Yogesh Shouche and Brian Austin, followed by a formal vote of thanks by Kamlesh Jangid, as the convener of BISMiS 2016 and he welcomed everyone to South Africa for BISMiS 2018.



a)

b)

Figure 1. BISMiS 2016, a) Geographic affiliation of participants, and b) Group photo of attendees

a)

b)

d)

c)

Figure 2. Opening ceremony at BISMiS 2016. a) Registration of participants (Tapan Chakrabarti, Svetlana Dedysh, Pelin Yilmaz, Peter Kämpfer, Joërg Overmann); b) Traditional Hindu welcome of Brian Hedlund by Sunil Dhar; c) Yogesh Shouche, Peter Kämpfer and Brian Austin releasing the Souvenir; and d) Opening address on "Taxonomy of Prokaryotes - New Challenges in a Global World" by Peter Kämpfer.

Figure 4. Moments captured during the scientific and poster sessions at BISMiS 2016.

Figure 5. Moments from the cultural evening and other fun events during BISMiS 2016.

Figure 6. Jacob Miller Receiving the IJSEM 'Best Taxonomic Student Poster Prize' from Aharon Oren.

a)

b)

c)

Figure 7. William Whitman Presenting the Student Travel Awards to a) Nisha Patel, b) Marike Palmer, and c) Anukool Vaishnav.

Figure 8. William Whitman Presenting the Bergey's T-shirt to Yogesh Shouche and Kamlesh Jangid for a very successful BISMiS 2016.

Figure 9. Brian Austin receiving the Bergey's Medal from Svetlana Dedysh on behalf of the Bergey's Trust.

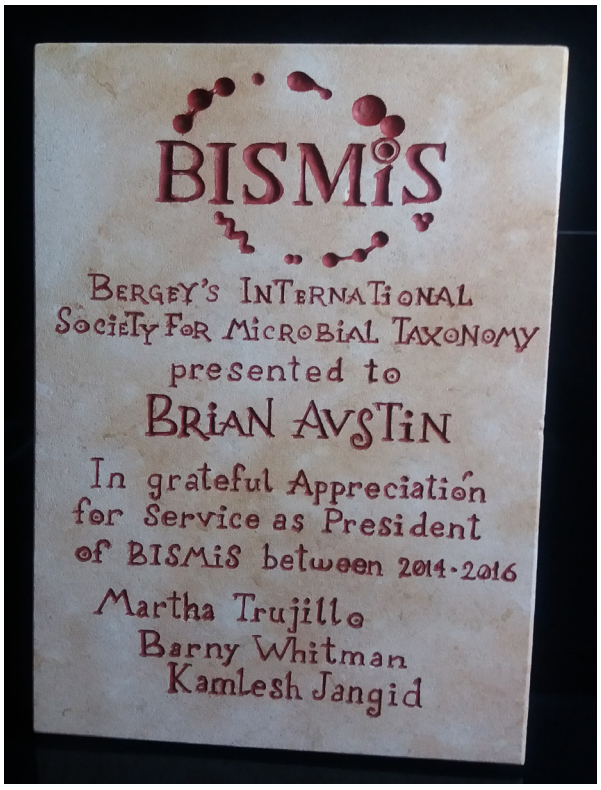


Figure 10. Brian Austin, the outgoing President of BISMiS receiving the Engraved Stone Plaque from Martha Trujillo, the new President of BISMiS.

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Seeking Truth in the Microbial Cosmos

James Staley

Thanks to all who worked in my laboratory over the years for your friendship, hard work and most importantly your passion for research and the pursuit of truth.

Many microbiologists are interested in pathogenic organisms. My foremost interest was always in basic microbiology. Early interest in chemistry instilled in me a desire to better comprehend the variety and interrelatedness among the various microbial groups in a fashion similar to that of the chemical table of elements. I have come to regard the vast and poorly understood diversity of microbial life on Earth and perhaps elsewhere as a cosmos within the cosmos. My lab's research included the study of a variety of Bacteria and even some Eukaryotic microorganisms as we investigated many aspects of microbial diversity, ecology and evolutionary biology and enjoyed research as an adventure into the scientific unknown.

Background

I was born in Brookings, South Dakota, the third and youngest child in a family whose grandparents on both sides were pioneers. My father's ancestors were primarily Pennsylvania Dutch. The surname Staley is the Anglicized version of the Swiss name, Stähli who came from the Interlaken area of Berne Canton. They immigrated to Pennsylvania in the early 1700s then into Virginia after the American Revolution and into Ohio in the early 1800s and South Dakota in 1899.

My mother's family was primarily Scottish and English. Many of her ancestors came into Massachusetts from England and Scotland in the 1620s - 1650. One of our ancestors was John Forbes, a Presbyterian cleric from Aberdeen Scotland who was banished to France for religious reasons by King James I of Britain. Forbe's American grandson, Caleb Forbes had a daughter Mary who married Caleb Gates. Their son, Thomas, is in the same lineage as William Gates who founded Microsoft. One of the fun things we discovered is that this is the same branch as Princess Diana Spencer and her sons Princes William and Harry.

My parents, Newton Staley and Isabelle Trotter, were among the first in their families to receive baccalaureate degrees. They met at South Dakota State College (now South Dakota State University) and were married in 1929 at the beginning of the Great Depression. My older brother Robert, my late sister Nancy and I (Figure 1) all attended South Dakota State College in Brookings in the 1950s.

My mother and father, who received a degree in electrical engineering and Master's in education, were teachers during our childhood. My father served as a superintendent of schools in several small towns in South Dakota. He was hired as an engineer at the US Bureau of Reclamation and we moved to the larger town of Huron. The Bureau was responsible for planning and constructing transmission lines that carried electricity from the new dams being built on the Missouri River to

Figure 1. Upper row: Isabelle and Newton Staley Lower: James, Nancy and Robert -1942

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population centers in Minnesota and Nebraska.

My interest in science developed during my youth. I wrote a report on Louis Pasteur in Junior High School. My father encouraged my lifelong interest in science and in finding solutions. He often gave me challenging puzzles, including a complex architectural problem that the engineers at the Bureau struggled with that I was able to solve. My interest in finding solutions continues today with the testing of novel hypotheses.

At the completion of my senior year, I was fortunate to be selected as one of 48 Explorer Scouts, one from each state, to attend an International Boy Scout Jamboree in Japan during the summer of 1956 - a wonderful opportunity. We all flew into the Sand Point Naval Air Station located on Lake Washington in Seattle. After touring Seattle we boarded a troop transport that landed in Yokohama. We toured Japan prior to and following the Jamboree.

University Education

When I began college in 1956 I first majored in chemistry, but because of my broad interests, changed majors several times. I decided to pursue a career in science when the US began to place more emphasis on science and technology after the Soviet Union launched Sputnik in 1957. During my senior year I enrolled at the University of Minnesota where I graduated in 1960 with a BS in math.

I wanted an advanced degree because it provided greater opportunity to do research. I decided to pursue a degree in microbiology because I recalled how much I enjoyed Professor Robert Pengra's course at SDSC. I was accepted at Ohio State University (OSU) and moved to Columbus in 1961. Ohio State gave me a strong background in traditional bacteriology. Professor Robert Birkeland was Chair of the Department of Bacteriology. He was from North Dakota and we often chatted about our mutual backgrounds. I worked in professor William L. Boyd's laboratory for my master's degree. Bill, who received his PhD from Herman Lichstein at the University of Minnesota, had an NSF project to study polar microbiology. My master's project compared the serine deaminase (dehyratase) activity of *Escherichia coli* with that of a psychrophile, a strain of *Pseudomonas* Professor Boyd isolated from arctic tundra (Staley, Boyd Can J Microbiol 1967 13:1313). Most importantly it grew at 4ºC, unlike *E. coli* whose lowest growth temperature was 8°C. The upshot was that the cell-free enzymatic work indicated the two purified enzymes were very similar kinetically and in temperature response whereas the whole cell work showed significant differences, suggesting that the psychrophile's enzymatic activity was more active at lower temperature due to enhanced cell membrane permeability.

Boyd's research project provided me with the opportunity to work in the arctic and Antarctica, which was very exciting. In 1962 I spent the summer months at Point Barrow, Alaska (June through August) and during the winter months (October into February), I was at Cape Hallett, Antarctica, a joint New Zealand-US base with a few scientists from the US and New Zealand. My fieldwork studied the survival of various bacteria in soils collected at similar North and South Polar latitudes (Point Barrow and Cape Hallett). Emmanuel Rudolph was the senior US biologist at Hallett. Rudy was a botanist from OSU who was determining the growth rates of lichens on rocks in glacial moraines near Hallett Station by photographing them annually.

At that time, the US Geological Survey was preparing maps of the inland mountainous terrain near Cape Hallett. Later, in the 1980s I discovered that they named glaciers and mountains for the nearby Hallett scientists, including my namesake 2,560 meter-high mountain, Mt. Staley!

After I received my Master's Degree at Ohio State, I applied and was accepted at UC Davis and the University of Illinois for a doctorate. My decision to go to Davis was based primarily on my research interests and the West's natural beauty. I first visited the Los Angeles area (Irvine Ranch) while I was a boy scout at the 1953 Jamboree and later presented a paper on our Antarctica work at a meeting at Stanford University.

Initially I hoped to work on psychrophiles in John Ingraham's laboratory at UC Davis, but he lacked space. Later, we named the most psychrophilic

Figure 2. L to R: Robert Mah, Jim Staley, Robert Hungate, Paul Smith, Marvin Bryant, Ben Paynter – some former graduates and post-docs from Hungate lab

bacterium known, Psychromonas ingrahamii in his honor (Auman et al. 2006 IJSEM 56:1001).

I approached Robert Hungate and was delighted he accepted me in his lab. Professor Hungate was a remarkable scientist who studied rumen microbiology. Since I had strong interests in microbial ecology, it was a natural fit. Dr. Hungate was the first student of Cornelius (Case) van Niel, a Medal of Science recipient from Stanford whose general formula for photosynthesis was found to apply to plants and algae as well as the photosynthetic bacteria he studied.

Others in Hungate's lab were Patricia Grilione, Malcolm (Ben) Paynter, John Robinson and Bill Smith, his technician. I have many fond memories of the Hungate lab, especially the annual haggis celebration on Guy Fawke's Day each year (Figure 2).

My work in Hungate's laboratory was an extension of work begun as an NIH Trainee during the summer of 1964 with Richard Martucci, another uncommitted graduate student. We worked in a small, vacant teaching laboratory. While Dick studied some extreme halophiles that were triangular in shape, I was fascinated by caulobacters, having just taken Professor Mortimer Starr's course on microbial diversity. Using Houwink's dilute peptone (0.01 %) medium, enrichment cultures were inoculated primarily from Putah Creek that passed through campus. In addition to Caulobacter spp, I discovered some multiple-appendaged microorganisms in the enrichments. With NIH funding, my objective became to isolate, describe and name them for my dissertation.

Two new genera, *Prostheco-microbium* and *Ancalomicrobium*, were isolated, characterized and named (Staley 1968 J Bact 95:1921). The genus *Prosthecomicrobium* contained obligate aerobes that grew readily on dilute plating media. However, in order to isolate *Ancalomicrobium adetum*, which was much less numerous in enrichment cultures, a different approach was needed. Unlike virtually all other bacteria in the enrichments, these appendaged bacteria did not attach to the glass surfaces of the slide or cover-slip. Therefore, I designed a sterile glass column with glass beads and passed the enrichment through the column. The spread plate of the first droplet from the column contained colonies of *Ancalomicrobium* with few other species. Eureka! I felt an adrenaline rush from isolating a pure culture of this novel bacterium as it was something that no one else in the world knew. I experienced this several times in my career.

I cannot thank Dr. Hungate enough for his supporting my doctoral work in his lab even though it lay outside his own studies. Later I realized that he respected my independence because he, too, was also an independent scientist whose research was quite different from that of Professor van Niel.

Bob Hungate could not see the small appendages on

the *Prostheomicrobium* cells in the phase microscope because of his detached retinas, and relied entirely on my description of them. During this period, Professor van Niel, who was retired, visited the lab. Fortunately, his eyesight was excellent so he could see the small appendages. It was a relief to me that he could confirm to Dr. Hungate they were there, prior to having electron micrographs.

In the tradition of the time, professors from Berkeley were placed on PhD committees of students from Davis. Michael Doudoroff was on my orals committee and because of his knowledge of Caulobacter, Roger Stanier was placed on my reading committee and he provided valuable insight about my studies.

Professor Stanier was fascinated by the bacteria and wanted to see them, so cultures were provided. His wife Germaine Cohen-Bazire examined them in the electron microscope (EM) and concluded that the unusual structures we had seen in cells of P. pneumaticum were gas vesicles. I had seen them in EMs, but did not know what they were because they had not yet been reported in the literature. Furthermore, she also saw them in Ancalomicrobium adetum. Fortunately she and Norbert Pfennig were studying gas vesicles of photosynthetic bacteria and knew them at that time, although they were unknown in heterotrophs. Since then, our lab remained vigilant about novel gas vacuolate bacteria and isolated and named several others.

I coined the term 'prostheca, -ae' meaning 'appendage' in Greek as a general term for the cellular appendages of bacteria. My isolates were planktonic and did not attach so their appendages should not be termed 'stalks' and the term 'pseudostalk' coined by Jack Pate for *Asticcacaulis* did not seem apt either.

This was the first time I described novel taxa. The organisms were isolated, characterized and officially named following the Code of Nomenclature for bacterial taxonomy. Two *Prosthecomicrobium* species were named, one which was gas vacuolate, *P. pneumaticum* and another without the vesicles was named *P. enhydrum* (Staley 1968 J Bact 95:1921). The long-appendaged bacterium was named *Ancalomicrobium adetum* (Figure 3). I wanted Dr.

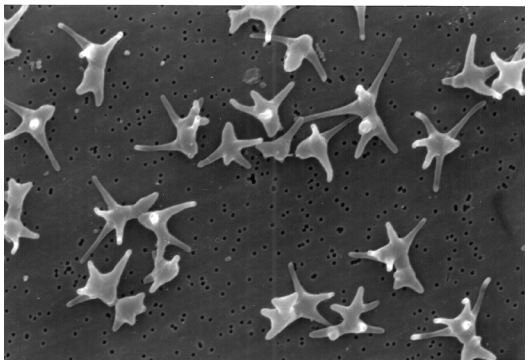

Figure 3. *Ancalomicrobium adetum* SEM (pore diam 0.2 mm) courtesy Alex Van Neerven

Hungate to be on the publication, but he refused saying that, even though it was from his lab, it was not his work. This is but one example of his integrity and generosity – rarely encountered in science today.

I came to appreciate how significant Robert Hungate's scientific contributions truly were. His laboratory did everything possible to comprehend the overall metabolism and microbial ecology of the rumen. He isolated all of the anaerobic bacteria and archaea that played major metabolic roles, including methanogens, fermenters and cellulolytic bacteria and also studied the protists. In addition, he determined what substrates each group used and what products each produced. With this information he quantified the entire metabolism of the rumen and furthermore demonstrated which processes were most important using radiolabeled substrates (see Hungate's book, The Rumen and its Microbes 1966 Acad Press).

His lab also demonstrated that hydrogen was a limiting substrate in rumen metabolism. This effect, termed 'interspecies hydrogen transfer' occurred through a symbiosis between fermenting bacteria, which produced hydrogen gas and methanogens that utilized it. Subsequently this symbiosis was found to be a more general phenomenon occurring also in anaerobic sediments. Hungate's experiments indicated that although the concentrations of hydrogen were extremely low in the rumen, it was a key substrate not only for methanogenesis but for ruminant metabolism as well. The methanogens effectively removed hydrogen so quickly that it permitted the hydrogen-producing fermenters,

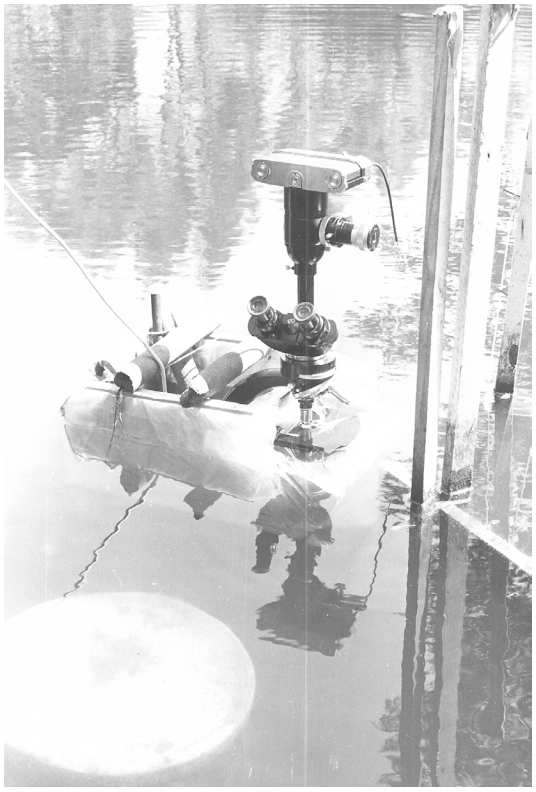

Figure 4. Immersed microscope. Note camera and microscope placed in protective box with stool to sit on in water. The incubation was carried out on immersed slides brought to the microscope at several times during the day for photography.

which were inhibited by excess hydrogen, to metabolize.

I found it surprising that Robert Hungate was not elected into the US National Academy of Sciences (NAS) to which many exemplary scientists belong, as in my view his work elucidating the metabolic activities and identities of the rumen microbiota qualified him to be, not only a member of the NAS but indeed, the Father of Microbial Ecology. The invaluable lesson I learned from this is that it is not how luminaries evaluate one based on their opinions and information, but it is the contributions one makes that are important. I believe one must be kind but stand up for oneself, be open-minded, develop a thick skin, contribute novel findings, suggest recommendations for improvement and have the humility to admit when you are wrong.

I completed my doctoral work at UC Davis in 1967. While at Davis in 1963, I married my sweetheart Sonja Jeanne Erickson, also a Huronion, and we had a son, Greg and a daughter, Wendy (Fig 11. Although I initially intended to do a postdoctorate in Germany, the NSF foreign postdoc program was discontinued the year I applied. Professor Hungate suggested that I interview for an academic position. During the winter of 1966-67 Phillip Gerhardt, Chair of Microbiology and Public Health, invited me to visit Michigan State University. MSU's microbiology program was expanding. They had just hired Peter Hirsch as an Associate Professor and had an opening for a junior faculty member in general microbiology. Professor Gerhardt showed me the Department and drove me through the snow to the MSU Biological Station at Gull Lake at Hickory Corners where a microbial ecology course would be taught in 1968. Following the visit, I was offered and accepted an Instructor position. Sonja, the children and I moved to the Cherry Lane faculty apartments in East Lansing in August, 1967.

Michigan State University 1967 - 1969

The move to MSU was very stimulating. I shared interests with Associate Professor Peter Hirsch because of his studies of the Hyphomicrobium group of prosthecate bacteria. Peter was also interested in the prosthecate and budding bacteria we studied including our nascent studies of the Planctomycetes to be discussed later. When Peter accepted a position in Kiel, Germany, as Professor, he continued working on these bacteria and I spent a sabbatical leave in his lab in the 1990's.

Peter and I taught the first microbial ecology course at the Gull Lake Biological Station in Hickory Corners during the 1968 summer. While there I studied the in situ growth of algae while wearing waders and sitting on a submerged stool in a pond. A Zeiss GFL phase microscope (Figure 4) was modified so it could be immersed in the pond in a plastic-covered box to protect the microscope from the water. A 40X water Immersion objective was used to examine glass slides incubated nearby.

Fields containing isolated algal cells were located using a calibrated stage. Slides were transferred to the stage underwater to follow the growth of individual algal clones (Figure 5). Fields were relocated with the stage micrometer and

photographed periodically from early morning to dusk for several days. Cell sizes, division and growth rate were calculated from photographic prints.

Regardless of the algal species, the pattern was always the same. During the daytime, photosynthesis resulted in cell growth. Then overnight, cells divided. The published photos with several time points were of a Chlorella species (Staley, 1971 J Phycol 7:13). Other algal species were also followed and showed the same pattern in which growth (increase in cell size) occurred during the daylight period (Figure 5). Over night, no cell enlargement occurred. However, cell division occurred indicating that DNA replication happened during the night most likely to alleviate light mediated mutations.

Another early career goal was to isolate strains of the morphologically distinct bacteria that Henrici and Johnson (1935 J Bact 30:61) reported from glass slides immersed in Lake Alexander, Minnesota. They saw cells of a 'fusiform caulobacter' and budding bacteria they called 'blastocaulis' and 'pasteuria'. Dilute peptone (0.01%) and peptone and yeast extract (0.005% of each) cultures were used to enrich for these unusual bacteria from various freshwater sources. I was very excited to discover a 'fusiform caulobacter'in one enrichment. A Dutch student, Jan deBont, was working in my lab and I suggested that he isolate it. Within a short time, Jan had a pure culture. Because it was immotile and differed from Caulobacter species in other ways, such as a lack of prosthecal crossbands, it could not be included in the genus Caulobacter.

After initially reporting it (deBont, Staley, Pankratz 1970 A van Leeuw 36: 397) we later named it Prosthecobacter fusiformis (Staley, deBont, deJonge 1976 Ant van Leeuw 42:333). As discussed later, this was the first member of the phylum Verrucomicrobia as well as the Plantocmycetes-Verrucomicrobia-Chlamydia (PVC) Superphylum isolated in pure culture, but remained unassigned until its 16S rRNA gene sequencing 20 years later (Hedlund et al. 1996 IJSB 46:960) followed by the description of three additional species (Hedlund, Gosink, Staley 1997 Ant van Leew 72:29). The PVC will be discussed later in the Evolution section.

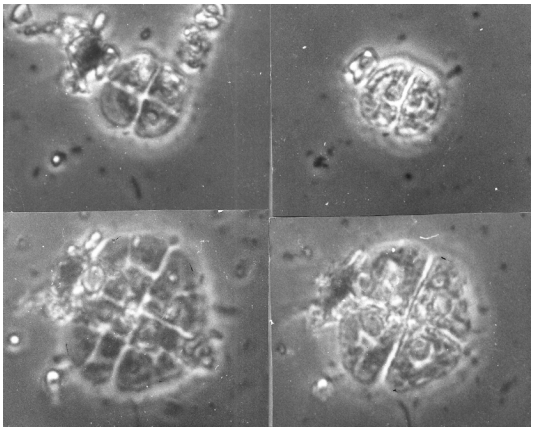

Figure 5. Unpublished algal clone showing two overnight divisions from UL to LR: 7:38 pm (2 cells), 8:27 am (4 cells); 7:05 pm (4 cells), 8:33 am (8 cells). Note clone size is similar overnight but cell division occurs in both far right panels.

University of North Carolina, Chapel Hill - 1969 to 1971

In 1969 I was offered a position as Assistant Professor in the Department of Environmental Sciences and Engineering at the University of North Carolina, Chapel Hill. Since Robert Mah, also a Hungate PhD student was an Associate Professor there, I was delighted to accept. I regretted leaving good colleagues behind including professors Peter Hirsch, Jim Tiedje, Ralph Costilow, Bob Brubaker, Phil Gerhardt as well as friends Ed and Kazuko Ozaki.

Mark van Ert was my first graduate student. He worked on gas vacuolate bacteria we first isolated in Michigan from various freshwater sources. Although most bacterial colonies appear translucent, gas vacuolate impart a characteristically chalky white appearance due to their effect on light refraction. Using this criterion Mark isolated additional strains from North Carolina. He determined that they were members of the genus "Microcyclus aquaticus" (van Ert, Staley 1971 J Bact 108:236) now Ancylobacter aquaticus.

My second student, Joanne Tusov received her Master's degree for determining the distribution of *Planctomyces bikefii*, *Planctomyces guttaeformis* (Figure 6), "Metallogenium", and two unnamed microcolonial organisms, one that formed a large rosette and an iron oxide-depositing organism from North and South Carolina lakes. Unfortunately, this

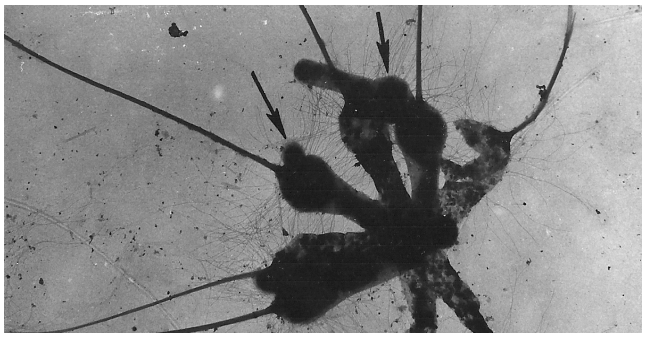

Figure 6. Planctomyces guttaeformis, an uncultured budding rosette. Note arrows for buds at different stages of develop-ment. Apical stalks is ~20 µm long. Ideal candidate for single-cell genomics.

work was not published. Klaaske deJonge, another Dutch student was also in the lab.

A year after arriving at UNC our departmental Chair, Professor Dan Okun informed faculty during the annual retreat that our large institutional NIH grant was unlikely to be renewed. Since I was one of the most recent hires, my position appeared in jeopardy. Soon thereafter, Professor John Sherris, the new Chair of Microbiology from the University of Washington called. He would be in the area and asked if we could meet for dinner. At dinner he indicated that the Department of Microbiology and Immunology at UW was looking for a replacement for Professor Erling Ordal who was approaching retirement. John asked if I might be interested in applying. I was. After the seminar in early 1971 UW offered a position as Assistant Professor to begin that fall.

I was first in Seattle in 1956 when I traveled to the International Boy Scout Jamboree in Japan. The second time was a stop on the way to Point Barrow in 1962 at the time of Seattle's World Fair, which I visited the night before leaving for Alaska. I was delighted that opportunity returned me to Seattle and the University of Washington where I remain today.

University of Washington 1971 to Present

The University of Washington was a hotbed of molecular microbiology and taxonomy in the 1960s. Yeast genetics was a major area in eukaryotic biology. Professor Brian McCarthy's lab originated the use of DNA-DNA hybridization (DDH) to demonstrate the relatedness between different bacteria. John Johnson was a post-doc in Erling Ordal's lab and they used DDH to clarify the relatedness of Vibrio species. Later Don Brenner, who was a student of Neal Groman, helped perfect the procedure and took a position at the CDC (Communicable Disease Center) and became a member of Bergey's Manual Trust. In addition, Professor John Liston was Chair of the Institute for Food Science in the School of Fisheries.

After I arrived in Seattle, John Sherris introduced me to John Liston and I worked closely with them in developing a curriculum for undergraduate students in microbiology that would serve both departments and other biology programs on campus. I was delighted to know John Liston because he and his students worked on bacterial systematics. One of his PhD students, Bill Wiebe, was completing his degree with John, and I served on committees of several of John's PhD students. Liston was also a member and Chair of Bergey's Manual Trust. Rita Colwell, a close friend, was Liston's student but she completed her PhD before I arrived at UW.

I had an NSF grant to study Caulobacter biology and ecology. Postdoc support enabled Thomas Jordan to come to my lab. Tom was a graduate student with Jack Pate, who isolated and named *Asticcacaulis* as a PhD student of Erling Ordal, and was a professor at the University of Wisconsin. Tom worked on Caulobacters in Jack's lab.

Prosthecate bacteria and *Microcyclus* (*Ancylobacter*)

I was itching to test a hypothesis I had developed as a graduate student at UC Davis. I wrote a term paper for professor A. G. (Jerry) Marr's course in which I hypothesized that the cross-bands Caulobacter produces in its prostheca (Caulobacter researchers call it a stalk) were formed at the time of cell division.

Tom and I set up experiments to test the hypothesis. The first experiments used synchronous cultures

with swarm (motile) cells harvested from growing cultures. We followed their growth by taking periodic samples and examining them under the electron microscope (cross-bands cannot be seen by light microscopy). We found the first generation cells contained, at most, only one cross-band in their stalk, and then after a second generation, two began to appear in support of the hypothesis they are formed during each cell division (Staley, Jordan 1973 Nature 246:155).

A second type of experiment used the inside of a sterile glass tube as a place for caulobacter cell growth. Caulobacter swarm cells produce a holdfast that allows them to attach to glass surfaces. We inoculated the interior surface of glass tubes with an active culture of Caulobacter to enable swarm cells to attach to the interior of the tubing. We then attached the glass tube to sterile rubber tubing and continuously provided fresh sterile medium from a reservoir to allow cell growth while flowing medium carried away unattached cells. We maintained this system continuously for 52 hours (approx. 19 generations). After the growth period, we removed the glass tubing, teased cells from the interior of the tubing with a sterile loop and examined them with the electron microscope. Some cells contained as many as 18 cross-bands in confirmation of the hypothesis that they are formed each generation. No other investigation has reported so many crossbands in Caulobacter cells.

The upshot of these experiments is that cells produce a cross-band in their stalk at the time they undergo cell division thereby verifying the hypothesis. The cross-bands are analogous to annual tree rings because they tell how many generations old a Caulobacter cell is.

In Britain, a student of Crawford Dow used a baby bank procedure to synchronize a Caulobacter strain, and did not confirm our findings about cross-band formation. I was irritated because they did not try to replicate either one of our methods, but their work cast doubt on ours. It was not until professor Jeanne Poindexter was on sabbatical leave in my lab in the 1990s that we used a third method to test the hypothesis. In this approach, we made the logical assumption that the distribution of cells in an actively growing population should have twice as many cells with one cross-band as those with two, and further that those with three should be found at a quarter the number of those with one cross-band and so forth. We found this true. In our minds we had demonstrated unequivocally the validity of the hypothesis (Poindexter, Staley 1996 J Bact 178:3939).

Subsequently, knowledge of cross-band formation was used to estimate caulobacter grow rates in aquatic habitats. Jeanne and I placed glass slides with formvar-coated EM grids in Lake Washington and removed them after one, two and four days. Then we located microcolonies and counted the number of cross-bands in those cells with the greatest number of cross-bands realizing that the earliest attaching cells would have more cross-bands than those that attached later. In this manner we were able to estimate that the most rapidly growing Caulobacter cells underwent cell division every 6-8 hours (Poindexter, Pujara, Staley 2000 AEM 66:4105).

Richard Moore collaborated with us on the systematics of prosthecate bacteria. I met Dick when he was a post-doc in Peter Hirsch's lab at MSU in 1968. Dick was a UW student with Brian McCarthy and used DDH to classify halophilic bacteria for his PhD. He obtained an academic position at the University of Calgary. We used DDH to compare various prosthecate genera including Prosthecomicrobium and Ancalomicrobium strains confirming their taxonomy (Moore, Staley 1976 IJSB 26:283). We also published on Caulobacter and Asticcacaulis species along with Jeanne Poindexter and Jean Schmidt (Moore et al. 1978 IJSB 28:349) largely confirming their phenotypic classification.

My lab studied the temporal and vertical distribution of Caulobacter species in Lake Washington using replicate ten-fold dilution series of 0.0l% peptone medium so that MPN (most probable number) could be used to quantify their abundance by phase microscopic observation. This took several years to finalize and various members of the lab were involved including Allan Konopka, Fred Palmer, Joe Dalmasso and Tini Meise from Netherlands (Staley, Konopka, Dalmasso 1987 FEMS Micro Ecol 45:1). We discovered the abundance of caulobacters (species

were not differentiated) increased dramatically during the early spring and decreased in late summer and fall indicating that caulobacter abundance was closely associated with the primary spring algal blooms.

Gas Vesicles, Microcyclus and Prosthecate Bacteria

Allan Konopka, my first PhD student, used gas vacuolate strains of Microcyclus (now Ancylobacter) aquaticus to study the process of gas vesicle formation. We knew gas vesicles collapsed by increasing hydrostatic pressure or centrifugation. Gas vacuolate cells were centrifuged and gas vesicle reformation was followed by EM (individual vesicles cannot be seen by light microscopy) during subsequent growth and development to see whether collapsed vesicles could be re-inflated or needed to be re-formed. The results were clear-cut. The initial re-appearance of gas vesicles was of small bi-conical units. They enlarged in size and at a certain width, elongated (Konopka, Staley, Lara 1975 J Bact 222:1301). Thus, original vesicles could not be re-inflated although collapsed vesicle subunits might be recycled to form new vesicles.

With Dick Moore's help, we conducted a DDH study of several other Microcyclus aquaticus strains. We could not find a sufficient difference between the gas vacuolate strains and those that lacked vesicles to describe them as separate species suggesting the gas vesicle genes were likely on a plasmid (Konopka, Moore, Staley 1976 IJSB 26:505).

Erling Ordal mentioned he had observed polyprosthecate bacteria in pulp mill aeration lagoons. My second PhD student, Patricia Stanley, conducted a study of several different lagoons at various paper pulp mills in Washington and Oregon. We confirmed and quantified Erling's observations (Stanley, Ordal, Staley 1979 AEM 37:1007). Finding the polyprosthecate bacteria in aeration lagoons suggested a possible dissertation topic for Pat. I was always interested in the kinetics of update of organic substrates by bacteria in aquatic habitats and closely followed John Hobbie and Richard Wright's work indicating that bacteria take up organic substances at low concentrations and further they do so by Michaelis-Menten (MM) enzyme kinetics. With that in mind, Pat set out to determine whether Ancalomicrobium adetum was involved in the utilization of organic materials in a Weyerhauser lagoon in Everett, Washington. Tritium-labeled acetate was used. Community levels of uptake were measured using the entire community by the procedures of Wright and Hobbie. Autoradiography was used to ascertain the uptake of the morphologically distinctive species. The amount of radioactivity of each silver grain associated with the autoradiogram was determined for two distinct species, an unidentified 'elongated rod' and A. adetum.

The results were dramatic (Stanley, Staley 1977 Limnol Oceanogr 22:26). First, the community uptake of acetate indeed followed MM kinetics. The elongated rod also took up acetate according to MM kinetics at a very high rate. In contrast, A. adetum was less active, but also assimilated acetate according to MM kinetics. To my knowledge this is the first time a bacterial species was shown to individually uptake a substrate in its natural habitat at a rate that could be calculated.

My first two PhD students also published a sole author article as one of their publications. I did this as a tribute to Robert Hungate. Pat's individual paper described the first phages, several DNA T-type phages, for *Ancalomicrobium adetum*. Subsequently because of the competitive grants process this was discontinued.

Interestingly, *Ancalomicrobium adetum* is the only known fermentative prosthecate bacterium. Because of this, Mitch Saier approached me to collaborate on determining whether it utilized the same phosphoenolpyruvate sugar phosphotransferase system used by other fermentative bacteria such as *E. coli*. We tested this and, low and behold, it did! (Saier, Staley 1977 J Bact 131:716) This suggested that this bacterium might be related to *E. coli*, which seemed very unlikely because of the disparity in habitat, morphology, taxonomy, etc. However, later when it was discovered that the enteric bacteria are in the Gammaproteobacteria and *A. adetum* is a member of the Alpha-proteobacteria, two related subphyla of the Proteobacteria, this made more sense.

I always wanted to determine the fermentation products of A. adetum. At MSU this was technically challenging because of the antiquated gas-liquid chromatography available in 1967. However, by the 1990s gas chromatography had improved dramatically. In addition, Alex Van Neerven, a technician came to my lab, courtesy of Professor Alexander Zehnder from Wageningen, Netherlands. Alex was familiar with gas chromatography and UW had a professional contract service that conducted highly sensitive and accurate gas-liquid chromatography coupled with mass spectrometry. When the A. adetum fermentation products were analyzed, we were incredulous. They produce the exact same mixed acid fermentation products as *E. coli*! (Van Neerven, Staley 1998 Arch Microb 149: 335) This raises important, yet still unanswered questions: One is "Which came first, *A. adetum* and its fermentation, or *E. coli*?" I hypothesize it was A. adetum because as a free-living organism it was likely fermenting carbohydrates for many millions of years before the mammalian hosts of *E. coli* had evolved. Interestingly, this hypothesis could be tested by conducting phylogenetic trees of some of the enzymes involved in these processes. Other unanswered questions are "How did this entire pathway evolve separately in an Alphaproteobacterium and a Gammaproteobacterium?" and "Do other unidentified bacteria contain it?"

I was very impressed by Alex's SEM skills. He was able to produce excellent images of *Ancalomicrobium* (Figure 3) and *Prosthecomicrobium* strains. As part of his work, he isolated several more strains of Ancalomicrobium from pulp mill aeration lagoons. This is remarkable, because until then we had only two strains, and our lab remains today the only one that has ever isolated *A. adetum*.

Alex also investigated conditions under which gas vesicles were formed by *A. adetum*. He discovered that the ideal conditions for vesicle synthesis were fermentative conditions in which the temperature was 8°C or lower (as found in the anoxic hypolimnion of lakes) and the preferred carbohydrate was trehalose not glucose. This was not published before he left my lab and most unfortunately he died in a laboratory accident shortly after returning to Netherlands. We named *Prosthecobacter vanneervenii* after Alex (Hedlund, Gosink, Staley 1997 A van Leeu 72:29).

My lab continued to study the polyprosthecate bacteria throughout my career. One of the most remarkable species described was *Prosthecomicrobium hirschii* (Staley 1984 IJSB 34:304). This organism has a motile stage and produces budding cells with both short and long prosthecae. The life cycle differs from *Caulobacter* species which produce a motile cell following cell division before it produces a prostheca and becomes immotile. *P. hirschii* buds to produce a short-appendaged cell from a short or long-appendaged mother cell. Likewise, a long-appendaged cell may produce a short or long appendaged daughter cell. Motility occurs only in the short-appendaged cells, which makes sense in that it takes less energy to move them than the long-appendaged cells. When culture density increases, only motile, short appendaged cells are produced. The explanation for this life cycle pattern is not understood but it has genes for quorum sensing (Professor Peter Greenberg, personal comm) suggesting that higher cell densities may induce dispersal.

Recently *Prosthecomicrobium* was found to be polyphyletic indicating it contained two new genera we named *Vasilyevaea* with species V. enhydra and V. mishustinii, and Bauldia with two species B. consociatum and B. litoralis leaving P. pneumaticum as the sole species of the genus (Yee et al 2010 IJSEM 60:2960). Further, *P. hirschii* will be renamed "*Prosthecodimorpha hirschii*" in the new edition of Bergey's.

The lab isolated, named and classified other gas vacuolate bacteria. One was Enhydrobacter aerosaccus (Staley, Irgens, Brenner 1987 IJSB 37:289), another Aquabacter spiritensis (Irgens et al 1991 Arch Microb 155:137) and others isolated from sea ice (below and Table 1).

Another evolutionary hypothesis is that gas vacuoles provided an ancient mode of motility for Bacteria and Archaea (Staley 1980 Origins of Life 10:111). In support of this, they impart movement (up or down in water column gradients) that requires little energy and are found in many bacterial phyla and the

Euryarchaeota (methanogens, halophiles) that are regarded as more ancient than the Crenarchaeota.

Biodiversity, The Great Plate Count Anomaly and Water Quality

My initial interests in aquatic microbiology centered on freshwater habitats for several reasons. First, I grew up on the Great Plains far from an ocean and had a strong emotional affinity for rivers and lakes that were places of fond memories for swimming, fishing, canoeing and family holidays. Second, I loved limnology and audited Professor Charles Goldman's course at UC Davis. Third, unlike the more complex marine environment, limnology is a simpler ecological science based on lake ecosystems that can be more completely studied physically, chemically and biologically.

Professor Bob Wetzel taught the limnology course at Gull Lake laboratories at Hickory Corners where Peter Hirsch and I taught microbial ecology and observed with Jan Krul the in situ behavior of "Toxothrix" (Krul, Hirsch, Staley 1970 Ant van Leeu 36:409) which lyses during observation of wet mounts! Now that's something interesting to study!

When I first came to UW, I joined the International Biome Project (IBP) studying Lake Washington. In addition, I met Professor Tommy Edmondson and his wife Yvette, who was a student of Henrici. The first few years were dedicated to freshwater work in Lake Washington (e.g. we reported patchiness of heterotrophic bacterial communities Staley, Methot, Palmer 1976 AEM 31:1003), pulp mill oxidation lagoons and the impact of Mt St. Helens' 1980 eruption on nearby lakes.

My lab routinely used direct microscopic counts combined with plate counts to examine the correspondence between Total Microscopic Counts and Viable Plate Counts. Fixed samples for total cell counting used the latest acridine orange staining procedure (the first USA version was developed by Don Francisco and Robert Mah at UNC) from Professor John Hobbie, who I first met at the US McMurdo Antarctic Station in 1962.

A phrase, The Great Plate Count Anomaly was introduced in a review paper (Staley, Konopka 1985 Ann Rev Micro 39:327) to denote the inability of viable counting to recover the total number of bacteria from natural habitats such as Lake Washington. Interestingly, as discussed in the Mt St. Helens work below, the correspondence between the two techniques increases as the habitat becomes more enriched suggesting that natural habitats contain many microorganisms that are more difficult to cultivate than those in enriched environments.

I was invited to be an adviser to Brazil's Biota program on biodiversity and spent several years attending annual meetings - a wonderful experience (Staley 2001 BIOTA/FAPESP http://biotaneotropica.org.br.). I also led or was involved in several ASM Biodiversity symposia.

After my Australian sabbatical leave (1977-78) where I studied the incidence of budding and prosthecate bacteria in lakes of various trophic states in New South Wales (Staley, Marshall, Skerman 1980 Microb Ecol 5:245 – we found their incidence increased along with other bacteria at higher nutrient levels), I began more applied work with the Environmental Protection Agency (EPA). In particular, we used microbial limnological procedures to investigate bacteria at the various stages of the Seattle Water Treatment system. While professor Liv Fiksdal was on sabbatical leave we used non-standard EPA procedures including total bacterial counts (acridine orange), viable counts at various incubation temperatures, etc to enumerate bacteria (Fiksdal et al. 1982 JAmWWAssoc 74:313). Postdoc Jim Maki led a study following the recovery of bacteria after chlorination (Maki et al 1986 AEM 51:1047)

Later we published on the use of Bacteroides as a substitute for *E. coli* as an indicator bacterium for drinking water contamination (Fiksdal et al 1985 AEM 49:148). The idea is that it is better than *E. coli* because Bacteroides are more numerous in wastewater and therefore easier to detect using immunological methods (Moench, Johnstone, Staley, 1984 AmWWAssoc Water Quality Tech Conf 12: 129). More importantly since Bacteroides are not able to reproduce aerobically, their actual numbers in receiving waters would be a better indicator of water quality.

Impact of Mt St. Helens eruption on blast zone lakes

In 1980, following an ASM meeting in Miami, I was flying back to Seattle when I learned of the Mt St. Helens eruption. Robert Wissmar, Alan Devol and J. Sidell, scientists with whom Fred Palmer and I worked on the IBP, invited us to join in an investigation of the aftermath of the eruption on lakes in the blast zone. We were delighted. It was difficult to obtain samples. A helicopter was required to sample each of a dozen or so lakes inside the blast zone and three control lakes on the southern flanks of Mt St. Helens not impacted. Because of sampling difficulties and space, our lab collected two test tube samples from each lake: one sample fixed with formalin and a second aseptic sample was iced for cultivation.

I always enjoyed working with Fred who was older and had a wealth of experience doing microbial ecology and marine microbiology. I respected Fred's advice on many matters. Fred was the lead technician on several projects including the Mt St. Helens work. Leo Lemicke, a rotating graduate student and technician Richard Peet also worked on the project.

Total counts were made using the acridine orange procedure. Viable counts were determined by spread plating 0.l ml of lake water and incubating at room temperature. We soon realized we were greatly underestimating the concentration of viable bacteria although it was the typical dilution we always used for mesotrophic lakes like Lake Washington. Therefore, we subsequently plated higher dilutions except for the unenriched control lakes. We also enumerated total and fecal coliform bacteria by standard MPN (most probable numbers) procedures.

Although there was little time to hypothesize about what might be happening in the blast zone lakes, it soon became apparent. And it all made perfect sense. Unlike the thriving bacterial and protozoan communities, at the macroscopic level, virtually all of the vegetation and animal life on the North face of Mt St Helens was killed by the blast which was directed northward. The watersheds of the lakes were filled with dead vegetation and animals. The organic concentrations rapidly enhanced bacterial growth, in effect making the lakes eutrophic to varying degrees depending on the organic loads each received.

I was a co-author on a paper that documented the sudden increase in organic material in Spirit Lake and its eutrophying effects including increased ATP levels (high bacterial levels) yet low chlorophyll levels (low algal concentrations) and evidence of reduced oxygen concentration after impact (Wissmar et al. 1982 Science 216:178). A more complete picture of the bacterial changes was published in another paper from our lab (Staley et al 1982 AEM 43:664). The concentrations of total bacteria exceeded 10^7 per ml, ten times that of the control lakes. Viable counts exceeded 10^6 per ml versus less than 10^4per ml in the control lakes.

One of the most surprising results was found in Castle Lake in May, 1981. Almost 50% of the total count consisted of spiral shaped bacteria. In our publication we thought it was a Spirillum but later Noel Krieg suggested it was likely an Aquaspirillum. This species initially grew on the plating medium although after several transfers, ceased growing. More importantly, it utilized organic acids. Evidence indicated this was perhaps the first report of a primary bacterial succession in a lake apparently driven by waves of changing organic acids that enabled one species that could most effectively utilize the acid to dominate for awhile before another substrate and species were enriched.

We conducted a follow-up unpublished study on the lakes after six years. Although the microbiology of the lakes had returned to a semblance of normalcy, as I write today, the vegetation and animal life are still far from full recovery.

Desert varnish and manganese oxidation

My lab collaborated with several other groups on campus including Professor John Adams in Geology. We were brought together by Randall Perry an MS student from John's lab who was interested in our work on manganese oxidation in Lake Washington led by PhD student, Eileen Gregory (Gregory. Perry, Staley 1980 Micro Ecol 6: 125) that provided evidence that "Metallogenium" is not a living

organism although many manganese oxidizing bacteria were found in freshwaters (Gregory, Staley 1982 AEM 44:509).

Desert varnish is a brown to black iron and manganese oxide coating found on desert rocks. The mechanism of its formation has been controversial and thought not to involve silica found in many rock coatings. One hypothesis is that iron and manganese oxidizing bacteria are responsible for its formation as purportedly validated using Koch's environmental postulates (Dorn, Oberlander 1981 Science 213:1245) which require that strains responsible for a process be isolated and retained. When I requested his strains of "Metallogenium" and Pedomicrobium, Dorn told me that he did not have them but suggested I isolate them from samples he could provide! Later some of his work was challenged (1998 Science 280:2041) and for perhaps the first-time ever in American science, Dorn sued some of his collaborators who claimed he was 'doctoring' samples! (1999 Science 286:883)

John Adams' and our lab carried out fieldwork in the Sonoran Desert north of Phoenix, Arizona for several years. Fred Palmer and I went to Phoenix to collect samples and conduct experiments. One of our most important discoveries was of microcolonial fungi (MCF). We found them, not only on rocks with varnish, but on ordinary rocks from deserts. These small colonial fungi lacked algae and therefore were not lichens (Staley, Palmer, Adams 1982 Science 215:1093).

Although MCF are common and widespread, they and their classification was unknown. Through cultures we and subsequently others obtained, they are now classified in the literature as Dothideomycetes. Interestingly, they are phylogenetic ancestors of the Ascomycetes (Ruibal et al 2009 Stud Mycol 64:123) a common fungal lichen group suggesting that MCF were likely one of the earliest colonizers of terrestrial environments before lichens evolved. If so, they must derive their foodstuff entirely from windblown organic material because they lack photosynthetic algae.

Fred Palmer led the study on the colonization of MCF on large stones in Eastern Oregon to follow their development near the northern extent of their distribution in the Great Basin (Palmer, Staley, Ryan 1990 New Phytol 116:613). More northerly climes favor lichen growth.

MCF excrete acids that erode stone structures, especially marble. Their discovery opened a new field of study. My German colleague, Wolfgang Krumbein and others investigate the damage they inflict on historical monuments such as the Parthenon in Greece as well as ordinary stone buildings.

We also collaborated with others using samples collected from the Negev, Sahara, and Gibson Deserts on other continents. Several papers were published on the associations of microorganisms with varnish (Taylor-George et al 1983 Microb Ecol 9:227; Staley et al 1983 BMR J Geol Geoph 8:83; Palmer et al 1986 Geomicro J 4:343; Staley, Adams, Palmer 1992 Soil Biochem 7:173; Adams, Palmer, Staley 1992 Geomicro 10:99). I was delighted to have undergraduates Bruce Hungate (Robert Hungate's grandson) and Peter Kjellander, who both became scientists, work on manganese-oxidizing bacteria in my lab one summer (Hungate et al 1987 Can J Microb 33:939).

Our most recent publications with Randall Perry, who obtained his PhD in Geology in the UW Astrobiology Program, provide evidence that silica is, in fact, involved in desert varnish coating (Perry et al. 2006 Geology 34:537) and provided a revised definition of the term biomineral (Perry et al 2007 Sedimen Geol 201:157).

Jeremy Dodsworth, a rotating graduate student, carried out an interesting unpublished study using DNA extracted from varnish coatings during a particularly wet spring. He discovered that Cyanobacteria dominated his 16S rDNA library. This is notable because most previous studies were carried out during dry periods when Cyanobacteria were unapparent suggesting that rare wet periods may play a significant, yet understudied role in varnish formation perhaps by providing organic material to MCF and bacteria.

Marine Microbiology

I was first introduced to marine microbiology in North Carolina. I was invited, as an assistant on a short marine cruise on a Duke University boat with John Hobbie from North Carolina State, Professor Lawrence Pomeroy from U of Georgia and others who were comparing procedures for studying biological community biomass and activity - a wonderful experience.

Thomas Odum, a Professor in our Department at UNC, was conducting a study of ponds that contained 50% sea water mixed with 50% wastewater in Morehead City on the Carolina coast. I set up the immersed microscope system to study the growth of algae in these lagoons and quickly realized that the algae in this system behaved entirely differently from the freshwater habitats in Michigan. They did not remain attached in one place on the glass slide surface! Clearly, I could not re-locate individual clones to study their development - the study had to be abandoned.

...to be continued in the next issue of The Bulletin.

The Bulletin of BISMiS (2018), Volume 7, part 1, pp 33-38

An Adventure to BISMiS 2016 in Pune, India by Five American Undergrads

Victoria M. Wilson, Jacob R. Miller, Emily A. Carson, Devin C. Frantz, Kyle T. Jacobs

When each of us chose to attend Lycoming College, a small undergraduate school in central Pennsylvania, the idea of traveling to India, or any country for that matter, was the furthest thing from our minds. Although our reasons for committing to an institution of approximately 1300 students are numerous and varied, we all share many underlying commonalities that are central to our institution's core values. In particular, the individualized teaching environment provided by our Science department has enabled us to build invaluable relationships with our professors. One of the advantages afforded by this has been the ability to work alongside our professors conducting research in their labs. This immersive experience has not only enabled us to hone our laboratory prowess, but has given us a foundation with which to explore and develop our own personal interests within the scientific community. Although the opportunities afforded by this institution are boundless, never in our wildest dreams did we imagine that by working in Dr. Jeff Newman's microbiology lab, we would find ourselves amongst the scenic beauty and captivating culture of India; all for the purpose of attending an internationally renowned conference of professors and graduate students to present and discuss research that is reshaping the field of microbial taxonomy.

Dr. Newman first presented the idea of attending Bergey's International Society of Microbial Systematics conference in the late Fall of 2015, at which time the prospects of financially and logistically undertaking such a trip seemed laughable. How could a group of undergraduate biology majors possibly take part in an international conference of this caliber, with expected attendees consisting of scientific leaders in the field of microbial taxonomy? Fortunately, Dr. Newman had a plan that would eliminate any doubts that we may have had, and ultimately, transport us from the comfort of our own lab at Lycoming College, to the Pune Microbial Culture Collection in India. Infectious with optimism, he soon encouraged the five of us to prepare and submit abstracts of our microbial reclassification and novel species characterization work. Shock and elation fail to aptly convey the feelings we shared when weeks later, we received word from Dr. Kamlesh that our abstracts had been accepted and that we would be presenting our work.

Upon returning to college for the 2016 Fall Semester, less than two weeks separated us from embarking on our journey halfway around the world. Fast-forward to the day of our departure, Dr. Newman and Karen, his wife, successfully managed to corral five students, luggage and all, through a bustling New Jersey airport and onto our flight, despite nearly misplacing our research posters in the process. A measly fifteen hours later, our jetlagged group stepped into the otherworldly Mumbai, India. Thus was the beginning of our captivating, convivial, and enlightening journey, aptly dubbed, "Lyco-Micro Takes India."

Upon exiting the plane through the jet bridge, we were greeted by a clean and modern Mumbai airport, whose eye-catching design was adorned with fascinating murals and ornate art fixtures. After retrieving our luggage, we made our way outside to locate the taxi drivers who would transport us 4 hours to Pune! A crash-course in road navigation served as our introduction to Indian culture; an experience most accurately depicted as a chaotic, yet beautiful dance of cars, rickshaws, motor-bikes, buses, pedestrians, and even animals. Miraculously, all collectively shared the same narrow roads that wound from the hectically dense Mumbai, through the breathtakingly untouched countryside. Traversing across Mumbai was to partake in a drive-through lesson of Indian history and culture. With the gracious help of local translators, we were provided a bounty of information regarding India's

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past history, present state, and future trajectory. Not only were our accompanying translators extremely eager to share their knowledge, they were down to earth and easy to talk to. This allowed us to comfortably discuss topics of any nature, whether it was politics, religion, or anything in between. Moreover, they graced us with a number of tips that were very useful during our stay.

The architecture of Mumbai and the countryside, although vastly different, were very pleasing to view and aided us in our journey of understanding Indian history and culture. Through the windows of our cramped cabs, we caught glimpses of ornate buildings designed with stylistic motifs spanning Gothic, Victorian, Art Deco, and Indo-Saracenic influences. Sprinkled among the larger features of the city were extravagant temples, tranquil parks, and innumerable shops, markets, and vendors, all with a unique South-Asian twist that contrasted the more prominent centerpieces of the city. Many areas along our drive were slowly becoming reclaimed by the jungle, as trees, vines, and various overgrowth crept up and engulfed buildings; and the further from the city we wandered, the more the splendor of nature began to expose itself as we climbed over the mountains into sprawling countryside. As the sun began to set on our scenic excursion towards Pune, there was the unmistakable feeling of being privy to one of India's many secrets, the tranquility and mystery of nature.

As untouched mountain suddenly yielded again to the human influences of gas stations, high rises, and road-side vendors the city that for months previous had been a far-off dream was now a physical reality. Unfortunately, our late arrival forced appreciating the scenery and life of Pune on hold till the following morning, but fortunately finding delicious sustenance was an easy task. Therefore, we were quick to appreciate the cuisine of Pune as we eagerly devoured food that we all immediately loved!

The first official foray within the bounds of Pune was a trek, better yet adventure, from our hotel to the main conference hotel where evening reception was to be held. A maze of twists and turns, double-backs, and retraced steps taught us the lesson of the unreliability of Google maps as a source of walking directions in a city such as Pune. When one expected walking route was unavailable, a detour brought us through an area labeled on Google Maps as the "Aundh Slums". As we walked through the narrow streets past goats and stray dogs, we saw children playing, fruit and vegetable vendors pulling carts in the streets, small store fronts with hanging strips of packaged snacks, women in beautiful saris going on with everyday life. While such living conditions and homes had never been seen by any of before, the shared daily activities of life seemed very normal. After finding the site of the evening event and walking back to our hotel on a direct route, we prepared for the opening session.

Dressed in our best attire for a good first impression at the Pune Microbial Culture Collection, we trekked up rocky hills and through narrow walkways between buildings (thanks Google maps!) prior to our right-on-time arrival at the Microbial Culture Collection. With mere seconds to spare we collected welcome bags and claimed open seats just as Dr. Kamlesh welcomed all attendees and officially opened the conference. Thus began our immersion into the operations of an international scientific community.

Intrigue and intimidation best sum our emotions felt at the conclusion of the introductory remarks by Dr. Peter Kämpfer on the "Taxonomy of Prokaryotes - New Challenges in a Global World." Intrigue because Dr. Kämpfer spoke of difficulties inherent to accurate taxonomic placement when no official classification system exists. While we were all aware of the ambiguity in taxonomy, as our research under Dr. Newman has taught us, Dr. Kampfer's remarks were a sobering reminder of the meaningful contribution of taxonomy research from seasoned professional all the way down to novice undergraduates. He also instilled in us budding scientists a fair bit of (good) intimidation as we came to understand the incredible vastness of the microbiology field and how far we all yet have to go in our transformation into competent, independent scientists. Yet, there we were in India, as active contributors to a field whose nuances are revealed day-by-day as we continue to develop our scientific skills. After a thought-provoking lecture that set the stage for the rest of the conference everyone quickly dispelled from the hall to prepare for the evening mixer provided at the Seasons Hotel.

Prior to the mixer, our understanding of the culture of the microbiology community was the results of stories related to us by professors and previous students who had experience attending conferences. Whatever the stories may have intimated, it was now our turn to experience it ourselves! Our expected fear of inadequacy and inexperience mingling amongst seasoned professionals were quickly laid to rest with the inviting atmosphere of the mixer where conversation was quick to develop. The mixer provided the opportunity to network with other conference attendees, learn about their individual research, where they are from, and their experiences in India. Held in the back of all of our minds during the evening was the humbling thought that we were walking amongst the very scientists that made discoveries and developed taxonomy tools that we use within our own research. By the mixer's conclusion we had met scientists from around the world, many of whom traveled even greater distances than we did, and all with vastly different perspectives and cultures, but all with exciting research that we looked forward to learning more about in the forthcoming days.

Research under Dr. Newman is structured so as to create reinforcing parallels between discoveries made by genome analysis and those seen in phenotypic comparisons as a means to create a full picture of the capabilities of a species and where it belongs in the current classification framework. Our most heavily utilized genome tools include eDDH analyzed by the DSMZ's Genome-Genome Distance Calculator, Average Nucleotide Identity (ANI) and 16S rRNA gene comparisons using the Chun Lab's EZtaxon tools, and Average Amino Acid Identity using RAST and our own tools. As these are some of the metrics we are most familiar with, Dr. Jongsik Chun's presentation on "Comparative Genomics for Taxonomy of Prokaryotes" was one of several presentations that stood out for its particular relevance to our research goals. We can count ourselves among the lucky few who have had the opportunity to learn about a new tool from a lab before it has even become available.

Another lecturer, hailing from the University of Las Vegas, Nevada, Dr. Brian Hedlund, gave his keynote speech on "Cultivation-Independent Genomics Approaches and Their Relevance to Microbial Taxonomy." which took a focused look at some of the areas of ambiguity noted by Dr. Kampfer in his opening address. Dr. Hedlund took the issue of unofficial taxonomy to analyze phylo-rank over/under classification as a result of evolutionary relics, single-cell genomics, and geographic limitations. An issue that hits particularly close to our research as the creek from which we analyze organisms is at the mercy of the effects of upstream temperature changes caused by pollution. Dr. Boris Vinatzer echoed the sentiments of Dr. Hedlund with a potential circumnavigation to rote taxonomy by establishing Life Identification Numbers (LINs). The small world of the field became apparent as an alumnus from our lab, Kevin Failor, is a Ph.D. student in Dr. Vinatzer's lab at Virginia Tech.

On Tuesday evening we were treated to dinner and a cultural program of performances by singers, instrumentalists, and dancers within the auditorium of the National Centre for Cell Science. The performances were beautiful and the historical background provided with each act made it all the more enriching of an experience. The set list included a sitar, flute, and drum trio, raga singers, and classical raga dancers. It was captivating to hear the sitarist, flutist, and drummer not only play in beautiful harmony, but exchange solos with one another in a bout of lighthearted competition. The rhythms and scales of Indian music have a unique way of evoking special feelings within an audience that encapsulate the mystique of Indian culture. The same was the case for both the classical raga singers and dancers. The sounds and movements of the performers were truly ethereal. To have been fortunate enough to view the performances was incredible, but also have the understanding of their significance and meaning within Indian culture is memorable. Dinner was confirmation that Indian cuisine is diverse, but indescribably delicious. Bread varieties abounded, from chapaati, dosa, naan, and paratha, all with slightly different textures and flavors. At the end of the evening it was agreed that gulab jamon is the perfect dessert to end an evening of music and conversation.

Lecture on Wednesday kicked-off with Dr. Austin's keynote for "The Role of Cultures in the Twenty First Century" chaired by himself and Dr. Yogesh followed by Dr. Kampfer and Dr. De Vos series in "Modern Approaches to Identification." Dr. Yogesh gave an insightful lecture on the research performed by the MCC as a whole in addition to where his own personal research interests lie. The work the MCC does to understand the unique microbiome of India from rivers, land, and the atmosphere stands as a model for the great relationship science and community can have in providing depth of understanding to the strong tie that exists between people and the land. In a country whose urban centers are quickly spreading and where modern and rural find themselves in ever increasing contact, a determination of the country's microbial community will ensure preservation of a vast number of novel and ecologically important species.

Up until Wednesday evening we did not believe Pune could become even more lively, but the bus ride to DYNA Biotech put a whole other side of Pune on display. A side of reverent dancing, music, and marching all to honor Ganesh. What was thought to be a simple bus ride became an experience in an often unseen side. India is nothing but full of surprises where no day is ever normal! At DYNA Biotech we were all given a surprise regal experience complete with a red carpet, music, and a traditional welcome of flowers and face markings. There by the entrance as well was another gorgeous kolam. Beautiful yet fleeting and impermanent; another new discovery for us in a country of mysteries. DYNA Biotech was a perfectly gracious host honoring Dr. Yogesh and several others as well as giving all female attendees a thoughtful and memorable gift.

In the blink of an eye we found ourselves waking up on Thursday morning to the last day of the conference. Our time in India was coming to a close far too quickly! The conference ended on lectures concerning cyanobacterial taxonomy and technical problems becoming of greater concern when describing new taxa and proper implementation of "the code" for accurate nomenclature. Altogether vital issues to be addressed in the future for both cyanobacteria and microbiology as more cost-effective technology becomes available to greatly accelerate the rate of newly discovered species.

With the close of Session 6 our first experience of an international conference had come to a close. Fortunately, Dr. Yogesh and the Organizing Committee ensured the conference ended on a day when the entire city of Pune would be celebrating

Figure 1. Enjoying a dinner while in India

Figure 2. Fond memories from our rickshaw ride!

Ganesh. This was a once-in-a-lifetime memory to close the conference. Like most cities, exploration of the area leads to vastly different experiences depending upon whether it is day or night. During the day lavishly decorated Ganesh shrines seemed to occupy every-other street corner, lending even more color to an already vibrant cityscape. At night these shrines transformed into beacons of communal worship. Bright lights adorned every inch not covered in colorful beads or fabric to bring into the physical the halo of reverence given to Ganesh.

All of this could be seen and felt while still sitting in rickshaws traveling to meet up with Mandar, his wife Sayali, and his brother Guarav, all whose kindness to lead us through the awesome chaos that is the Ganesh festival and in the process create an unforgettable experience for us deserves our humblest thank you. Once we all successfully reached Dandekar bridge the epic adventure began. After losing sight of the bridge and delving into the throngs of people packing every street we quickly lost track of street names and all sense of direction. Thankfully, Mandar and Sayali smoothly navigated every congested street with the adept skill of a city dweller. With those three as our guides there was no fear of getting lost so long as we managed to stay together. A skill more difficult than one might think given the swiftly moving streams of people snaking between those stationed at various shrines and floats. We prevailed though and were rewarded with a city overtaken by celebration, complete with food, electronic music, dueling bands of drummers, and young people enjoying all of the merriment.

Thankfully, through good fortune and careful planning on the part of the MCC's organizing committee we were able to experience the climax of the Ganesh Festival. Mandar, his wife, and brother successfully managed to immerse us in the heart of the party. With a sea of people amidst us, we meandered our way through the streets to witness first hand one of the most integral parts of the ceremony, a band of percussionists wielding large homemade drums, instruments not only used to keep time, but pulsate a life giving beat that could shake your bones to the core. It was as if the entire party was in sync to this riveting sound, and everywhere we turned, the locals were elated to see the sensory overloads that we must have been wearing on our faces. Over the course of the night we managed to attract numerous groups attempting to coerce us to join them in a dance. As the rhythm of the drums wore on, we no longer could resist the

urge to join the people in a street shakedown. Soon enough, they were introducing us to many of their favorite moves, and the entire group was partaking in an utterly surreal experience, and although it wasn't the most gracious display, at that moment, we ultimately felt as if we truly were a part of the Ganesh festival celebrations.

After working up an appetite, we decided to find a local delicacy to chow down on. With a number of options to choose from, Mandar, Sayali, and his brother's decided upon a vendor selling a local onion flatbread dish with and dipping sauce. Not only was the meal absolutely delicious, but it reminded us of breadsticks and marinara sauce, only much tastier. After successfully being part of the festival, we visited a flat owned by Mandar's or Sayali's family to relax and enjoy the Indian versions of a mango fruit milkshake that they so graciously purchased for us. It was at this moment that we realized the extent of our newfound friends' hospitality had no limits. Within the walls of their cozy home, we gathered around their floor to share stories and bouts of laughter .

Mandar's friend and colleague, Kamal, showed up and joined in on our comradery. Some time passed and we found ourselves reenergized and prepared to head back out on the city for one last mission, to view the centerpiece of the whole festival, a Ganesh statue clad in 24k gold. With the savvy navigation skills of our local companions, we managed to locate the float carrying this highly sought after idol. As we got closer, people were hectically scrambling to catch a glimpse, and somehow, we managed to get within feet of it. Every event that graced our way that night would have never have been made possible without our newfound friends. It was sad to ultimately say goodbye to them, but someday, maybe our paths will cross again.

At the conclusion of the conference the staff of the Microbial Culture Collection were gracious enough to allow conference members to tour their facilities. For us students it was the first industrial scale microbiology facility we had seen filled with equipment we had only ever seen in pictures or had been unknown to us previously. Some of the more interesting tools that were used to collect bacteria from the atmosphere. There were a few familiar instruments and it was gratifying to see the same research techniques that we perform are also performed halfway across the world in India, in addition to many of the labs that the speakers work in/manage.

Other cultural activities in Pune and Mumbai were planned by Dr. Newman's wife Karen. These included visits to the Agakhan Palace where Mahatma Gandhi had been imprisoned, and the Haji Ali Dargah Muslim Pilgrimage site on a small island off Mumbai that is accessible only during low tide.

Some of us will shortly be graduating from Lycoming College while others have one more year to go, but we will all leave having had the invaluable experience of participating in Bergey's International Society of Microbiology third meeting on Microbial Systematics and Metagenomics in Pune, India. We owe our gratitude to Dr. Newman for his motivation and support in making the trip of a lifetime turn into reality for all of us. Also, for guiding and educating us in the research that enabled admittance to the conference and made it into an incredible opportunity to apply the knowledge and skills we have learned in his lab.

To Dr. Kamlesh we owe you a huge thank-you for providing detailed information and guidance in journeying to India, recommending places to visit for food and/or culture , and tips on navigating Pune. Dr. Yogesh ...for hosting the conference at the MCC where we were all provided a truly immersive cultural and scientific experience in India. All of hard work by the organizing committee, often behind-the-scenes, did not go unnoticed, and is deserving of a standing ovation. Thank you all for a truly amazing educational experience.

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Being a Taxonomist in the 21st Century

Patricia Benito and Raúl Riesco

A researcher's career is a long and bumpy journey. Ahead of every graduate student there is always a long path, filled with crossroads and foggy curves, but at the end of the road, achieving one's goals pays off. Even now that we are halfway through our PhD, we have only discerned a couple of foggy and unpredictable turning points in the future.

We started our scientific training back in 2009, when we began our Bachelor Degree in Environmental Sciences at the University of Salamanca. For the first time, we dealt with nature with a pure scientific approach: we learned how important diversity was to keep an equilibrium in Nature, and how to conserve and protect it. The concept of species and how these species related to each other began to take importance in our education, it was there when our travel through taxonomy started.

Our training during our undergraduate degree, was fundamentally focused on botany and zoology, and it was not until 2011, on our third year of studies, when we finally landed in the microbial world. It was a marvelous discovery, the dark side of life, hidden, but linked with every process in Nature. If the preservation of diversity in plants and animals was indeed important for nature, how can be any less important for the prokaryote life? Let us imagine for example that the organic residues did not decompose, how will life thrive? Solutions for global problems like climate change and famine had always been centered on the macroscopic world. We had been placing red flags without taking into account the microbial activity is the ground that holds them in place!

We only spent one semester in Environmental Microbiology, but it was more than enough to tap our curiosity on the subject. On our first opportunity, we talked to our professor, Martha Trujillo, about the best way to enter in the research world… and we started working collaborating in her lab, straight away! We spent one year and a half in the laboratory, learning the ways of molecular biology, and the ecology and taxonomy of the phylum Actinobacteria. This experience defined our career, and changed our goals: being a scientist became our first priority.

After finishing our degree, we decided to widen our training in Microbiology with a Master degree in this discipline. It was a nice opportunity to tap on other areas of expertise in other cities, meet other scientists, each one specializing in specific fields. We experienced work in other laboratories, we fiddled with new techniques and we made many contacts for the future. We even had our first national taxonomy congress, our very first contact with the real scientific world.

When we finished our Master degree, we faced an important decision: to begin working for some company or to continue on the scientific road? Unfortunately, the economic crisis had a big impact in our country, Spain, and public funding for research and student's grants was severely affected. Therefore, this decision was essential for our future… It was a very difficult decision, but we were determined to move forward and continue with our scientific career.

We returned to Salamanca, where we started our PhD studies with the guide of our former professor, Martha Trujillo. We focus our project in the diversity and taxonomy of *Micromonospora* and how this genus interacts with legumes.

In the development of a thesis research, sharing your results with other scientists is always very stimulating. Many times, as we become specialists on a very narrow field of knowledge, the simple fact of sharing your theories helps to realize things

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Figure 1. Patricia & Raul in the laboratory

that were totally amiss in our work. National and especially international meetings, like the third Meeting of Bergey's International Society for Microbial Systematics (BISMiS), offer the students an opportunity to share their results with researchers of recognized renown, an excellent occasion to interact and exchange ideas directly with them.

When Martha, elected president of BISMiS at that time, suggested the possibility of presenting our work in Pune (India), we accepted without a second thought. It was the very first international congress of our careers as scientists! Having our abstracts accepted for our very first international congress was a thrilling experience. A lot of distinguished scientists, who we only knew by their name on a paper, were going to attend the meeting. It meant an important chance to make connections with other researchers at a global scale and of course it was an excellent opportunity to share our work, see other points of view and of course, travelling to a very different country, India.

Leaving aside the importance of the meeting for our work, we could not forget the relevance of BISMIS in the world of microbial taxonomy. Unlike most people think, taxonomy is a science in constant evolution, it changes and adapts, following the unstoppable advance of new technologies. New methods to work on microbial taxonomy are explored by scientists all over the world, some of them very promising, and it is the duty of the BISMiS society to coordinate and direct them in a harmonious way. In meetings like the one that took place in India, the future path of taxonomy is decided. Witnessing in person these developments was a very exciting experience for us. Systematics is currently in a critical turning point.

The recent advent of high throughput genome sequencing has provided new and very powerful tools for a more precise classification, identification and characterization of novel species of Bacteria and Archaea. The old "gold standards" of taxonomy are proving to be insufficient and in some cases, quite unreliable, so maybe it is time to improve or replace them: It will be a formidable challenge for the BISMIS society. The very first step will be the revolution of conviction, a change of mind that highlights the importance of a solid and functional taxonomy over the old and unpredictable path. In this time of change, taxonomists of all over the world must collaborate and be flexible enough to implement new techniques in their studies.

As representatives of a new age of taxonomists we should be taking special attention to the changes that are taking place in this field. We have no choice but to be innovative and proactive. In the BISMIS meeting a lot of compelling new ideas were discussed, new techniques were valued and old methodologies were improved. This might serve as a referent, we must envision taxonomy and systematics as a living and evolving science, and at the same make it workable and stable. We are proud to say that with this meeting, the new generations have taken note.

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BISMiS 2018 Preview: Microbial Systematics Indaba

Stephanus Venter

After the success of the third BISMiS meeting in Pune, India last year, BISMiS 2018 will be hosted by the University of Pretoria, South Africa from 8 – 11 April 2018. The meeting will be held at the Misty Hills conference centre, situated close to both Johannesburg and Pretoria. After the three previous meetings, BISMiS has become known as the foremost meeting for all microbiologists sharing a passion for bacterial systematics. BISMiS 2018 will again provide excellent opportunities to exchange scientific ideas, catch up with old friends and meet new colleagues.

This conference will have a true South Africa identity as it will be based on the idea of an "indaba." An indaba, in the traditional African culture of Zulu and Xhosa speaking people, is a gathering where people get together to sort out the problems that affect them all. At these gatherings everyone has a voice and an attempt is always made to find common ground and to collectively decide how to go forward. We hope that we will again have delegates from all over the world that will meet for BISMiS 2018, the Microbial Systematics Indaba.

As part of the Indaba theme we have invited researchers from different parts of the world to present lectures and facilitate discussions. The opening address will be given by Ramon Rossello-Mora, Mediterranean Institute for Advanced Studies in Mallorca (Spain). Jongsik Chun, Bioinformatics Institute at Seoul National University (Korea), recipient of the 2018 Bergey award will also give a presentation on his work on the use of genomic data in bacterial taxonomy and metagenomics. Discussions on the future direction of species descriptions will be facilitated by the editors of the three main journals in the field, i.e. Martha Trujillo (IJSEM), Iain Sutcliffe (Antonie van Leeuwenhoek) and Ramon Rossello-Mora (Systematic and Applied Microbiology). Other invited participants include Barny Whitman from the University of Georgia (USA), Brian Hedlund from the University of Nevada Las Vegas (USA) and Wilhelm de Beer from the University of Pretoria (South Africa).

The BISMiS conference will directly follow the bi-annual meeting of the South African Society for Microbiology which will also be held at the Misty Hills conference centre from 4 - 7 April 2018. BISMiS participants are encouraged to extend their stay to join this meeting, which will be attended by microbiologists and students from all parts of the country. The SASM meeting will provide an ideal opportunity to establish new contacts or even collaborations with microbiologists from a country known for its biological diversity.

Misty Hills Conference Centre

Misty Hills (http://mistyhills.co.za/), the conference venue will provide an excellent backdrop for the Indaba. Delegates will be housed in stone-built thatched rooms and suites which are furnished to complement the indigenous South African surroundings. The venue is lavishly decorated with brightly coloured African fabrics, artworks and handmade furniture.

Delegates can also look forward to real African experiences such as the traditional braai (barbeque) and drumming session. The property boasts the world-famous Carnivore Restaurant, a truly authentic African dining experience where diners can feast on a sumptous variety of game and domestic meats. We will, however, not forget our vegetarian colleagues who will have the opportunity to feast on the fresh produce and vegetarian dished specially prepared for them.

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The venue is situated in a summer rainfall area and the weather in April is typically very mild, with day time temperatures often reaching 26 °C while the nights are colder at around 10 – 13 °C. It is therefore recommended to bring clothing for both warm and chilly conditions. The area has an average of 8 rainy days in the month of April, which are typically associated with late afternoon showers.

The closest international airport is OR Tambo Airport in Johannesburg which is only 60 km from the venue. The conference organizers, Carlamani Conferences and Events will be able to organise transport between the airport and the venue. They will also deal with all logistical and administrative arrangements. Details of registration, fees and accommodation are available at the conference website: www.bismis.co.za

Presentations

The scientific part of the conference will be organised by Stephanus Venter and a programme committee consisting of some of the current officers of BISMiS. Abstracts are invited for the meeting and can be submitted online via the conference website: www.bismis.co.za/abstracts. The closing date for Oral presentations is Monday 20 November 2017 to facilitate programme compilation. Early submission of posters are encouraged but the final deadline for poster submission is Monday 22 January 2018.

Travel awards

Bergey's Manual Trust will sponsor five travel awards for students and other young investigators to attend BISMiS 2018 in South Africa. Three of these awards will be for any of the young participants with the other two targeting participants from Africa specifically. These awards will cover the conference registration and 3 nights of accommodation but will not cover any traveling costs to and from the meeting. An ad-hoc selection committee will evaluate the applications.

Eligibility: To qualify for consideration the applicant must be:

1. A current BISMiS member
2. Submitted an abstract for presentation at BISMiS 2018 as the presenting author
3. Be younger than 40 years (based on your age in April 2018)

Submission Requirements:

1. Abstract to be submitted online by 20 November 2017
2. One-page write-up on how the meeting will be useful in achieving your research objectives and benefit your career.
3. Nomination Letter (may be written by a professor, advisor, mentor, employer, or director of the department)
4. E-mail the motivation and nomination letter to fanus.venter@up.ac.za by 30 November 2017.

The University of Pretoria

Established in 1908, the University of Pretoria (http://www.up.ac.za) has grown to become the largest residential university in South Africa with close to 60 000 students. It is a research-intensive university with the vision of creating knowledge to make a difference both locally and globally. The University consists of 9 faculties and a business school. The Faculty of Natural and Agricultural Sciences, to which the biological science disciplines

belong, train more than 6 000 under and post graduate students each year.

Enjoy the beauty and diversity of South Africa

The central location of the conference venue provides many opportunities to explore the rest of the country (http://www.southafrica.net). Cape Town is only a 2 hours flight from Johannesburg with opportunities to explore the beautiful scenery associated with the Cape Floral Region, taste some of the top wines in the world or visit historic sites such as Robben Island. Alternatively, after a one hour flight you could be in Durban, famous for its beaches and the warm Indian Ocean. You could also learn about culture of the Zulu people, the largest ethnic group in South Africa.

If you would like to see the BIG FIVE there are wonderful opportunities to go on a safari to the Kruger National Park (430 km). Other opportunities closer to Pretoria include the Pilansberg National Park (150 km) or the newly established Dinokeng game reserve (40km). A day visit to the Sterkfontein Caves, Cradle of Humankind is also recommended. Here you can explore the site where Mrs Ples and Little foot, two important hominid fossils belonging to Australopithecus africanus were discovered. More details of pre- or post- conference excursions can be found on the website.

Please join us for the BISMiS 2018, the Microbial Systematics Indaba. Hope to welcome you all.

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Call for Abstracts

BISMiS has become known as the foremost meeting for all microbiologists sharing a passion for bacterial systematics. BISMiS-2018 will again provide an excellent opportunity to exchange scientific ideas but also to catch up with old friends and meet new colleagues.

The **BISMiS conference** will directly follow the biannual meeting of the South African Society (SASM) for Microbiology which will be held at the same venue.
BISMiS participants are encouraged to extend their stay to join this meeting, which will be attended by microbiologists and students from all parts of the country and Africa.

ABSTRACTS for the BISMIS conference can be submitted online by Monday 20 November 2017 via the conference **website: www.bismis.co.za/abstracts**.
Authors must register on the system
Closing date for Oral presentations is Monday 20 November 2017 to facilitate programme compilation.
Early submission of posters are encouraged.
The deadline for poster submission is Monday 22 January 2018.

Abstracts must be formatted according to the guidelines and example provided online. It is the responsibility of the authors to ensure that the abstract is correctly formatted and suitable for publication. Conference organizers reserve the right to request changes or corrections to abstracts were necessary.

Venue:
The conference will be held at Misty Hills hotel and conference centre, situated at the foothills of the Swartkop mountains on the threshold of the beautiful Kromdraai Valley in Muldersdrift, Misty Hills is one of the most popular hotel and conference venues in Gauteng.

Accommodation bookings will open as part of the online registration process early November 2017

Various sponsorship opportunities are available, also allowing for exhibition space at the venue. For logistic, conference enquiries, contact the organisers

For Enquiries:
For conference logistics, sponsorship and administration, please contact
Carla de Jager
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