Oral History Center
The Bancroft Library

University of California
Berkeley, California

Caution and Care: William A. Clemens and the Evolution of Paleontology at the University of California Berkeley

Volume I

Interviews conducted by
Paul Burnett
In 2014, 2015, and 2016

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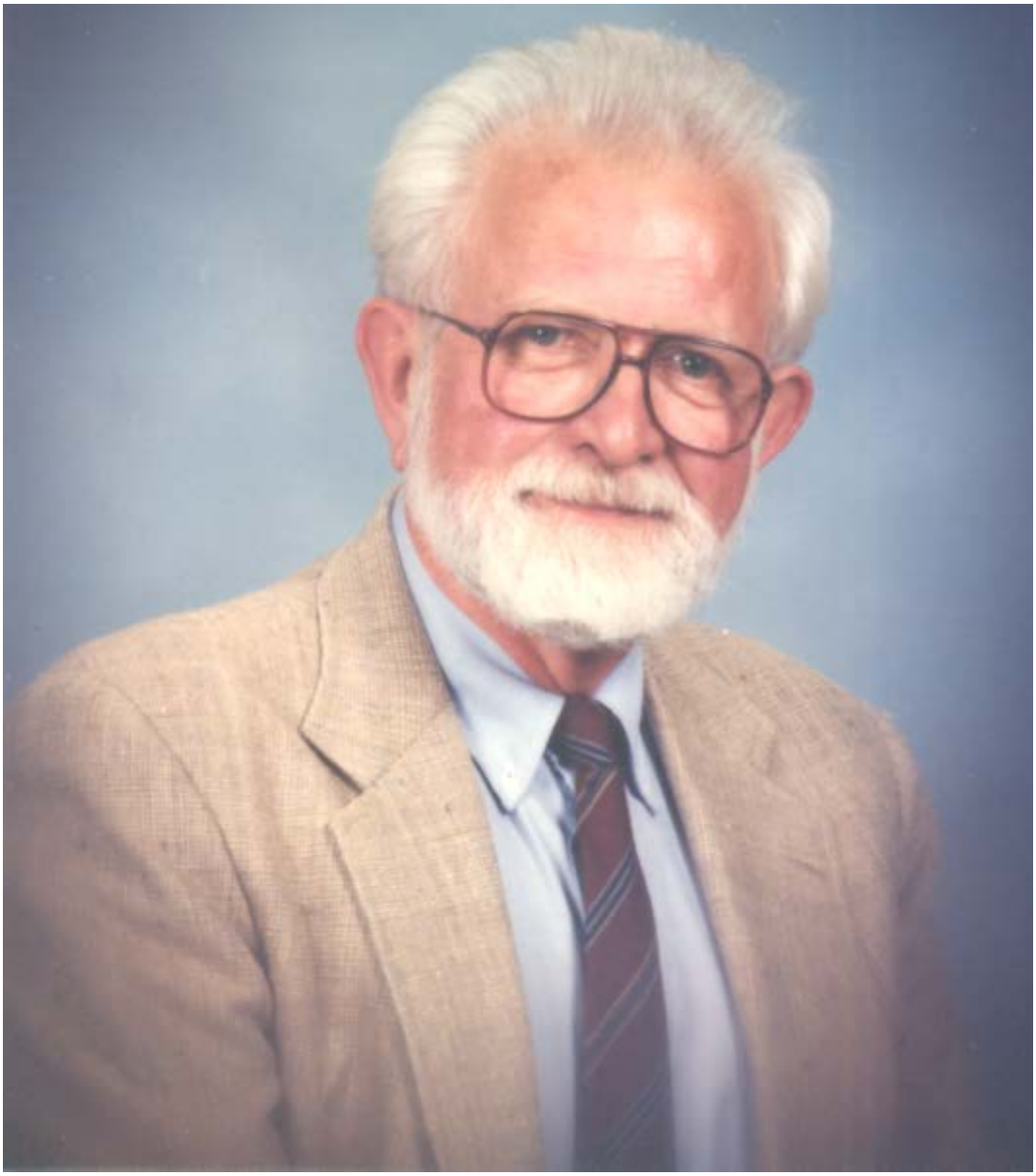

William A. Clemens, circa 2015
Photo courtesy William A. Clemens

Sitting on Bill's Chevy Blazer. Jordon, MT, 1979
Front: Mark Goodwin, Cathy Engdahl, Mike Greenwald, Lowell Dingus
Rear: Jane, Bob, and Duane Engdahl (Skinner Award honorees), Bill, Dave Archibald
Photograph courtesy of Mark Goodwin

William A. Clemens is Professor of Paleontology Emeritus at the Department of Integrative Biology and the Museum of Paleontology at the University of California Berkeley. Born and raised in Berkeley, Dr. Clemens did all of his post-secondary education at UC Berkeley and, apart from six years as a professor in the Zoology Department at the University of Kansas, spent his career back at UC Berkeley, as a full professor in the Department of Paleontology (later folded into the Department of Integrative Biology) and as the Curator of the UC Museum of Paleontology. This oral history explores Dr. Clemens' many significant contributions to the expansion of fossil collections and his seminal works in the description and classification of mammals of the Mesozoic Era and beyond. The second volume of this set contains the oral histories of twelve of his graduate students and Charles Marshall, who is the current director of the UCMP.

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Interview History

The Bill Clemens/UCMP oral history project has been several years in the making. Historian Sam Redman first proposed to do a history of members of the University of California Museum of Paleontology in 2011, specifically to interview Dr. William Clemens and a number of his graduate students. The concept behind the project was novel and important: to document with long-form oral history of successive cohorts of students who were advised by a single scholar, while at the same time interviewing the scholar in depth about the evolution of his field, as well as the key transformations in the institutions in which he played significant roles.

UCMP Associate Director Mark Goodwin was the fulcrum in organizing the project, from fundraising to arranging for interviews with Bill's students from all over the world. My first session with Bill was December 18, 2014, and my last was March 10, 2016. One of the factors contributing to the length of time spanning these sessions was the fact that Bill was caring for his wife Dorothy "Dot" Clemens while she battled cancer. There was some hope that she would live to see the project completed, but she ultimately passed before its completion. After a time, Bill resumed the project, in tribute not only to UCMP, his colleagues, and students, but also to her memory, as Dorothy Clemens was deeply committed to ensuring that Bill's oral history was documented for the ages.

Several themes are explored in the interview. There is a longstanding concern in the history of science with the ways in which scientists establish and maintain their credibility within and beyond their communities. By the 1950s, the queen of the sciences was physics, and the public was consumed by the promise and peril of high technology, from the splitting of the atom to the electronic consumer items in the shops. In the public mind, paleontology perhaps had more in common with the 19th-century field sciences than with the growing domains of digital computing or molecular biology.

When Bill Clemens started his undergraduate work UC Berkeley Department of Paleontology at the beginning of the 1950s, the modern evolutionary synthesis in biology, which linked laboratory research in genetics to field studies, statistical analysis, paleontology, and Charles Darwin's theory of evolution, had only just been worked out before the war. The helical structure of DNA was announced in Bill's junior year. In other words, Bill began his career at the beginning of a new common cause in science — the evolution of species and their adaptations to changing environments — with cascades of new questions to follow in the decades to come.

The drama of paleontology is often heightened by the interest in the gigantic specimens. Owing in part to the Evolutionary Synthesis, the paleontologists of Bill's cohort were interested, not just in the structures of fossils specimens themselves, but in where and how they lived in relation to one another. To get at some of these ecological questions, these students turned to the very small microvertebrates which could be found with a new technique of screenwashing, basically sifting for tiny fossils. What they found in the Lance Formation in Wyoming in one season equaled the number of fossils of their kind ever discovered up to that point. The field was moving away from the romance of the big dinosaurs and toward a more detailed understanding of evolutionary relationships among specimens and of the developmental characteristics that might tell the scientists something about how the creatures lived.

It's important not to understate the importance of this scale and extent of fossil collection. The organized work of Clemens' generation and the one that followed made possible newer types of data-intensive computerized research on paleontology, evolutionary biology, and climate change, areas far beyond the classification of fossils based on their structure. In fact, it is not uncommon for doctoral students today to conduct their research entirely with collected specimens in a laboratory, although Bill might not recommend this exclusive a course of study.

It is here that we come to an important focus of this history, which incorporates the second volume of this project: the thirteen interviews with Bill's graduate students and the current leader of the UC Museum of Paleontology, Charles Marshall. Bill and his students are witnesses to the changes in the field of paleontology, the increasing use of computing to process large quantities of data, and the field's involvement in the most pressing questions of the last four decades: the resilience of species, the interdependence of organisms, and the consequences of a changing climate on the abilities of organisms to adapt to both sudden and gradual changes.

These questions are also a reflection of my initial interest in credibility in science. Through these interviews, we see how paleontology has adapted itself to a changing scientific climate, contending with the introduction of new species of ideas such as the asteroid-impact hypothesis for the extinction of most dinosaur species at the end of the Cretaceous, or through the adoption of sophisticated mathematical analyses of the surface structure of mammalian teeth to answer questions about the evolution of a particular species' diet millions of years ago. Scientists struggle for credibility, and one way of doing so is to hybridize their research techniques and programs with the dominant sciences of the day, such as molecular and structural biology. The Department of Paleontology's integration with the Department of Integrative Biology at UC Berkeley was part of a larger effort to cross-fertilize ideas and techniques from different but related disciplines that focus on evolutionary processes. "Interdisciplinarity" had an early home here at Berkeley and especially at UCMP, long before Integrative Biology was founded in the 1990s. One result of this integration is that the UC Museum of Paleontology has once again assumed a worldwide leadership role in the conduct of cutting-edge research, though it has long led the field of mammalian paleontology.

On a more human level, you will find in these pages that the engines of research and innovation are fueled by human virtues as much as intellect. Bill and Dot's patience and empathy for Bill's students, as they navigated the challenges of graduate school and the dust and heat of the field, are well documented, as is Bill's curiosity, meticulousness, patience and care with which he draws his scientific conclusions. It is surely a mark of his influence that his students have taken up his approach by using new techniques and evidence, carefully tested, to gradually move their respective fields forward increment by increment.

Paul Burnett

Berkeley, CA, 2017

Introduction, by Jason A. Lillegraven, the first graduate student of Bill Clemens

Jason A. Lillegraven

Arts & Sciences Distinguished Emeritus Professor of

Geology/Geophysics and Zoology/Physiology

University of Wyoming, Laramie, Wyoming, USA

Parallels — Getting a secure start on a career in science is always a challenge. In the early 1960s, both Assistant Professor William Alvin Clemens ('Bill') and the then recent master's-degree holder Lillegraven ('Jay') were in remarkably parallel settings—even though immensely separated in terms of attained knowledge about their common interests in paleontology of the Mammalia. The lives of those two academic beginners converged via U.S. mail in September 1963, followed by their first face-to-face contact in the late summer of 1964 in Lawrence, Kansas. I arrived on the KU Jayhawk scene following study in South Dakota to become Bill's first student to seek the PhD degree.

Correspondence — Ever since those days, I have saved almost all of our correspondence—now totaling hundreds of richly informative documents. The diversity of our exchange ranges across broad paleontological concepts and taxonomic details, news of our personal lives, commentaries on local settings, field work, friendly and absurd insults, surprises as recognized through our microscopes, and views about the marvels of organic evolution. Bill's wife Dorothy ('Dot') regularly joined in the fun with her own perspectives. And yes, of course all those items of correspondence will be properly archived and made accessible to the professional community.

Extractions — In preparation for this brief contribution to Bill's extensive oral history, I extracted the bulk of our correspondence from my file folders and read it all again. I did so because of the realization that I am in a unique position in having coexisted in person with Bill for three wonderful years (academic years 1964–'65 through 1966–'67), when both of us were rank beginners in our university roles. Although refreshing those memories from 1963 to today was rewarding in itself, my focus today is to answer the question, 'How did Bill do as a neophyte professor in guiding his first doctoral student?'

In terms of reliability of my analysis, recognize that this was my first experience with an academic advisor who was so young. Mentors approaching senior citizenship guided my previous studies (undergraduate at Long Beach State College with the brilliant teacher John A. White; and master's degree at Rapid City's School of Mines with the taciturn 'professor's professor' Robert Warren Wilson). Dr. Clemens, in contrast, was a mere six years older than I. Nevertheless, at the time it hardly occurred to me that we were so close in age. His levels of knowledge in nearly all matters were so profoundly greater than mine that I responded almost the same way as in my prior experiences with advisors far more senior. Bill immediately put me at ease personally, and I just naturally responded in awe professionally. Dot, as well, instantly made me feel comfortable and welcome in their home, and I was treated almost as a junior colleague.

The truth is, and as I more fully appreciated in the following decades, even from the outset I was experiencing absolutely genuine expressions of personal warmth from the Clemens family.

O**pportunity** — To my special delight, we linked through love for the conduct of field-based studies. Starting almost a year prior to my arrival in Kansas, Bill and I were discussing possible dissertation projects. In the most pleasantly diplomatic way, he encouraged broader thought than my own suggestion to basically expand my master's project within the White River Group. Little did I know that less than a year later he would bestow upon me the opportunity of a lifetime to take scientific charge of a project in uppermost Cretaceous strata of the Red Deer River valley in the beautifully rolling plains of southern Alberta. Bill had already done the background work that would involve international cooperation including assurance of the existence of wondrous new fossils and the opportunity of suitable field vehicles along with field assistants and supplies—continued for three full summers. Even at the time I recognized the generosity that was based almost completely on his faith in my abilities. The realities—as well as the attendant responsibilities—of that generosity become progressively clearer through each and every subsequent year of my life.

Terror — Bill and I had adjacent offices during our three years of overlap at KU. So the academic guidance I experienced toward the zoology diploma was thorough and a regular topic of discussion. In addition to the diversity of courses that one would consider as 'normal' for the discipline (e.g., invertebrate zoology, comparative physiology, evolutionary systematics, mammalogy, a summer course in marine ecology, etc.), I'll never forget the question he asked of me dealing with the coming fall semester of my second year. "How would you like to take an advanced course in geology from a world-famous University Distinguished Professor?" The teacher was Professor Curt Teichert, and the graduate-level course was 'Geological Development of the World.' I was one of three graduate students, we met weekly surrounded by Dr. Teichert's immense personal library, and the four of us alternated doing the week's assigned two-hour presentations. That was a stunningly important and positively terrifying challenge for all of us; it included many early hints toward plate tectonics. And that's the kind of academic guidance Bill would make into the stuff of an irreplaceable university experience.

Embarrassment — One fine day early in my second year at KU Bill showed another quite unexpected and wonderfully valuable aspect of his academic treasure chest. Almost always he had his facts correct prior to making sweeping statements. Note that I said 'almost.' That morning we were chatting about the early diversification of marsupial and 'placental' mammals. And he said something like: "You know, Jay, there have been no early embryological studies done on marsupials since the time of Sir Richard Owen." Oddly, something about that statement didn't quite ring true for me, so I spent that same afternoon plowing through historical and current literature in KU's massive biosciences library. That initiated my learning about the very existence of high quality and truly exciting literature on early development across the Marsupialia. I don't know when I've enjoyed a conversation so much as the one I initiated with Bill the following day! His erroneous comment of the day before eventually led to composition of 'Polarities in mammalian evolution seen through homologs of the inner cell mass' (2004, *Journal of Mammalian Evolution*, v. 11). But rather than having been embarrassed by my exhortations after the initial experience in the biosciences library, Bill actually was enlivened and genuinely pleased by our interaction. Although I then recognized that nobody's perfect, much

more importantly I better appreciated that Bill's generous reaction was yet another sign of a great academic advisor!

Comprehensiveness — How about Bill's knowledge of his own field of mammalian paleontology? Anyone who has taken his courses has experienced astonishment over the thoroughness of his carefully updated notebook, the breadth of his personal awareness of the key localities and their biostratigraphic relationships, and his seemingly encyclopedic recall of essential identifying characteristics of the faunas. The late Professor Donald E. Savage, my close friend and regular handball opponent, told me much about Bill as a grad student in the late 1950s at the University of California, Berkeley. At that time Bill had very strong competition from several other top-notch doctoral candidates. According to Don, when he would quiz the group of students about some aspect of the diversity of extinct mammalian groups, Bill was rarely the quickest to respond. But almost always, Bill's answers were the most accurate, thorough, best organized, and most articulately presented along with specific mentions of the relevant literature. And that was Bill's style in the classroom as well. Glitz was never a primary goal for this man, but thoroughness and scientific credibility simply could not have been higher. And his updated lecture notes were fully accessible to anyone bold enough to ask.

Stress-barometry — How about his diplomacy, or simply dealing with difficult people? Bill and I probably could not be more different in that personal capacity. Outwardly, he is an extremely mild-mannered, universally cordial individual. Nevertheless I did learn important lessons, especially by unobtrusively observing seemingly trivial details. Particularly telling was to intently watch his 'stress barometer' as surreptitiously revealed by his knotted jaw muscles and clenched teeth as they threatened to pierce clear through the battered stem of his tobacco pipe.

Churchillianism — More seriously, I must cautiously mention one occasion that demonstrates his genius in calming troubled waters. Upon completion of a publication, I had failed to acknowledge—by name—a particular person who had contributed aid to initial establishment of the project. Clearly, I was in error through that 'unfortunate omission.' And the fit hit the Shan through that individual's broad dissemination of a fearsome letter containing unwarranted personal vilifications, inappropriate assertions, and it nearly led to an international research disaster. But Bill, quite on his own while in England, composed a graciously apologetic response, which must have been very difficult considering here-unspoken details of the complete story. Then, in a separate, wonderfully phrased letter to me, Bill let me know that the situation probably was neutralized and that "No more can or need be done." Translated correctly knowing Bill, that very phrase actually said "Now keep your bloody mouth shut!" Handled less intelligently, that incident could have been the end of a wonderful relationship and perhaps more than one career. I know that, and experience has informed me that sometimes one really must bend over backwards simply to appease, no-matter how great the pain. That's easier said than done, of course, but Bill handled the situation masterfully in a manner that protected us both. What he did remains beyond my diplomatic abilities even today. It also caused me to appreciate that I might be better as a regimented Eagle Scout than Bill, but he operates much more like a Winston Churchill than I could ever emulate.

Earthiness — Through the years, I have heard from several of Bill's acquaintances that one of his flaws is he's just 'too perfect'—indeed, they said he's an outright 'prude.' Let me here

and now put that nonsense to rest by relating a single incident that told me so much. Back in the 1970s a devilishly funny author named Barry Humphries was establishing himself as a Mark Twain-equivalent for Australia. One of his prime characters in comic books and film was a supremely irreverent, heavily beer-drinking young Aussie named Barry 'Bazza' McKenzie who loved beautiful sheilas, didn't get along with the Poms, and chundered richly with tomato skins. A favorite quotation from one of Bazza's drinking-pals was: "Mon Dieu. I tell ya, Baz, I'd'a crawled over 'alf a mile of broken glass just to hear that little sheila piss into an empty jam tin." So what is the relevance of Bazza to Bill's reputed humorlessness? Well, to my utter astonishment and delight, he carried a pair of Humphries' illustrated Bazza-sagas all the way back from Australia and quietly presented them to me with a smile. I guess he didn't want me to be 'too perfect' either. And those two comic books are treasures today within my professional library.

Independence — About midway through my third year in Kansas I learned that Bill was accepting a faculty post at UC Berkeley. Rather than fomenting a disaster for me as a KU graduate student, Bill turned what initially seemed like a lemon into a pitcher of splendid Margaritas. Indeed, I learned soon enough that I really could complete the dissertation research under conditions of real independence. That knowledge came largely thanks to Bill's thoughtful planning just when I needed confidence the most. With close cooperation from KU's administration, he eased the way by continuing as chairman of my graduate committee, providing extensive correspondence from Berkeley when needed. His letters typically included a significant section dedicated to some relevant and instructive aspect of mammalian paleontology. Those arrivals, therefore, were scientifically important little essays, and they remain of interest today. Remember too, that was in the time of carbon paper and envelopes, well before today's convenience and dispatch allowed by digital technology.

Benevolent Professionalism — Also very important at the time, Bill responded with good advice almost immediately when I needed help in structuring a final draft. He even traveled from Berkeley to Lawrence to chair the public defense of my research. Thus, in that last year I enjoyed the best of two usually contradictory worlds—holding a sense of genuine academic independence simultaneously with secure knowledge that I could get solid help if needed. I suspect that almost nothing in that overall arrangement is common, as my young advisor went far out of his way to see that the arrangement actually worked! His levels of responsibility in the guidance of a student and Bill's performance of the duties of a mentor were unlike anything typical of a beginner in higher education! He held from the beginning the wisdom of a benevolent professional.

Berkeley — My studies at KU were completed before the end of the 1967–'68 academic year. Later that year, Bill was one of three supporters for my application to join the faculty at what was then called San Diego State College. I successfully interviewed for the position in Zoology that was to begin in the fall of the 1968–'69 school year. But Bill's strong influence on my everyday life did not end there. Indeed, because he was going to be spending that year studying Mesozoic mammals in England, he saw to an invitation for me to conduct a post-doctoral year of independent research at UCB. With a National Science Foundation traineeship in hand, and with the great courtesy of San Diego State's blessing to hold off my residence for a year, my wife and I moved from Lawrence to Berkeley. Before our arrival, and without our prior knowledge, Bill had contacted UC's Faculty Housing Office to check on availability of a suitable

apartment, he had received all of our worldly belongings from the movers into his home garage, and he even paid the movers from his own pocket because I had sent a standard check (rather than a certified version) which the movers had refused! Now that's service way beyond the call of duty . . . .

Despite the chaos in Berkeley during that year of the Peoples' Park riots and unfortunate departmental distractions, the long-term benefits of that postdoctoral year of scholarship, limited teaching (Paleo 101, Phylogeny and Evolution), and establishment of new professional contacts were enormous. And those experiences simply would not have been possible in the absence of Bill's unexpected invitation.

Flexibility — Bill Clemens has always been keenly focused on his fossils, their description, and how they can be best interpreted. In my presence, however, he was stuck with a student who kept drifting off into related disciplines—such as structural geology with my master's thesis, comparative mammalian reproduction with my PhD dissertation, paleogeographic evolution of the Rocky Mountains later, and even today with the nature and timing of large-basin structural fragmentation into small remnants (2015, Late-Laramide tectonic fragmentation of the eastern greater Green River Basin, Wyoming: Rocky Mountain Geology, v. 50). This cheeky graduate student even wrote to Bill (letter of November 20, 1968) about this tendency to stray from disciplinary purity, saying "The problem with paleontologists is that they're too damn [sic] interested in fossils . . . ." Was Bill threatened or even uneasy about advising such a cross-disciplinary renegade? If he was, it was never, not even once, made obvious to me. Quite to the contrary, Bill seemed to thoroughly enjoy joining with me into new avenues of our research. I think we both recognized that such diversions continued to be directly linked to essential underpinnings that could be provided only by information gleaned from the fossil record. And that is exactly what all Earth-science professors should come to realize!

Shortstop — The present summary is very personal. It is short on science, but long on Bill Clemens' characteristics as a beginning professor, personal mentor, and research-oriented human being. With exception of the much-too-early death of our beloved Dorothy, Bill and his children have earned an almost ideal life together, with admiring fans living all across this beautiful globe. I feel enormously honored to have been a consequential part of the story of Bill's early days as a professional paleontologist and mentor. I'll be the first to admit that Bill has had several intellectually much more gifted students than I. But he has never had a more appreciative student than I continue to be.

Interview #1 December 18, 2014
Begin Audio File 1 clemens_bill_01_12-18-14_stereo.mp3

01-00:00:09
Burnett: This is Paul Burnett, interviewing Dr. Bill Clemens. It is December 18, 2014, and we're here at the Valley Life Sciences building of the University of California, Berkeley. Dr. Clemens, I think almost every child, it seems, develops a fascination for dinosaurs, and an excitement around the kind of work that you have done for the last several decades. As it turns out, in your case, childhood is an important point of inspiration for you, in your career. So, let's go back and talk a little bit about your family, about your family background, and your ancestry. Can you tell us a little bit about the Clemens family?

01-00:01:11
Clemens: It's been an interest, to trace one's ancestry. We can get the Clemens family history back to records from the 1790s, when an ancestor, Richard Clemens, was living in Steubenville, Ohio. The picture is sort of jerky, if you will, little snippets of information, but it looks as though his son, John Clemens and his wife Roseanna, went down the Ohio River to southern Indiana. There they homesteaded in a place called Clifty Creek in Greene County. Now, they were there in the 1830s, and we have a story of a frontier family, lots of relatives in the area, and a certain amount of intermarriage. During the Civil War John Clemens—he was my great-great-great-grandfather—enlisted in the Union Army. His unit, the 97th Regiment of the Indiana Infantry, was attached to Sherman's army and they went off in September. Unfortunately, that winter, in camp in Tennessee, he died. One death certificate says it was of typhus, and another typhoid. Whichever; his life came to a conclusion. His widow, a remarkable woman, remarried. Skipping a couple of generations to someone I knew, my grandfather volunteered for the Army and served in the Spanish American War. He was shipped out to the Philippines, came back, and as Granddad put it, he was imprisoned for a month on Angel Island. This was the mandatory quarantine.

01-00:03:44
Burnett: What was his name, your grandfather?

01-00:03:46
Clemens: He's also a William—a William Alvin. I was named after him; not my father. Then Granddad didn't come back to California until 1939, when my father enticed him and Grandmom to come to Berkeley to see the "World's Fair", the Golden Gate International Exposition. There were a number of stories told by Granddad about his time on Angel Island. It's been fun to go to Angel Island and see the barracks where I assume he was held in quarantine, and get an idea of the view from the island. San Francisco is so near, but yet, so far. To be isolated out there must have been a challenge. Granddad went back to Southern Indiana and went to work in the coalmines. He married and my father, Vincent Clemens, was born. Now, after I don't know how many

months, there was an accident in the coalmine and Granddad was injured. I don't know how seriously, it wasn't that bad, but it convinced him that he didn't want to be a miner.

01-00:05:16
Burnett: It was an intimation of mortality, occupational mortality.

01-00:05:18
Clemens: There was something along that line, yes. A number of relatives and friends from the area had moved west. This, interestingly, was at the time when the railroads were providing transportation for people who would go to the West, so they could get settlers on or adjacent to all that land that was given to the railroads. Granddad went out first to Oregon. I think it was friends of the family that were living there. He said there are just too many trees.

01-00:06:12
Burnett: Clearing them would be an overwhelming challenge.

01-00:06:14
Clemens: Clearing them for a homestead with the idea of farming would be a lot of work. So, then there were relatives in Wheatland, Wyoming. Wheatland is very close to the eastern border of the state, and just to the south of the Platte River. There's a depression east of Wheatland called Goshen Hole. It was in Goshen Hole that Granddad decided to homestead. The only trees around were cottonwoods in the few valley bottoms, but the land was open. What turned out was that his homestead had some arable land, but also, outcrops of the Chadron Formation, which was just extremely fossiliferous. That was the first sort of connection of Clemenses with paleontology. This was 1913-1914, before US entry into World War I, and life of a homesteader was not lucrative.

01-00:07:50
Burnett: Was he farming wheat?

01-00:07:52
Clemens: As far as I understand, it was wheat—strip-farming. Sometime after initially settling in Goshen Hole, he moved the family into the little town of Yoder and basically became a carpenter. The first time I went to eastern Wyoming, that was where he and Grandmother were living. The paleo connection here is rather interesting.

01-00:08:31
Burnett: Can you talk a little bit about the Chadron Formation and how fossiliferous is it? Is it a unique place for a certain type or range of fossils?

01-00:08:42
Clemens: Yes, it is. It's got its own characteristic fauna and flora. Imagine a landscape some 36 to 37 million years ago. It was not a grassland, but an open area with a variety of plants and animals. The Chadron's fossils document the beginnings of a number of lineages that we know today. You're getting early records of tapirs and rhinos, various kinds of cats and dogs. If you saw them

today, you'd say they're strange, but from an evolutionary viewpoint, you're seeing the origins of the modern fauna. In terms of how fossiliferous the Chadron is in that area, apparently when Dad got there, there were skeletons of a variety of animals just weathering out on the surface. I've got a couple of titanothere teeth over there.

01-00:10:10
Burnett: Should I grab it?

01-00:10:11
Clemens: Grab one of the two.

01-00:10:15
Burnett: I'll do this pretty carefully.

01-00:10:17
Clemens: Oh, they're in pretty good shape.

01-00:10:23
Burnett: Can you grab it by the hand?

01-00:10:26
Clemens: Yes.

01-00:10:36
Burnett: It's a distant ancestor of horses, modern horses?

01-00:10:42
Clemens: It's in that group, but this particular lineage became extinct. They're extremely common forms in the Chadron in Wyoming. This is an upper molar of one of these beasts. Now, to visualize it, think of a rhino. They were certainly as large as rhinos. They had a very curious snout and you can see an indentation about this long in the snout.

01-00:11:28
Burnett: Several feet long, it seems, almost. A couple of feet?

01-00:11:31
Clemens: Couple of feet, yes. When these teeth weather out, you get this purplish-to-blue enamel showing up on the surface. Dad and his brothers and some of the other boys in the area realized that there was a market for these teeth. The dentist in Torrington, which is a nearby town, and some other dentists who were traveling through would pay a dollar apiece for teeth like this.

01-00:12:14
Burnett: A not insignificant sum to a young boy.

01-00:12:15
Clemens: In 1913, it wasn't insignificant. As my interest developed in paleontology and I went into the field, Dad was very quiet about what they had done out there. [laughter] Towards the end of his life, my wife did an oral history with Dad.

He confessed to her what they did. They learned very quickly that if you saw a backbone weathering out, at one end or the other, there would be a skull with teeth in it. So, I don't know how many he and his friends dug up, but he said it was a number of skeletons. Sometimes, they dug the wrong way. They didn't learn about the nature or orientation of the vertebrae. They collected teeth and sold them. In my career, my relationships with professional, commercial collectors, have been rocky, but to think that my father was once... [laughter]

01-00:13:40
Burnett: It was relatively small scale, though.

01-00:13:42
Clemens: Small scale and for a good cause.

01-00:13:52
Burnett: This is an important aspect of life on the periphery in the United States and elsewhere, in Australia, that homesteaders would be collecting this stuff. In this case, your father's network or circuit was really local. It was local dentists who would pick these up.

01-00:14:17
Clemens: Probably, unless they were traveling through the area.

01-00:14:19
Burnett: Unless they were traveling, and maybe they were reselling them in major cities for a fairer sum.

01-00:14:26
Clemens: They may well have been.

01-00:14:28
Burnett: That's a big feature of natural history in the nineteenth century, these vast networks of farmers and itinerant folk who were just collecting this stuff at a small commercial level. So, I was going to ask you about whether your family, at any generational level, were aware of those kinds of networks, or was it talked about in Wyoming at that time, that this is something you could do? Or was it just kind of part of the background, that this stuff is everywhere?

01-00:15:06
Clemens: Gosh, that's a hard set of questions to deal with. I'll say within my family, there was little talk of this. As I later got really interested in paleontology, this didn't come up. In my experience in other states, yes, every so often you would hear tales of bone-diggers who came through an area. Certainly in eastern Montana, where I got involved later in my career. Barnum Brown was well-known as not a commercial collector; he was collecting for the American Museum. He left an imprint on the history of the area. Brown was a very effective collector, a good scientist, and a very social animal. I've got a picture of a Fourth of July party taken by Barnum. This would have been 1907-1908. It shows a whole series of locals posing around the front of the cabin. One of the boys in that picture, I got to know years later. He had tales

about Barnum Brown and his collectors. So, I think you'd have to say an answer to your question would depend upon the locality.

01-00:17:09
Burnett: And whether it was part of a network that would stretch back to the American Museum of Natural History or the Smithsonian, where scientists had kind of, I don't want to say colonized an area, but they had staked out an area that they were active, or whether they had contacts with locals. They'd established some kind of circuit whereby it was known that you could go to this person and they could provide fossils. Either you could pay for them, in one sense, but there was also a kind of prestige relationship as well, I imagine, that they had.

01-00:17:53
Clemens: I'm not really a historian of our field. On the other hand, you could point to Como Bluff, this wonderful graveyard of Jurassic dinosaurs, right along the Transcontinental Railway. Yes, there's quite a history of collecting there, and staking out claims. Fort Bridger was another site that served as a base for early collectors. So, again, it's geographically spotty.

01-00:18:39
Burnett: So, your grandfather had established the family base in eastern Wyoming and Goshen Hole. Can you talk about the subsequent generation a little bit as well?

01-00:18:57
Clemens: My father went to school in the town of Yoder. He completed the eleventh grade in Yoder. As he used to say, "I was the top student in my class; there was only one student in my class." So, for his senior year, he went off to a nearby town, Torrington, where there was a larger high school and graduated there. Through family ties back in Indiana and Illinois, Dad applied to and was accepted at the University of Illinois. My mother, I know less about her family, grew up in the southern part of Illinois and came to the university and became educated as a high school science teacher. That's where they met. I don't know much about their university careers. Dad talked of going to Gary, Indiana, in the summers and working in the steel mills. He was interested and got his degree in electrical engineering.

Westinghouse Electric may well have provided some kind of encouragement or support during that period. When he graduated, he applied to Westinghouse and General Electric. Westinghouse accepted him and he went off to Pittsburgh to have the indoctrination, training and all that. The story that tickles me is one Dad told about completion of the course. They held what he called a hiring hall. One of the bosses got up and said, "Now, we need someone who knows the West." Dad volunteered that he'd grown up in Wyoming, and the answer was, "Oh, well, fine, you know all about the West. We're assigning you to Emeryville, California."

01-00:21:40
Burnett: By that, they meant west of the Mississippi.

01-00:21:53
Clemens: West of Pittsburgh. So, Dad came out, Mother followed a year later, and I was born here in Berkeley.

01-00:21:57
Burnett: What year was that?

01-00:21:59
Clemens: Nineteen-thirty-two.

01-00:22:02
Burnett: So, that's pretty much at the nadir of the Great Depression.

01-00:22:08
Clemens: It was, yes.

01-00:22:10
Burnett: Your father was a young professional; he had just started working at that point.

01-00:22:13
Clemens: He had just started. The first house I remember here in Berkeley is down on Channing Way, just below Martin Luther King. Then, in 1937, they built a house up on Fairlawn Drive in the Berkeley Hills. Fascinatingly, the cost of the land, the architect, and building the house was $7,000. They had a twenty-year mortgage. I think it was twenty years, but World War II came along, and by the early forties, they'd paid off the mortgage. That was my family home in the Berkeley Hills.

01-00:23:11
Burnett: Well, that was a good line of work to be in for him. In the Great Depression, he would have been in demand in the electronics industry.

01-00:23:24
Clemens: As Dad would say, "I'm not into electronics; I'm into sixty-cycle, 110 volt," which proved to be a talent and a background that served him very, very well. During World War II, he represented Westinghouse out at the Kaiser Shipyards. Those ships needed light switches and electrical outlets in the rooms and that kind of thing.

01-00:24:06
Burnett: So, by that you mean electrical infrastructure? That was his domain of expertise.

01-00:24:13
Clemens: Well, for example, Etcheverry Hall and its main electrical supply including the reactor next to it. Dad worked with the architects to design it and supervised its installation. His last job with Westinghouse, which must have lasted five to ten years, was over in San Francisco, doing this kind of basic

wiring design for a number of the buildings that were going up after the war. I don't know what they call it now—it used to be the Alcoa Building—there's a Westinghouse escalator in it and it still works!

01-00:25:20
Burnett: So, in the 1930s, your family were getting established in Berkeley and your father did well doing electrical work for various industries and for the universities.

01-00:25:35
Clemens: For Westinghouse, which had a plant down in Emeryville. I think if you go across the Powell Street entrance to the freeway, just before you start up going toward the Bay, there's a great, big, brick building. That's the replacement for what was Westinghouse's plant. That was his base until he started working over in San Francisco.

01-00:26:17
Burnett: So, your family had moved far from this fossiliferous Chadron Formation. But the fascination with fossils did not disappear entirely from the family. Can you talk about how that continued?

01-00:26:39
Clemens: Before the war, we made a couple of trips back to Goshen Hole to see my grandparents and my uncles. Maybe two or three times, I went out to the badlands and collected bits of bone and so on. Then, during the war, with gas rationing, it was impossible to travel back.

01-00:27:11
Burnett: Do you remember the first time you did that? How old were you? Is it something you did that you just don't remember when you started—it's something you always just remember doing?

01-00:27:23
Clemens: Well, I can remember a couple of times collecting out there. I would have been less than ten years old, so seven, eight, or nine, before the war shut down the trips back to Wyoming. In terms of my interest in science, with the opening of the Bay Bridge, it was possible to easily travel over to the California Academy of Sciences. I still have vivid memories of the academy and some of the exhibits. During the war, I was a Boy Scout, and our troop, which used to meet in the old clubhouse up at Codornices Park, had a very definite emphasis on getting out and hiking. So, we'd have day or weekend trips to Mount Tamalpais or Mount Diablo, and so on. The troop also had a summer camp in what's now the Desolation Valley Wilderness Area. It's largely a granite terrain with a few volcanics and to me it was fascinating. It was not true wilderness, but just being out and away from settlements; that intrigued me.

As a Boy Scout, you earn your merit badges, and one was on path finding. This was fun. The guy who was the counselor for that badge knew of the troop,

and quickly learned of my interest in the Sierra. So, as part of the requirements for the badge, he said, "You've got to read John C. Frémont's account of his crossing of the Sierras in the winter." The only place in Berkeley you could get a copy was in the Bancroft Library, which was then up in attic over Doe. I can still remember spending a couple of Saturdays going up there and reading the journal. There was a tie to the library and the campus. All these things contribute. I can't say one thing is most important.

01-00:31:02
Burnett: An awareness of this thing called a university at a young age, that can have a tremendous impact on a young person. An encounter with history, even though paleontology is pre-history—doesn't get more "pre" than that.

01-00:31:26
Clemens: It was interesting. After I'd done the reading and came back to talk with the counselor, he questioned me about what Frémont recorded. What things did he think about that he felt were worth writing down? Okay, there's the day-to-day journal, but also, you see comments on the different kinds of plants that he encountered. They found a couple of hot springs, and I don't know how they did it, but he reports chemical analyses of the waters in these springs. So, in a way, it heightened me or sensitized me to think about, years later, what should I put in my field notes? What's going to be worth recording and what isn't? So, I'd look at this as another contributing factor, sort of setting me up for what has been my career.

01-00:32:47
Burnett: Geology and paleontology grows out of this grand tradition of natural history, right, and that's part and parcel of exploration. There was a kind of romance about that, right? There's a romance about exploration and the Boy Scouts, going out.

01-00:33:09
Clemens: At that time, yes. Here in the Americas, you have the Humboldt Expedition and the natural history that's recorded by some of the Spanish explorers. It's fun to discover things, I'll admit it. I get a rush when I pick up a fossil and recognize that it really is something new, and new to science.

01-00:33:45
Burnett: We'll talk about this later, too, about the nature of the field sciences, but there seemed to be an attraction for you, the appeal of kind of "roughing it," in quotation marks, of going out to fairly remote places, under-explored places? The Scouts were kind of exciting that in young boys.

01-00:34:11
Clemens: Yes, I guess they were, then.

01-00:34:14
Burnett: That's something that was attractive to you?

01-00:34:17
Clemens: It was, and particularly the summer camp up in the Desolation Valley Wilderness Area. That was a chance to get out on your own and wander, which I found fun.

01-00:34:40
Burnett: In a previous conversation we had, you mentioned that you were introduced by your father, in some ways, to the University of California Museum of Paleontology.

01-00:34:37
Clemens: Oh, the titanothere? I remember him coming down to the museum—this would have been probably in the late thirties—with fragments of titanothere teeth, and a very brown-stained old horse tooth. Those are the two things I remember. He contacted, it might have been Ralph Cheney or Ruben Stirton, and learned what they were. With museums like this, from the word go, you've got a public outreach, public education function that must be maintained. Not just maintained, but really promoted—they're the taxpayers and we're the recipients.

01-00:36:08
Burnett: So, I imagine that happens a fair bit, if there were collectors out there. This was a transplant, someone who had come from Eastern Wyoming and had these in his possession. That must have been a little bit exciting for them, to have this visit.

01-00:36:28
Clemens: Those were the days of the WPA. If you get into the history of the museum, the WPA played a major role in providing workers to collect and prepare fossils. Dave Smith, one of the staff members, has been putting together the history of our museum's involvement in the "World's Fair", the Golden Gate International Exposition. The University of California's exhibit there included a number of exhibits of prehistoric animals, dioramas that were constructed by regular employees or people hired just for this project. Chancellor Strong's brother—I think I have to say "was" a very talented artist. He painted the backgrounds for these dioramas. The sculptor who provided the models, William Gordon Huff, lived here in Berkeley. He was involved in not just preparation of the exhibits for the University, but also sculpted some of the monumental statues for the 1939-40 "World's Fair." The connections are just amazing.

01-00:38:21
Burnett: When did you first learn that your father had come to the University of California Museum of Paleontology to find out about those teeth?

01-00:38:38
Clemens: I think it was in the late thirties. He talked more about the brown horse tooth, from a modern horse, and his disappointment that it wasn't a fossil.

01-00:38:54
Burnett: At any rate, your father was interested in these fossils and as a young boy, you had gone back, prior to the restrictions of World War II, and had engaged in fossil collecting.

01-00:39:18
Clemens: On those trips, Dad met his parents and three brothers, and they wanted to sit around and reminisce. One person not to overlook is my mother, who was a trained high school science teacher. So, what do you do with a little boy who's bored silly? She took me to the homestead, and we looked for fossils. Not just there, but as I thought back about it in preparation for this interview, I remembered the number of ways that she, as an experienced science teacher, sort of pushed me one way or another. Never this, "You are going to be a scientist." On the other hand, there were a number of ways in which she just promoted my natural interests.

01-00:40:20
Burnett: Not just in the case of fossils, but also, the workings of the natural world.

01-00:40:27
Clemens: Chemistry was her strength. Like any kid, I had a chemistry set. I can remember talking to her about doing experiments and that kind of thing. So, yes, it was a general fostering of my interests.

01-00:40:49
Burnett: The chemistry set, you had to have one as a boy, so other friends of yours, I imagine, also had chemistry sets. Was there an exchange of ideas about experiments you could do?

01-00:41:07
Clemens: Not really. It didn't really come till we got into high school, and there, talking with classmates. One of my classmates was a very good friend, Jon Applequist, went on to get his Ph.D. in chemistry and taught for a number of years at Iowa State University. I remember talking with him, things opening up, and his explanation of topics that I didn't get in the classroom. One's taught by your fellow students.

01-00:42:00
Burnett: I'm just recalling that in my father's day, they had chemistry sets but there was this fascination with pyromania, essentially. They were interested in building better rockets, and his friend blew his thumb off when he tried to build a rocket. There was this kind of boyish fascination with what you could do with chemicals. I was wondering if that had been part of that.

01-00:42:29
Clemens: It was part of the mix. Remember, this was World War II. All sorts of bombs were being dropped and explosions being set off.

01-00:42:21
Burnett: Did they have radio kits, too? Did some boys get little crystal sets and things like that?

01-00:42:28
Clemens: Crystal set, yes. It wasn't until my son was growing up, and we would go to RadioShack to get a set so he could make a radio or a measuring device, that I was exposed to the field. When I was growing up, it wasn't that well organized and merchandised.

01-00:43:36
Burnett: We were talking about your attending Berkeley High School. Your mother was a science teacher, so I imagine she gently encouraged you in the sciences?

01-00:43:49
Clemens: There was certainly support, yes. Looking ahead to going to university, very definitely one of the things one did was to take a series of science courses. At Berkeley High at that time, they had an earth sciences class. I call it a remedial course—it was for folks for whom science wasn't their thing. The most rigorous courses were, in the sequence I took them, biology, physics, and chemistry. Very good instruction, looking back on it. For one, it was either a semester or a year, I worked for the physics instructor, Mr. Van Weynan, setting up experiments and demonstrations, and then taking them down. I found that really a good background. Again, as we talked earlier, a number of students at the high school—Jon Applequist, for one—went on in science. Having a community of people with similar interests was outstanding. I understand now that Berkeley High is ranked as one of the best high schools around here with a whole series of students heading off to colleges and universities, which is great. I'm glad to see it continue.

01-00:45:51
Burnett: But at the time, it did not offer the kind of training that would have allowed you to go further in paleontology or in the earth sciences? It wasn't inspiring. It was the proverbial "rocks for jocks" class.

01-00:46:14
Clemens: I don't want to overstate it, or I should understate it, that yes, I had this sort of background interest in fossils, the tie with Wyoming, the family tie. It really didn't occur to me at that time that there would be an interesting career in paleontology.

01-00:46:38
Burnett: Did you think of other careers? Were you thinking of careers as you moved towards university?

01-00:46:45
Clemens: I was thinking in terms of chemistry and chemical engineering. I don't know why I settled on that. Maybe the engineering aspect, reflecting my appreciation for what my father had done or was doing, but it just seemed like

a neat thing to do. I got through the first year quite well and then hit quantitative analysis and that wasn't for me, no.

01-00:47:22
Burnett: You weren't inclined towards the quantitative methods?

01-00:47:28
Clemens: It was the techniques that were involved in doing the analyses. The idea of having those data from the analysis was fine, but some of the pickier things that one had to do to get a proper result, no, that wasn't me. [laughter] I had a very good teacher in the class, the lecture material was fine, it was just going into a laboratory and doing that quantitative work, no. I didn't get any fun out of that.

01-00:48:20
Burnett: You did get fun at some point when you moved towards your undergraduate experience. Can you talk a little bit about courses that did inspire you? What kind of avenues did open up for you, in terms of your curiosity?

01-00:48:33
Clemens: In terms of my curiosity, certainly the biological sciences were interesting. I remember the course in animal physiology was really a striking one. That course filled the main lecture hall in LSB. What else did I have that first year? The introductory biology was another one. This would be 1952-53. Then, looking it in the catalogue, I saw Stirton's Paleo I. So, what the heck, if I'm going to explore, there is another area, and I have a little interest in it. It turned out that Stirton was a fascinating instructor. Of the two TAs, Bill King was a fine guy, but Wann Langston, in his gruff way, helped me build my interest. Through the years, I kept contact with Wann. From Berkeley, he went to Canada. He invited Don Savage and Malcolm McKenna and me up there for a fascinating field trip. Then, he moved to the University of Texas. In the last part of his career I visited him several times. Our paths crossed in terms of the Late Cretaceous fossils that were found on the North Slope. That's another story, but the point I want to make is that getting to know Stirton and Wann certainly attracted me to the field of paleontology.

01-00:51:08
Burnett: R.A. Stirton was the director?

01-00:51:11
Clemens: At that time, he was both director of the museum and chair of the department.

01-00:51:18
Burnett: So, he was paleontology here at Berkeley, a big force in it, definitely.

01-00:51:23
Clemens: A major force. There were other major forces, too. No university department is without politics.

01-00:51:34
Burnett: So it was a dynamic place, shall we say?

01-00:51:36
Clemens: Yes. It was good fun because the department and the museum had been moved out of Bacon Hall, and we were up in the attic of the Hearst Mining Building. What shall I say—the space was interestingly divided, so there were little corridors and cubicles. It certainly wasn't designed and built for a department. On the other hand, there was a real community. You couldn't really avoid any of the faculty and they couldn't avoid you. There was a tradition of folks meeting for coffee in the preparation lab every morning, so there was a lot of interchange, which I thought was just great. One of my disappointments about the way modern university buildings are designed is that they frequently don't focus on that dynamic of bringing people together in an informal way, and bringing them together on a regular basis.

01-00:53:23
Burnett: Down to the way that new buildings are constructed, they actually don't take that into account, because this is something that's talked about in the histories of other famous, well-established departments, that there are these informal spaces, like the space in front of the elevators at the economics department at the University of Chicago, that's where so many of their ideas were hatched, just talking around the elevator. There's other stories of how a department's physical space really shaped how people socialized or were socialized and how they interacted. That interaction was really key in spurring intellectual debate and cooperation and collaboration. That was part of it accidentally because it was cramped, it was unpleasant—is that the case? It was kind of a not-so-ideal set-up.

01-00:54:20
Clemens: It was cramped. I won't say it was unpleasant, but it wasn't the spacious grandeur that we get in some of these academic buildings. Although it's really jumping ahead, when I came back to join the faculty, we were housed in what's now McCone Hall. We had a series of offices for graduate students. We would make sure that the students, four or five in an office, represented different fields of paleontology. Paleobotanists talked to invertebrate paleontologists, who talked to vertebrate people. Here in this building, you've got the professor at his or her lab, and their students are all brought together. They get to know the major themes in the research and teaching of that particular professor, but where do they get the cross-fertilization? There's a strength in both patterns, they're different strengths. I think maybe it's because I grew up with it, I feel the mixing of disciplines is really excellent.

01-00:55:59
Burnett: And stimulating for further inquiry. So, you were taking other courses in your undergraduate studies, but was it this kind of work culture that drew your further towards studying paleontology?

01-00:56:26
Clemens: Work culture?

01-00:56:29
Burnett: In the sense that it was in contrast to, say, so you were not all that inspired by chemistry because of the quantitative elements, but also because the classes were massive, right? In other words, your encounter with paleontology was a social one, in part, and it was a good kind of social work, that you could see that people were debating and talking with each other. You were drawn to that?

01-00:57:02
Clemens: I think that was it. The problems I had with quantitative analysis were in the laboratory, trying to get those darn balances balanced, and that kind of stuff. It consumed a lot of time and there was plenty of room for error. It's not the numbers that came out. Good quantitative analysis, fine, you could do a lot with it. What drew me, I think, deeper into paleo was the interaction with Stirton, Langston, and, particularly, Don Savage.

01-00:57:53
Burnett: Can you talk about Don Savage a little bit?

01-00:57:54
Clemens: Oh, Don! Yes. Don was very interested in the study of mammals, which intrigued me, and in the geological aspects of paleontology. In particular, methods of trying to determine correlation between one area and another, what we'd call biostratigraphy today. He was in the forefront, in terms of testing the first potassium argon work that was done here. Jack Evernden, Garniss Curtis, John Reynolds, pioneered in the development of techniques of radioisotopic age determination. What Don did was to team up with Garniss and Jack and go out to Nevada, where there are a number of beds which include the volcanic ashes that can be used for radioisotopic age determination. Vertebrate paleontologists had used their biostratigraphy to establish their sequence. Don and one of his grad students, Gid James, tied in with Evernden and Curtis and they went out, collected ashes that were related stratigraphically to fossil localities, to test the sequence. There's a paper—I'd have to look it up—in which they show that yes, indeed, that biostratigraphy worked on a crude basis. There were no, as I remember, errors in the sense of missing the sequence, but the age determinations were primitive.

01-01:00:22
Burnett: On the order of a hundred thousand years?

01-01:00:24
Clemens: Well, hundreds of thousands of years, so it lined up pretty well. At that time, there was an interest in correlating the early Ice Age deposits of North America and Europe. So, Don was involved in forming a team of French, Italian, and American paleontologists to work in Northern Italy, doing the same kinds of approaches in their analysis. They suffered working in all those vineyards. [laughter] We'll get to that in another meeting.

01-01:01:24
Burnett: He was an expert in biostratigraphy.

01-01:01:27
Clemens: That was his area.

01-01:01:29
Burnett: In general, roughly speaking, there were strengths of the paleontology department at Berkeley versus other departments in other universities.

01-01:01:39
Clemens: I think we were the only Department of Paleontology. Invertebrate paleontology was largely taught and the research done in geology departments. Vertebrate paleontology was and still is largely tied in with biology departments. So, in the Department of Paleontology one got this interplay between a biological approach and a geological approach to study of the fossil record of an area.

01-01:02:22
Burnett: That's the kind of unique brand.

01-01:02:25
Clemens: Berkeley still has this unique interplay of current faculty in IB and the museum. Cindy Looy is the paleobotanist, Charles Marshall and Seth Finnegan are the invertebrate folk, and Kevin Padian and Tony Barnosky work on vertebrates. Tim White and Leslea Hlusko represent the area of physical anthropology. I hope I haven't forgotten anyone.

01-01:02:59
Burnett: Just to give the context of the 1950s at Berkeley, there was a unique interdisciplinary focus on these fossil organisms. Was there a particular focus on the micropaleontology? There were the smaller organisms, or I misunderstood that?

01-01:03:27
Clemens: The forams, yes, there was. Ralph Kleinpell, who was deeply involved in biostratigraphy and using foraminifera and other marine microorganisms, was on the faculty. Kleinpell wrote the initial treatise on the stratigraphy of the marine Tertiary here on the Pacific Coast. He was followed by Zach Arnold. That was the other side of the coin—Zach was interested in growth patterns of foraminifera, and actually, for a number of years, had a lab up in McCone where he was growing forams and sampling them to see the different growth stages. It's the mix that's important.

01-01:04:45
Burnett: So, you are taking courses in paleontology as you go through your undergraduate. You declare a major?

01-01:04:54
Clemens: I guess I did. I must have.

01-01:04:56
Burnett: In the second or third year. At a certain point, you really got pulled in. So, what was the real turning point for you, when you decided this was something you wanted to pursue at a graduate level?

01-01:05:13
Clemens: I think the summer of 1953 with Don Savage, if you want a tipping point that was it. As we discussed, Don grew up in Canyon, Texas. His father was the chancellor at West Texas State. Don got his master's at Oklahoma and then came out here. There was material in the museum at Canyon that he wanted to study. So, the main purpose of the trip was to go out to Canyon, pack it, and ship it back. Peter Norton, then a graduate student at Berkeley, worked with us in Texas. Don being Don, one of his wonderful characteristics, sometimes an infuriating characteristic, was that he wanted to see many if not all the fossil localities whose faunas were involved in his biostratigraphic studies.

A usual pattern with Don would be to go to a locality, find out what levels the fossils were coming from. Then on the second or third day just as we were getting really interested, Don would say, "Okay, let's go. I've got another one to look at." A characteristic of that summer was that sort of a break between packing and crating. We went out to a number of really classic localities in the panhandle of Texas and the panhandle of Oklahoma, and would go out, relocate the sites that had been worked by others, have a look around, and make small collections. That gave me a background, if you will, into the late Cenozoic stratigraphy of Texas and Oklahoma. Then, coming back to Berkeley, we first went up into Kansas to see Claude Hibbard.

Hibbie had been on the faculty at the University of Kansas, a position that, many years later, I would take. From Kansas, he had gone to Michigan. Hibbie was interested in the small animals found in Pliocene and Pleistocene deposits of Kansas. So, we're talking about maybe the last five million years. Hibbie had a collecting technique that involved finding sites where you could get concentrations of small bone. Basically, he took samples of those rich deposits, took them to a stream or pond where he had a couple of washing boxes. Think of a foot-and-a-half by a foot-and-a-half square with fly screen on the bottom. Hibbie and his crew would wash out the sand and the mud. Then, they would dump out the concentrate on towels. Hibbie had some kind of arrangement with the athletic department of Michigan and had a nice supply of towels. The collecting technique was interesting. Hibbie also showed us some of his fossil localities. At Hibbie's camp I got to meet Mike Woodburn, who was a student then. In following years, Mike and I would work together in Australia and on various stratigraphic projects. This was a nice introduction.

The trip then went on to the Four Mile area in Colorado. I must say, the trip was interesting because Peter and I were driving a pick-up truck and Don wanted to take back a couple of walker hound pups for his children. So, we

built a kennel just behind the cab of the pick-up. The two pups traveled there, which became an interesting part of the story in Colorado when we arrived at Four Mile. Malcolm McKenna, who was then a graduate student of Don's, had a camp there. They were collecting and doing screen washing. Malcolm had two Siamese cats that he was very proud of—Ping and Pong. According to Malcolm, they were vicious hunters bringing down rabbits. When we turned the walker hound pups loose in the camp, they treed Ping and Pong, much to Malcolm's dismay.

01-01:12:13
Burnett: They stayed there until the pups were gone?

01-01:12:15
Clemens: Well, we had to get the pups corralled and the cats down.

01-01:12:22
Burnett: So, this screening technique, is it a bit derived from mining techniques, mining for gold? You're panning for fossils?

01-01:12:37
Clemens: The screen washing technique in vertebrate paleontology goes back actually to the 1700s in England, where it was a way to wash away the sand and silt, leaving the larger particles behind. So, depending on the size of your screen, you would get fossils of appropriate size. Hibbie was, I think, the first one in the United States to try to use this technique in any major way. Some of the earlier collectors—Barnum Brown up in Montana—found some anthills with fossils in them and washed them through burlap sacks. An interesting try. They got a few things, but Hibbie was sort of institutionalizing use of the technique. Then, Malcolm being Malcolm, recognized that that as wet concentrate was dumped out on towels, just the process of dumping it could break material. So, Malcolm used screen boxes for both washing and drying. This meant building two or three dozen boxes, and having one set in the water, soaking and ready to wash, the other set out to dry in the sun.

I have to credit Malcolm; he showed what that technique would do in terms of really expanding collections of small vertebrate fossils. Secondly, he was an active proponent of application of this technique. So, as you go around today visiting field crews interested in getting a broad sample of the fauna, you find that they open a quarry, hand-quarry it. Then, the material, the rock that they have quarried goes into the washing process. So, you'll get your large fossils during the quarrying and the small ones during the washing. It's been a major advance in our ability to look at the structure of ancient faunas as they're preserved. We've always got that bias, what gets preserved and what doesn't. The application of these different collecting techniques does, I think, give you a balanced sample of what's preserved in the rock.

01-01:16:27
Burnett: In natural history, they either weren't aware of it, or there was just a concern for the large quadrupeds, and they were focusing in the nineteenth century. In the mid-twentieth century, or perhaps earlier, there was an interest in getting this representivity? There was an awareness that you were missing a huge part of the available fauna?

01-01:17:06
Clemens: This is trying to make a generalization, which is always proved by its errors. Looking at what was going on in the late 1800s and early 1900s, in the United States and Canada, I think, one of the dominant influences here was the competition for big, ugly dinosaurs. You've got Henry Fairfield Osborn at the American Museum. Osborn was wealthy, and he involved people like Henry Clay Frick and the Morgenthau family. There wasn't a lack of money at that institution. Then, in Pittsburgh, you had Andrew Carnegie and his museum. Farther west in Chicago, the Field Museum was supported by the Marshall Field family. There was open competition between the museums to collect big, spectacular fossils to exhibit and attract the public.

There are some exceptions, but as I see it, during that period, the emphasis was on finding the big things. It's hard to think of—and I can't think of one right now—a study from that period that really looks at the total fauna. By the 1930s, you're beginning to see this kind of interest. No, it was the big, spectacular fossils that would please the donor. That was a major theme. With the screen washing, we'll get into it more when we talk about my graduate career, but Richard Estes, who was a fellow graduate student, really brought to the fore considering the entire vertebrate fauna. What about the fish, the amphibians—all those salamanders—and lizards? The change in focus was great, but we'll get to that.

01-01:20:03
Burnett: This is your exposure, in your undergraduate experience, you're young and this is a summer where you're visiting multiple sites in three different states?

01-01:20:19
Clemens: Three different states, and with Don coming back to Berkeley. After Four Mile we'd stop on the way. We went by Bridger Basin and had to stop for a day and look around. As I remember there were a couple of brief stops in Nevada.

01-01:20:35
Burnett: Also, meeting these scholars, these top scholars, at these institutions. There's this tremendous exposure to both the intellectual life and the work practices, and seeing different work practices. Just this incredible exposure.

01-01:20:53
Clemens: Yes, I was tremendously lucky. Again, it was the nature of the museum and the department, providing these kinds of experiences for a few undergraduate and graduate students, that really made a difference. When I got back to

graduate school, we had the Geology Department up above us. There was just a natural interplay, intellectual interplay, between different disciplines.

01-01:21:44
Burnett: When you went on this trip, you had one more year after that, right?

01-01:21:53
Clemens: I'd have to go back and look and see which courses I took. Very definitely, I had decided that I was majoring in paleontology.

01-01:22:06
Burnett: You wanted to take courses in geology to balance out what you had done?

01-01:22:12
Clemens: More biology than geology at that time.

01-01:22:22
Burnett: So, that cemented things for you, in terms of deciding that you wanted to go to graduate school and do this kind of work, by having this peripatetic introduction, right? You walked with the scholars to get this exposure.

01-01:22:40
Clemens: Crawled with some of them, but yes.

01-01:22:42
Burnett: Looking with magnifying glasses at these things. So, you decided at that point to apply for graduate school?

01-01:22:57
Clemens: No. I entered the university in September 1950, a few months before the Korean War broke out. By 1954, the war was still going on. In the spring of '51 I had to register for the draft. You had to jump through a number of hoops to get a deferment. At that time, we were still definitely a land grant college, so as an undergraduate I had two years of ROTC classes. So, I had an idea of what the Army was about. Let's say when I graduated in May of '54, I'd had it with the uncertainty of deferments from draft. Things looked as though they might be stabilizing in Korea, the armistice had been signed at P'annmunjŏm the previous year. I said, "I'll volunteer for the draft, get that over with." I had a little idea of what's going on in the Army. So, I did, and talk about blind fool luck.

01-01:24:44
Burnett: Or the ceasefire, at any rate.

01-01:24:46
Clemens: Ceasefire, that's what it is. Then, I was inducted in August. Now, President Eisenhower decided that if you were in the Army before January 31, 1955, you were a Korean War veteran and eligible for the GI Bill. That's what paid for graduate school, or part of it. My wife kept kidding me, I had eleven days' eligibility left and I didn't use them!

01-01:25:37
Burnett: "They also serve, who stand and wait," I suppose. [laughter]

01-01:25:45
Clemens: That's why I didn't immediately go to graduate school.

01-01:25:50
Burnett: You went through the training, or does ROTC count?

01-01:25:55
Clemens: No, I went in as a private.

01-01:26:00
Burnett: They still do the basic? It was twelve weeks, or whatever it was?

01-01:26:04
Clemens: Six weeks' basic, then we were given two weeks' leave. On my leave I contracted some kind of illness. At first, they thought it was mumps because there was a very big swelling on my neck. By the time they got around to testing, they couldn't figure out what it was, but this got me out of the cycle. I was put in another training company. When I walked into the new company the lieutenant in charge, a young guy like me, looked at me and said, "Do you know how to type?" I said, "Yes." "Well, our company clerk is just leaving. We need someone to do the morning reports. You're here." So, through the second six weeks of basic training, I was in the company office most of the time. Then, when that company was shipped overseas to Germany, I went along, but as an individual. I was sent to the replacement depot in Zweibrücken. The lieutenant who was in charge—I think he came from Dartmouth—said, "Looking at your record, you don't want to carry a rifle, do you?" I did not. So, I got assigned to Judge Advocate General's Corps, and became a teacher of shorthand—which I learned quickly—typing and military correspondence. We'll get into that part of my story maybe next time.

01-01:28:10
Burnett: That sounds great.

[End of Interview]

Interview #2 January 14, 2015
Begin Audio File 2 clemens_bill_02_01-14-15.mp3

02-00:00:06
Burnett: This is Paul Burnett, interviewing Dr. Bill Clemens for the University History Series, and it's January 14, 2015. This is our second session and audio file. So, the last we left off, you were briefly in the Army as part of the Korean conflict.

02-00:00:33
Clemens: Well, two years is not brief. [laughter]

02-00:00:38
Burnett: Your time began after the armistice had been agreed.

02-00:00:51
Clemens: As it turned out, I was drafted in August of 1954, after the armistice at P'annmunjŏm. The critical thing there, in terms of funding, is that President Eisenhower ruled that anyone who was in the Army at the end of January of the next year was a Korean Veteran. So, that gave me four years of GI Bill, support that was really necessary.

02-00:01:25
Burnett: In the last session, you did talk about being posted to Europe.

02-00:01:31
Clemens: Yes. To go back a bit, I was drafted in August, went into basic training, and in the second session of basic training, I learned that I was going to be posted to Europe. The other thing I learned about Army regulations concerning dependents was that Dorothy Thelen, whom I had been dating for five years, would not be considered a dependent if we got married as we planned, once I was overseas. She wouldn't get Army benefits like going to a P/X. So, beginning of January, she had two weeks to organize the wedding. I got a three-day pass. We got married, had a couple of weekends together before I was shipped to Germany. Transfer to Germany involved being posted to an old German border post. They call them Kasernes, where you have a series of barracks in addition to the headquarters. The US Army had taken over the Kaserne at Lenggries and turned it into a series of schools. We had a cooks' school, a dog trainers' school, and then the school for the Judge Advocate General's Corps. I was assigned to that to be trained in typing, shorthand, and military correspondence.

As we got into the course, two of the instructors were terminating and going home, so the word was out, the top two people in the class would be kept on as instructors. Now, Lenggries is a summer and winter resort—it's a beautiful setting up in the alpine region of Southern Germany. It would be sort of nice to stay there, so I worked quite hard, and came in third in my class. The guy who was first was a professional secretary and had worked for an officer, maybe the president, of an oil company in Oklahoma. When the folks at Lenggries said, "Well, we would like to keep him here," the people at US

Army Headquarters, SHAEF Headquarters, said, “No way, we want him back.” So, it became the second and third people in the class who were able to stay at Lenggries. Dorothy came over in May. We rented rooms in a very nice household in Lenggries and stayed there until the end of July of 1956. At least at that time, enlisted men earned a month’s leave every year. I had already used, in a mandatory fashion, two weeks of that between the first and second periods of basic training. So, we had six weeks plus some three-day passes and weekends to explore Europe. It was the first time either of us had been to Europe. We charted out three trips: one up into Scandinavia, one over to Paris and London, and then one south. I’d always wanted to see Pompeii, so that was our goal on that trip.

In terms of paleontology, I had a wonderful opportunity, I believe it was Charlie Camp who wrote ahead to Professor Stensiö in Stockholm. So, when Dot and I arrived there, he gave us a wonderful tour of the museum. In studying his work, I was fascinated by the way in which he was looking at the structure of the heads of some very primitive sort of fish-like vertebrates. The head shield is about the size of your thumbnail. What he was doing was taking these and setting them up, grinding off a small portion, and making an enlarged wax model. Grinding off a little more, making another model. It was like microtome sectioning of soft tissue. He was doing this kind of sectioning of these fossils and getting really some beautiful restorations of the skull.

That trip was particularly memorable because afterwards, he treated us to a really wonderful luncheon in the garden of the museum. Here I was; I just had a bachelor’s degree. I knew how to ask questions, but just on the basis of a bachelor’s degree. Stensiö made the comment, as we were leaving and thanking him, he said, “It’s a pleasure to entertain you. I hope that when you’re a professor, you’ll do that for the next generation.” Nice advice that we tried to follow.

At other museums Dot and I visited, we didn’t meet the staff, but certainly going through the exhibits, we got a picture of the European vertebrate fauna. Real material, not just pictures in your textbook. So, that certainly was a positive of those Army years. Secondly, the Korean War or conflict was over: the Army was winding down. They were reducing the number of students coming through our school, so the three of us enlisted men who were instructors had less and less to do. So, what to do with that spare time? Well, it turned out on the post, there were two libraries, one at the USO, had a very good collection of fiction, modern literature, and so on. There was also a library that specialized in a collection of books about the geology and geography of Europe and western Asia. I took the opportunity to do a lot of reading on those topics. Certainly that gave me a background, that was of help in my graduate work and later research.

Also, the family ties: Dorothy’s grandfather was born in Germany and immigrated to the United States. He first went to Rising City, Nebraska. That

part of Nebraska is just flat. Surprisingly for us so is the area west of Bonn, where he had grown up. After some time at Rising City, the family moved to National City, just south of San Diego. They planted a citrus orchard that did quite well. They had three boys—Dot's father and his two brothers. They waited until the youngest was ready to go, and eligible to enter the university. Then they rented a house here in Berkeley. Mrs. Thelen came up and kept house for three boys.

02-00:11:28
Burnett: Now, that's dedication to their education.

02-00:11:32
Clemens: I saw it later in Texas, this pattern that when the kids were ready to go to school or go to university, the family would rent a house in the university town and keep it as long as the children were going to the university.

02-00:11:56
Burnett: This is for ranching and farming folks who were out of town?

02-00:11:59
Clemens: Right, before long distance school busing and that kind of thing, or the development of a dormitory program.

Dot's father was president of the Class of 1904 here at Cal.

02-00:12:23
Burnett: What's the last name?

02-00:12:25
Clemens: Thelen. Dot was born here and grew up in Berkeley. In Europe, we were the first members of the American family to go back to Germany after World War II. Father Thelen had kept in correspondence with his relatives up to World War II. Then after World War II, he had sent care packages and that kind of thing to relatives. So, we made a number of family contacts that really helped in terms of getting familiar with what was going on in Europe at the time.

Then, my service in the Army had another consequence. Late in 1980s, when I was interim chair of paleontology, the dean had a celebratory dinner for all the chairpeople. Going through the various people he was honoring, when he got to me, he said, "This guy, Clemens, he's the only one of you whose first job as an instructor was teaching shorthand and typing." I think I still have that distinction.

02-00:14:09
Burnett: You probably do. I don't think there are any new shorthand experts being trained out there.

02-00:14:17
Clemens: Overall, a number of aspects of our time over there have played a role in development of my career and Dorothy's and my lives.

02-00:14:33
Burnett: Did you study or learn German while you were there?

02-00:14:37
Clemens: I learned a little German in high school. Of course, we were living on the German economy and needed some German to shop and that kind of thing. The discouraging aspect was that Germans who spoke a little bit of English wanted to speak English with us and have us correct them or train them. This pattern would go on. During the three years that I worked at the university in Munich and then the university in Bonn. Oh, here's an American, we'll talk to him in English and practice, yes.

02-00:15:39
Burnett: So, the relations between the base and the community, of course the base is a huge boon to the economy, the local economy, and I imagine that relations were relatively friendly by 1950.

02-00:15:55
Clemens: Sure, yes, I think that's fair. The Gotlobs were just very, very nice people. In fact, a couple of younger cousins, I guess—well, relatives—came to visit in Berkeley years later and looked us up. We hosted them during their short visit here. I described the relationships really friendly. If you bent a little, tried to speak German with some of the Bavarians who did not speak High German, it worked out well.

02-00:16:53
Burnett: So, you had your two years there and it was a formative experience, and you went and visited some collections and you met some professors in different countries. Did you visit anybody in Italy?

02-00:17:08
Clemens: No. Having grown up on *National Geographic*, I really wanted to see Pompeii and the ruins in Rome. So, no we had no professional contacts there. In Paris and in London, we were there at I've forgotten what time of year, but there were few staff around. We were just tourists.

02-00:17:37
Burnett: Lull, I guess.

02-00:17:39
Clemens: Going through the exhibits was an education. If you've been to either of those museums, the amount of material they have on display, particularly the amount of material they have crammed into the exhibition space in Paris—whale skeletons, giraffe skeletons, skeletons of little mice. You could just go through slowly and get quite an education in comparative osteology. It was wonderful.

02-00:18:17
Burnett: A tremendously long and distinguished tradition at that museum. So, you return to Berkeley, I presume, once you were finished. You're now married,

established, and your BA was granted in ’54. At this point, you’d had that wonderful summer with that wonderful exposure to Don Savage and these great thinkers and these great sites. You almost had a kind of survey of the possibilities of the field. So, can you talk about the process of enrolling in graduate school and some of the early decisions you made about what you would like to focus on?

02-00:19:11
Clemens: Let’s go back down to undergraduate days. There were three students who were ahead of me in the department in, say, ’52, ’53, ’54. One was Richard Tedford. Dick got into the field of paleontology in sort of an interesting way. He received his bachelor’s degree in chemistry at UCLA. Earlier Dick got in contact with Chester Stock. Chester had been a faculty member at Berkeley back in the twenties, then went to Caltech, and established quite an active paleontology/geology/stratigraphy program. Dick became acquainted with Stock, and went out in the field. Stock encouraged this, so that by the time he got to Berkeley, Dick had quite a background in field geology, field paleontology. He became interested and involved with R.A. Stirton—“Stirt”—who at that point was developing his program of research in Australia.

Before Stirt went to Australia, the vertebrate fossil record was essentially limited to Ice Age or Pleistocene animals. There were just a few, two or three, fossils that could be shown to be older. So, when Stirt and Dick went to Australia they were based in Adelaide at the South Australian Museum. They started prospecting the north, found and reworked some previously discovered Pleistocene localities. Then, going farther north, they came across a series of localities that we now know to be approximately of late-Oligocene through Miocene age. So, this was the first real documentation of that phase of evolution of the vertebrate fauna of Australia.

Dick and I became good friends. From Berkeley, Dick went to UC Riverside, then on to the American Museum. As we’ll get to later, the year I had to finish up one phase of Stirt’s work in Australia, Dick was extremely helpful in getting me settled and introduced. Through the years at the American Museum, he was so very helpful to any students coming in wanting to look at the collections. You had no qualms about getting a student to go to New York because you knew Dick was there.

Another person who will become involved in all this was Malcolm McKenna. An interesting guy, and a great guy. Malcolm went to high school at what was a boarding high school in Claremont—this is the Webb School. What do you do with a bunch of boys who are at a boarding school? I’m not sure whether Malcolm boarded or just came in from town. There was a remarkable man on the faculty, Ray Alf, who was a physical education teacher and track coach. Ray decided that one thing to do with the boys was to take them out and collect fossils. So, Ray developed what would become the Peccary Club, and

went out into the area around Barstow and other localities to collect fossils for the Webb School. This program grew and they had a big summer field trips that would go out to a whole variety of localities. So, Malcolm was involved in the Peccary Club. Then, finishing high school, he went briefly to Pomona and then Caltech; then he contracted tuberculosis. So, for a year, he was in a sanitarium, recovering from tuberculosis and reading texts and research papers on paleontology. So, when he came to Berkeley, here was a guy with, imagine, a year's worth of reading behind him. He was really knowledgeable. Malcolm received his bachelor's degree in '54, in the spring. He TA'ed Stirton's introductory paleo class the next fall. My wife took Stirt's course and Malcolm's lab section. In terms of progression in the field, he was really steps ahead of me. The other aspect of Malcolm, the McKenna family's really quite wealthy.

02-00:26:24
Burnett: Right, as in Claremont McKenna.

02-00:26:26
Clemens: As in Claremont McKenna. Malcolm's father was Donald and he was one of the original trustees. It was his uncle, Philip, who I think was the lead in establishing the college, or reestablishing it. Malcolm's and his wife, Priscilla's families were down in Southern California. This was '53-'54, and they had at least their son Douglas by then. How did you get from Northern California down to the south to see your family? Well, Malcolm decided to learn how to fly and buy a plane, and he did. Now, when it came to fieldwork, that Cessna was remarkable in its impact on field projects. My work in the Lance, that was the only time I've had a field crew that wasn't essentially stable in composition because Malcolm would fly back and forth between the Lance and Berkeley. He would fly out for five days or so, bring someone with him. They'd work in the field with us, and then Malcolm would take them back. He also brought out necessities. The necessities, I can vividly remember one hot summer day when we were down at Lance Creek doing the screen washing, Malcolm flew in about noon bringing cracked crab, white wine, and French bread—necessities.

02-00:28:51
Burnett: That's a very civilized day.

02-00:28:53
Clemens: Oh, it was.

To get the story in proper sequence now, when I came out of the Army, it was July of '56 and Dot and I didn't get back to Berkeley until sometime in August. Looking at Don Savage's field notes, that summer late in June, he drove a truck from Berkeley out to the airport in Scottsbluff, Nebraska, where he met Malcolm and Les Kent. Les is another story of a remarkable field man and preparator. I wish we had the basis for doing a history of Les because

here's what one historian of science described as the "technical crew," acknowledged in so many scientific papers, but not a full story.

Don picked up Malcolm and Les, drove to the Harold Cook Ranch, and there he met Richard Estes and his wife, Stella. Richard's was the third influential contact during my undergraduate days. He had started his graduate work in 1954, I think, maybe a little earlier. He was here at Berkeley while I was away in the Army. Richard worked with Charles Camp. Richard's research interests emphasized the study of reptiles, amphibians, what we are chastised for calling "lower vertebrates," but never mind.

02-00:31:31
Burnett: Was that a kind of new emphasis? Was there comparatively little attention up to that point paid to amphibians—salamanders and such creatures?

02-00:31:50
Clemens: As Richard developed his research, he was going into a new area. Prior to his work, if you wanted to know what amphibians and small reptiles were present at a locality, you'd get a faunal list, a simple list of taxa. Back in '53-'54, Arnold Shotwell, one of the graduate students here at Berkeley, began developing a method of taking large screen washing samples and analyzing them, trying to determine the relative abundances of the various taxa. Could you make a statement from their abundance and mode of preservation whether they were living close to the area of deposition of the fossils or living far away? Richard took that method, added some of his own interpretations, and so this was the beginning of bringing ecology into the study of entire fossil biotas. Then, you ask about interdisciplinary—yes. Here's one example of trying to bring ecology into paleontology, to ask questions about structure of prehistoric biotas.

02-00:33:45
Burnett: We'll talk about that more, I think, in detail, as we go along. This is the cohort that emerges at this time. These are not just the people you're working with then, but for the rest of your career, these are people that you know well and can count on, and they can count on you.

02-00:34:08
Clemens: I hope so. I knew them well, yes, and it was fun to work with them, a really stimulating time. Back to Scottsbluff and the Cook Ranch, now, this is the Harold Cook of Vetter's study.

02-00:43:22
Burnett: Jeremy Vetter, yeah, he's the historian.

02-00:34:25
Clemens: The period of Jeremy Vetter's study ends in about 1920, when Harold left his position at the Denver Museum and went back to the ranch. I think with Jeremy Vetter's study, and he admits it, with Harold and his father, he's dealing with—particularly in Harold—a very well-educated landowner, well-

educated in geology and paleo. Harold had spent about a year or so at the American Museum, taking classes while being employed as a preparator. Now, I think I can make the blanket statement, I have never had the opportunity to deal with another landowner with that kind of background.

02-00:35:33
Burnett: He's a bit extraordinary and a bit exceptional.

02-00:35:36
Clemens: Very definitely, and that summer of '56, he knew the location of what turned out to be a major locality that had been worked intermittently certainly since the late 1920s, or early 1930s, by people from Amherst and the University of Wyoming. Now, to put it in context, the first major collection of Lance mammals was made by John Bell Hatcher in the 1890s. Those mammal specimens went to Yale, and then some of them were shifted to the US National Museum. There's a small collection at Carnegie. Hatcher had moved from employment by Marsh at Yale to a position at the Carnegie Museum and made a small collection for them. Now, a milestone, if you will, on the study of Late Cretaceous mammals is George Gaylord Simpson's monograph that came out in 1928. It was based on his doctoral dissertation. He had probably 200-300 specimens handed down from earlier collections. Marsh had described them; Osborn had critiqued Marsh.

02-00:37:24
Burnett: This is O.C. Marsh at Yale?

02-00:37:26
Clemens: Yes, O.C., and then Henry Fairfield Osborn at the American Museum. George did a thorough job with what he had, but Marsh had given a formal name to just about every tooth type, and did not try very hard to associate them in dentitions. George made a good stab at that with the material he had in hand and the limited information on their collection. I or anyone else could not have done any better.

02-00:38:14
Burnett: When you say "associate," you mean to develop kind of relationship among species?

02-00:38:25
Clemens: Just in the dentition—premolars, one genus, upper molars, another genus, lower molars, another genus. It was really a mess. Years later, Zofia Kielan-Jaworowska, Rich Cifelli, and Zhe-Xi Luo published a book on Mesozoic mammals. They have a little chart there, showing the number of new taxa established or proposed in a series of years from 1890 up to the present. During the period when I was publishing my Lance work, the graph is just flat. I had so many Marsh names to choose from. For one genus named by Marsh that I recognized, there were five synonyms, names coined by Marsh and other early workers.

02-00:39:41
Burnett: This is almost prior to the system of Linnaean classification, there were all these competing names, and that getting some kind of systematic nomenclature took some doing. So, there's a kind of mini-version of that with O.C. Marsh's stuff.

02-00:39:56
Clemens: Marsh thought in terms of types of teeth and named them according to the accepted or the then-standard nomenclatorial system.

The question that I still have yet to answer is why did Don, Malcolm, and Richard go to Harold to get an introduction to Lance mammals? Now, it might have been the result of Malcolm's long-term interest in Mesozoic mammals, and he really knew the literature on the American Museum Mongolian expeditions, particularly the Mesozoic mammals they discovered. It might have been Don Savage who, throughout his career here, really wanted to get small samples from a lot of different localities to use particularly in teaching. In the early fifties, we had five or six isolated mammal teeth from the Lance that had been donated by Paul McGrew. Paul was a Cal graduate, got his master's in the thirties. I haven't figured out why he made the donation. So, they may have gone to the Lance with Don saying, "Well, we need some stuff for teaching." The only person who's still around who might answer that is Malcolm's widow, and I sent her an email to see if I can't jog her memory. Maybe next time, we can talk about that. I'll see.

02-00:42:28
Burnett: Great, that would be interesting to find out. The Lance Formation is particularly rich, is it not? Maybe we can break right now and come back and talk about, for the uninitiated, if you could talk a little bit about what's special about these fossil formations. These are these unique circumstances under which a large number of fossils, over millions of years, have been preserved successfully. That might be worth talking about to sort of set the stage for what's special about the Lance Formation.

02-00:43:15
Clemens: Sure.

02-00:43:22
Burnett: So, last we left off, you were talking about this extraordinary cohort of at least three people who had a big influence on you and you had a big influence on them during that time period and onwards. You maintained your friendships and your professional relationships throughout your careers. Upon your return, you decide to enroll in graduate school. This is something you had figured out before you even returned?

02-00:43:53
Clemens: Yes, it was my hope to be admitted to graduate studies at Berkeley. Don Savage took the plunge and agreed to be my major professor. Having worked with Don the summer of 1953 as he went to Texas and then later would take

us to Kansas and Wyoming, my interests then were really in sort of later Tertiary mammals—Miocene, Pliocene, that kind of thing. Now, because of what Don, Malcolm, and Richard had done in the summer of ’56 out in the Lance, it wasn’t hard to convince me that maybe there was something in the way of a doctoral dissertation in terms of the description and analysis of the Lance mammals.

Now, to go back to that summer when, Malcolm, Don, and Richard were taken out to the Lance by Harold Cook.

The valley of Lance Creek figured in the early history of vertebrate paleontology. When paleontologists were having a competition between the major museums, looking for big, spectacular things to put on display. Marsh at Yale was one of the contenders. The American Museum was just beginning to come online, and there was the Carnegie Museum in Pittsburgh, and a little later, The Field Museum in Chicago. Marsh sent John Bell Hatcher out in the American West to collect and explore. He wanted spectacular dinosaurs. Hatcher heard of a rancher’s discovery of a horn sticking out of a bank somewhere in the valley of Lance Creek. To make a long story short, he went up there, found a number of skulls and partial skeletons of *Triceratops*. While he was doing that, Hatcher, being a consummate collector, began looking at anthills. I don’t know whether this was prompted by the recognition that if you look at anthills near Indian encampments, the ants will have brought in isolated beads. So, if you want to get a collection of beads, go to an anthill. Well, Hatcher went to the anthills, and started to see small microvertebrates. He started screening, using a flower sifter as his screen, and began collecting material. As I said earlier, Hatcher first collected for Marsh, then for the Carnegie Museum.

These collections were essentially what was available in 1956 at the beginning of the summer. Harold led Don and Malcolm over to the valley of Lance Creek and they started working. If Hatcher had dry-screened anthills and gotten teeth, they ought to do the same, except they built proper screens. They started screening for microvertebrates and had some success.

By about the middle of June, Don noted that their success was tailing off. Then, Les Kent found a remarkable locality. Don had been recorded finding ten mammal teeth a day, or at most fifteen. Their first day at this quarry, just dry-screening the surface, they picked up forty. Malcolm, who had developed the underwater screening technique for his work in the Eocene of Colorado, decided to go down to Colorado where he had stored some of his underwater screening boxes. He brought back a few and they started testing screen-washing—not to say at commercial levels.

02-00:50:19

Burnett: Right, not industrial, necessarily.

02-00:50:22
Clemens: Well, okay, industrial. Looking at his field notes, Don kept track of the number of burlap sacks' worth of rock we quarried from a couple of the localities. You're talking about a ton, ton-and-a-half over the course of the three years. So, it was a big operation. In '56, they worked what we call Lull 2 quarry, then the next summer was rewarding. I was out there, this was '57, with Don. I can't remember if Malcolm was with us that day. One of the local ranchers, Jimmy Krejci, had seen Paul McGrew from the University of Wyoming collect in some areas. He directed us towards one—go down this two-track road, a quarter of a mile, and then up to the left or right, or something like that. So, I was driving the pickup truck and Don and other members of the crew were in back. There was a great big, obvious exposure, but it was up high and I couldn't see it from the cab of the truck. Don pounded on the top of the cab, saying, "Turn off, turn off." So, I went on a little farther and turned off and went up to the top of the ridge. Members of the crew, including Don, jumped out of the back of the truck, and just looked down. The ground was littered with bone, all of those beautiful microvertebrate fossils.

02-00:52:37
Burnett: Just exposed?

02-00:52:39
Clemens: Just on the surface, in amongst the grass. Now, we talk about blowouts in terms of the type of exposure you see in the Lance and some other areas. Basically, what happens is for one reason or another, the grass cover is thinned and soil gets eroded. Then, I think it's primarily in thunderstorms, you get tremendous wind and rain, and the smaller particles get blown or washed out, leaving a litter of larger particles—in this case, the microvertebrate fossils. So, we came back from the '57 field trip with a collection of microvertebrates probably equivalent to or slightly greater than everything that had been collected before. Collecting at Lull 2 and our discoveries in 1957 greatly expanded our collection of microvertebrates.

02-00:53:51
Burnett: In a single trip?

02-00:53:52
Clemens: In a single trip in 1956. The big discovery of Lull 2 came in July, and they left the end of that month.

02-00:54:02
Burnett: That's called Lull 2?

02-00:54:09
Clemens: Lull 2. The history here is that Hatcher went out from Yale and came back with his collections and a very rough map or set of directions to places he found dinosaurs and microvertebrates. About 1914 or 1915, Richard Swann Lull was a professor at Yale, went back to the area, tried to reconstruct the collecting localities, so Lull 2 is locality two as recorded by Lull. It turns out

our Lull 2 locality probably was not Lull's second locality but was a couple of hundred yards away. That was, at the beginning, the best we could do in terms of location.

02-00:55:27
Burnett: So, this is not the days of GPS, geolocation, then. This is field notes, saying obviously you have some kind of longitudinal coordinates? No? It's landmarked? It's "by the old tree?"

02-00:55:47
Clemens: The landmarks on Lull's map were crude tracings of the little tributaries to Lance Creek. Here's another aspect: Don Savage, at the beginning of World War II, went into the US Air Force, where he stayed for six years. He became a specialist in aerial photography and mapping. When he got back to Berkeley from the '56 field trip, he sketched out a map of the collecting area based on aerial photography. One of my jobs was to set up a grid system on that map and improve it by spending more time recording details from the aerial photos. I guess there were property maps for the area, but I can't remember finding a corner stake. It was either in '57 or '58, a US geological survey came out and put in the first benchmarks that would serve as bases for their topographic mapping.

02-00:57:29
Burnett: Well, no US geological survey, it sounds like, until '57-'58, for them to have accurate topographic maps of that area. These were the badlands, right, where the mining companies would probably have the best maps of those areas, one would think.

02-00:57:47
Clemens: The best maps of the area were around the Lance Creek oilfield. I must say that in terms of our relationships with people out there, the guys at the Lance Creek field were great. I had questions about how thick is the Lance Formation here? "Oh, well, look at our well logs." I had easy access to records and information that today would be proprietary information and that you'd really have to work to gain access to it.

02-00:58:32
Burnett: Oil drilling records end up being really important to the history of paleontology. That's some of the first indications of the crater around the Yucatan Peninsula, for the impact crater.

02-00:58:44
Clemens: Oh, Chicxulub, yes.

02-00:58:46
Burnett: That comes from prospecting data from the 1950s, an oil company in the 1950s had the first indications of that formation. So, this is an inadvertent ally in some respects, for getting information in these remote areas. That's all you

have, in some cases. You've got ranchers, miners, oil companies, and that's about it—and you.

02-00:59:15

Clemens: As it turns out, in the early eighties, Malcolm and Priscilla McKenna and Dot and I were invited to go to China. The purpose of the trip was to go to Inner Mongolia, the Chinese-controlled part. Now, Roy Chapman Andrews collected there. Basically, he was stopped at the Inner and Outer Mongolian border, waiting for permits to go farther out into Mongolia. So, while waiting they did some collecting. Then, after World War II, the Russians came in and worked with the Chinese and made collections. Well, that relationship soured and the Chinese made their own collections. So, one of the purposes of this trip was for Malcolm to bring his collection of Xeroxes, maps and notes from Roy Chapman Andrews and go out and relocate Andrews' collecting localities. Then, our Chinese colleagues would say, "Okay, that locality is called this in Russian, and this is what we call it today, in Chinese." It was quite an eye-opener. Again, it shows how dependent we are on maps. The thing I forgot to add, we had topographic maps of the area, flown by the US Air Force in that sort of inner regnum at the end of World War II. They got in there with their cameras. So, you've got to realize the evolution of the location of sites. Well, Dave Archibald published his Ph.D. dissertation in the early eighties. Part of the area that he included in his geological map was covered by topographic maps. Another part he had to sketch in from air photos. This was the late seventies, actually.

02-01:02:23

Burnett: Well, we should keep track of that, and we can maybe get an update. I imagine remote sensing becomes important and there's all kinds of new satellite stuff becomes so important to this—geotagging and all that is part and parcel of modern day practice.

02-01:02:40

Clemens: Another thing we ought to sort of keep as a thread is access to land. In the late fifties, when we worked in the valley of Lance Creek, ranchers thought in terms of their ranch and didn't differentiate between private property—a homestead, usually—and land leased from the federal government. With one exception, the ranchers we dealt with out there over those three years were open to our work. We'd go and ask them for permission to go on their ranch and they'd say, "Oh, sure. Yes, go ahead." The one rancher who said no did not have a very good reputation locally. He said, "No, unless you pay $25 per person per day for damage to our grass."

02-01:03:55

Burnett: On the leased land or on his land?

02-01:03:57

Clemens: On his ranch. The federal government wasn't interested in monitoring what we were doing in the way of collecting. There wasn't this distinction that you

see today. The other thing, going back and thinking about it, in the late 1950s, there was no concern about the financial value of fossils. The rancher who objected talked about damage to his grass and wanting the fossils to go to Laramie and not leave the state. That was it. Now, as we track along through later years of field work, you're going to see the development of federal management and oversight. Also later, the impact of commercial collecting, which just changed the scene. Let's follow that train, yes.

02-01:05:07

Burnett: We should, for sure, absolutely. One other general question for the general audience, this is a legendary formation. It's O.C. Marsh, who was originally collecting there, and this is the ground floor of paleontology in North America. Can you talk about the rarity or the frequency of these kinds of rich formations? How often do they occur on the face of the earth? This is a finite resource, very, very limited resource, scarce resource. Can you talk about the Lance Formation, its importance, and Hell Creek, for that matter? We'll talk about Hell Creek later, but in general terms, how rare are these conditions where you have such a rich record and such a complete record?

02-01:06:06

Clemens: How rare?

02-01:06:07

Burnett: Well, just by a point of comparison, there are digs, in a comparable sense, I think in Canada, there's Drumheller, there are a number of places where these sites are, and then there are lots of small sites around the world, I suppose. Maybe those smaller sites are driven more by proximity to a local research university and they need to go somewhere so that students can get exposure. I imagine that we're talking about a handful of really great formations in North America. Is that accurate?

02-01:06:45

Clemens: For the Late Cretaceous, there's a band of fossiliferous rocks exposed in the Western Interior. In Wyoming it's called the Lance Formation. In Montana, it's named the Hell Creek Formation. In Colorado, it's named the Lance or the Denver Formation. You get down to the San Juan Basin and rocks of this age have other names. In general, it's a series of deposits formed by outwash from the rising Rocky Mountain chain, beginning late in the Cretaceous and continuing into the Eocene. So, the beds of this age that are fossiliferous are initially limited in geographic extent. Now, in terms of localities within these formations that have been worked by vertebrate paleontologists, they are a smaller subset, and in part, it's dictated by discovery. You can only do so much in a month or two in a summer field season. You've got a museum director back there who really wants these kinds of fossils. You've got a group of budding graduate students and you want to get them into an area where they can get material that speaks to an interesting research question. But there's a lot of...

02-01:08:47
Burnett: A lot of players, a lot of stakeholders.

02-01:08:49
Clemens: Stakeholders, good, yes. Oh, I can think of areas, well, like the Bighorn Basin. Early in the last century Princeton worked in the basin. Glenn Jepsen was the leader of the field research. Then one of his students, Phil Gingerich, brought in field crews from the University of Michigan. The collections from the collections from the basin just built up and built up. You sort of come to thresholds where you say okay, I've collected this much, and now I'm beginning to see some of the rare forms, or I've collected this much more and now I can do some kind of quantitative study because the sample's large enough. This keeps bringing people back to collect more to answer an evolving set of questions.

02-01:09:52
Burnett: In a sense, you're saying it's more driven by the institutions and the actors themselves who are asking certain kinds of questions and they're looking for certain kinds of fossils. Really, that's the break, the limit on the kind of work that's being done, and of course, the budget and all of that as well.

02-01:10:26
Clemens: I haven't applied for NSF support for a decade. From what I hear from my colleagues, if they applied to NSF for money to go prospecting, they probably wouldn't get it. You've got to have the question. You have to have some kind of seed collection to develop your proposal. So, yes, the funding situation has changed drastically. Now, just thinking about Cal, I never wrote a grant proposal for any of that fieldwork in the Lance. You just assumed that money from the Alexander Endowment would pay for going out and collecting. Yes, I can remember writing sort of a budget of what I wanted and getting it approved by Stirton, who was director. It wasn't until I made the trip back east to visit museums that I had to write a grant proposal. That was to the Marsh Fund, administered by the Academy of National Sciences. Yet, today, I think for a very good reason, we're asking students to write grant proposals for what's relatively minor support in various areas. It's good practice.

02-01:12:24
Burnett: Absolutely. It's an essential part of being a scholar today. The Alexander Fund, could you talk a little bit about that, about what that supports? We can maybe leave that in detail for another session talking about the museum, but could you talk about the rough annual payout of that at that time or today, for example?

02-01:12:52
Clemens: No, really, I can't—I don't know the numbers.

02-01:12:55
Burnett: It's sufficient to support an expedition, a small expedition, into the field for a summer with some student assistance, I imagine, or graduate student assistance? Did undergraduates go?

02-01:13:13
Clemens: Yes, just a field crew. Again, back to Malcolm and his Cessna. He was bringing in friends, students and other friends, to work for a couple of days. We were camping out, so we had the money to pay for the food. It was just that.

02-01:13:41
Burnett: We'll talk about that in more detail as we talk about the project. So, they had decided that the Lance Formation was going to be fruitful for a series of expeditions—one in 1956 and another one to Lull 2.

02-01:14:08
Clemens: That's '56, when Lull 2 was found, and '57, when this other remarkably rich locality, which we call Bushy Tail Blowout, was discovered. I can remember, as graduate students, many of us were housed on the highest balcony around the atrium in Hearst Mining Building. We had desks in front of the windows. I have the recollection of Don coming over and suggesting that I might be interested, looking at the Lance mammals, instead of Tertiary things. Having learned about what they found in the summer of '56, and the opportunity to get tied in with Richard in a broader faunal study. It was an obvious decision, a great opportunity.

02-01:15:15
Burnett: Can I ask why you were initially interested in the Tertiary mammals? You said you were interested in, that was what you were going to do, that's what you were interested in. What drew you to that, initially?

02-01:15:31
Clemens: My first experiences in finding vertebrate fossils were on my grandfather's homestead. Right adjacent to it is a set of Chadron Formation badlands that are really pretty productive. Those two Titanothere teeth that I showed you, they're from that area. Then, in '53, going with Don to Texas, working on not just the Cita Canyon fauna, but he took us out to look at other late Tertiary localities. Then we went up to meet Hibbie (Claude Hibbard) in Kansas. There, he was working on Pleistocene deposits. This is what I'd been exposed to.

02-01:16:31
Burnett: Right, this is what you knew.

02-01:16:34
Clemens: This is one of the things that makes this question about why they went to the Lance so vexatious. The whole tradition at Berkeley up to that time had been focusing on Oligocene and younger vertebrate fossils. Malcolm broke a bit of ice in starting looking at the Eocene and his Four-Mile fauna. But why the Late Cretaceous? I don't know.

02-01:17:15

Burnett: Was it a kind of research homesteading? It's an area that was sort of staked out, but as you described, the late nineteenth century, Marsh's classification, there was no classification really except to say that I'm going to name all of these different species.

02-01:17:36

Clemens: Well, Marsh did that, that's correct. Then, very soon thereafter, Henry Fairfield Osborn wrote a critique of Marsh's work. In the late 1920s, George Gaylord Simpson reviewed everything that was available at that time in his dissertation, and you get his great monograph. With a couple of exceptions, that's where it stood in 1956.

02-01:18:21

Burnett: Perhaps there were new opportunities to revisit it in the light of new currents of research, new beginnings. You have said that in this cohort, they would later bring in a kind of ecological perspective. They're bringing in insights from other disciplines. You said interdisciplinary, it's in the mix, that's what's important about Berkeley and that's what's important about this period. So, could you talk a little bit about what was in the air? Maybe that's a partial answer to your question, that other people were thinking about bringing new disciplinary frameworks into paleontology that would elucidate new research programs?

02-01:19:02

Clemens: A partial answer, yes. Now, you as a historian of science would probably object or have a critique, but during this period, '56-'60, a number of things were happening in terms of study of the evolution of mammals. The reigning hypothesis about how the dentition evolved from a series of peg-like teeth in the primitive common ancestor of the amniotes into this complex tribosphenic type of dentition had been discussed and debated. Paleontologists were not at loggerheads, but a number of questions were being asked and the answers couldn't be found. Then, Bryan Patterson made a discovery of mid-Cretaceous mammals in the Trinity Group (Paluxy Formation) of Texas. These were isolated teeth, many fragmentary. Bryan interpreted them in a new way, or in a way that had only been speculated about before. Bryan had intermediates between the simple type and the advanced type. So, his paper that came out in '56, was sparking all sorts of interest about dental evolution.

So, many of our Mesozoic mammals are only known from dentitions. Until these wonderful discoveries in China, there was a certain amount of turmoil there. The discoveries that Kenneth Kermack; his wife, Doris; and the crew from the University College, London, were making in the early Jurassic fissure fillings were another, for me, threshold crossing. One of the characters that sets mammals in general apart is the fact that we have the three bones in our middle ear. If you look at their very primitive ancestors, basal amniotes, they have one bone in the middle ear, the stapes. Where did the malleus and the incus come from in an evolutionary sense? There was some fossil

evidence suggesting that bones of the lower jaw of primitive synapsids, amniotes including mammals and their immediate ancestors, that were modified and took on sound conducting functions. Based on studies of embryology of mammals the dominant theory was that these bones of the jaw shifted to the middle ear and became what we now call the malleus and incus. But where were the intermediate forms? This is what Kenneth and his associates were finding. For a vertebrate paleontologist specializing on mammalian evolution, this was exciting. I must say it was one of the things that drew me to applying to do a post-doc with Kenneth.

Another area that was just beginning to really be talked about was continental drift. When Wegener and du Toit proposed continental drift back at the beginning of the last century, I'm afraid some of our geologist colleagues on the East Coast just dumped on it. Well, the continents aren't that thick, they aren't that strong, you can't push them—okay. Thanks to the mapping in World War II, the mapping of the sea floor, views began to change. Hess, who was at Princeton and several other scientists were involved in getting this hypothesis of plate tectonics back into consideration.

02-01:24:59
Burnett: Well, there's, of course, that sonar data too comes into play for the sea floor spreading.

02-01:25:07
Clemens: Yes, that was coming in. I can remember that in '59 there was a discussion of the truth or fiction in plate tectonics. As I remember it was held at Larry Blake's (a favorite local restaurant and pub), and involved faculty and graduate students. The general feeling was no, it hasn't been demonstrated yet. Then, for me, the change in my views came later. What was the year that John F. Kennedy was assassinated?

02-01:25:50
Burnett: Sixty-three.

02-01:25:54
Clemens: That year, the Geological Society of America met in New York City. I remember going to the meeting; they had a half-day session on plate tectonics. I said, okay, they'll be debating whether or not it works. No, they were debating which direction, how fast various plates had moved.

02-01:26:20
Burnett: It was that quickly?

02-01:26:27
Clemens: The leaders in the field moved that quickly, yes. So, plate tectonics was there to be considered. In terms of biogeography, it really made us rethink the distribution of vertebrates and the interpretations that we'd been relying on before.

02-01:26:57

Burnett: Now, the earth itself is a moving target, right? The crust of the earth is a moving target. Then, they go through the whole process of figuring out the earlier, when you go back that far in time—it's 250 million years for the continents to spread apart and crash into each other. There's a kind of cycle over, that it takes 250 million years for Pangaea to sort of split apart. Then, the continents are crashing into one another. The timescale for this to occur, this is such a slow process, but if you're talking about fossil records that are hundreds of millions of years old, this is enormously consequential for the research that you're doing. So, that's in the air, but it's not settled during the time of your graduate work. So, it doesn't necessarily have an impact at that time. Certainly, the ideas around the mammal, the evolution of mammal hearing and the structure of the bones, it was exciting to you.

02-01:28:19

Clemens: One set of biogeographic questions that was pertinent or was present there in the fifties was why did the American Museum go to Mongolia in the twenties and thirties? As I remember, one of the driving forces of these expeditions was Henry Fairfield Osborn, who was looking for the ancestor of primates. He argued that primates had evolved in the Old World and only later had come to the New World. In the collections that were made over there, some of the Late Cretaceous mammals that they found dentally seemed very close to mammals we were finding in the Lance. Is this parallel evolution? Are we getting a picture of dispersal from North America to Asia or vice-versa? Where was the Bering Strait, then? Was there a Bering Strait? How close was it to the North Pole? These questions begin to come to the fore and began to be really critical to our research.

Also, I think we've got to mention the Dwight Davis/Rainer Zangerl translation of a revised manuscript of Willi Hennig's *Phylogenetic Systematics*.

02-01:30:20

Burnett: When was that, approximately?

02-01:30:22

Clemens: Their book was published in 1966. Earlier, it was 1956 or '57, Henning's work was just beginning to open the door to thinking about phylogenetic relationships. Again, as I've said earlier, it was our colleagues at the American Museum who championed these views; it almost became a belief system. They were applying it scientifically. I remember talking to Bob Schaeffer at the American Museum. He argued that there was one way to do science when it comes to understanding evolutionary relationships and that was cladistics.

02-01:31:18

Burnett: Well, perhaps we'll leave it with that faith that they had at that time, and we'll pick that up next time, and explore this in greater detail.

02-01:31:26
Clemens: Sure, be glad to.

[End of Interview]

Interview #3 March 4, 2015
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03-00:00:00
Burnett: This is Paul Burnett interviewing Dr. Bill Clemens for the UCMP Clemens Oral History Project for the University History Series. And it is March 4, 2015 and we're here at the Valley Life Sciences Building. And last we left off, we were talking about changes in the air surrounding paleontology. And so I'm wondering if you could talk a little bit more about what was influencing your thinking at that time.

03-00:00:45
Clemens: Okay. At that time, that would be during graduate school.

03-00:00:48
Burnett: During graduate school. That's right.

03-00:00:49
Clemens: There were a number of things going on that certainly caught one's attention. Just to run down a list. Certainly plate tectonics and the development of that field was afoot in the late fifties. I can remember arguments about did it occur or did it not. It was sort of surprising how quickly the whole idea became accepted in the beginning of the sixties.

There was a move afoot to question the way in which we classified organisms and studied their evolutionary relationships. The revised manuscript of Hennig's book on *Phylogenetic Systematics* had been translated by Dwight Davis and Rainer Zangerl at Chicago. And it was just beginning to be read and thought about. Oh, what are some of the other things that were going on?

03-00:02:13
Burnett: Well, can I ask you? So the Hennig book is in German in 1950 and then it's translated into English in '66, I think. In that time, were people talking about it, having read it in German or they'd made their own—the buzz had come even without the translation?

03-00:02:38
Clemens: Not to my knowledge. My suspicion is, at least among American colleagues, very few had the necessary command of the German language. So Dwight's and Rainer's translation really had an impact on the area and the paleobiological community. What are some of the other things that we were talking about?

03-00:03:16
Burnett: Well, there were debates about how to organize and how to classify. I guess that's in the systematics. I guess that's something that's happening?

03-00:03:27
Clemens: There were the beginnings of this, but let's wait until we get me to Kansas.

03-00:03:36
Burnett: Sure, sure. Yeah.

03-00:03:36
Clemens: A lot was going on. In terms of my work, there'd been a series of hypotheses put out about the evolution of the very complex teeth of later mammals. Bryan Patterson's paper, based on early Cretaceous material from Texas, really changed the way people were thinking. It didn't bring in dental embryology, but it was, to my mind, a precursor to the kinds of studies we see today dealing with the way the development of tooth morphology is influenced genetically. Morphology is primarily the product of the genotype and how that affects development.

And then I think another area that was really sort of bubbling at the time was the interplay of genetics, paleontology, and evolution. You saw it in George Simpson's works, particularly *The Meaning of Evolution* published in 1953. Prior to that, published in '49, was a series of papers that came from a conference sponsored by the National Academy of Sciences. They raised a number of questions. What was the role of extinction in evolution? That was up for debate. What was the range of variation in rates of change? These things were being discussed. So, yes, a lot was going on. Now, not being a historian of science, I wonder about saying that this was a time of profound change. I can't compare it with others, particularly earlier times. But, yes, a lot was going on and it was good fun.

03-00:06:23
Burnett: I think when they talk about the history of biology they talk about the evolutionary synthesis that sort of lab genetics has brought together with evolutionary studies, evolutionary history, and that takes place from the twenties on to the late forties. But really that just engenders a whole new set of questions. It doesn't settle anything. It just says, "Okay, now we're working more or less together." Sometimes a lot less than more.

03-00:06:56
Clemens: Yes. Looking in that context, certainly Sewall Wright's work was influential. In mammalian paleontology you began to see it picked up by George Simpson in his monograph on the Crazy Mountain Field and its Paleocene faunas. He was beginning to bring in treatments, quantitative treatments of variation. Then, with Anne Roe, their book *Quantitative Zoology* published in 1939, was a major contribution. The quantitative approach, I won't say comes creeping in, but you see it filtering in up to World War II and then there was a pause. Actually, before the end of the war, George comes back with his first book on evolutionary theory.

03-00:07:51
Burnett: Right. *Tempo and Mode*, I guess.

03-00:07:51
Clemens: *Tempo and Mode*. Then the National Academy-sponsored conference and then *Meaning of Evolution*. Yes. They certainly were in that era.

03-00:08:07
Burnett: And this was the Committee on Common Problems of Genetics, Paleontology and Systematics for the National Research Council in 1949?

03-00:08:15
Clemens: Yes.

03-00:08:17
Burnett: And so this is before you're a student but the proceedings of this conference were part of coursework or is this something that you and your cohort are kind of reading on the side? Does it become part of your training? Do you remember how you encountered these works?

03-00:08:44
Clemens: How we encountered them? We, the students in my cohort, read them and talked about them. So much of learning at the graduate level is what you learn by talking to your peers. This is not to demean what our professors were doing, but that was definitely part of it. Yes.

03-00:09:12
Burnett: They were facilitating an environment in which the graduate students can instruct each other, could inspire each other to explore new terrain.

03-00:09:20
Clemens: And we try to do it today.

03-00:09:23
Burnett: Yeah. I guess one of the things that the evolutionary synthesis could have engendered was that people felt freer to explore and range more widely outside of silos. So you could read something in genetics, you could read something, the goings-on in other disciplines to get ideas about how to proceed in your own work that might have hitherto been pretty siloed. Is that a fair description?

03-00:09:54
Clemens: I don't know. At least here at Berkeley the curricula in graduate school were not rigidly circumscribed and students were encouraged to branch out. Yes, the Department of Paleontology at that time was definitely skewed toward the geological aspects of the field. But there was no barrier or discouragement when you wanted to take a "zoo" [zoology] course. For me, one of the longstanding strengths of this university is that interdisciplinary activity is encouraged, and that's been great.

03-00:11:04
Burnett: Right, right. So it might be helpful to drill down a little bit into the work that you were doing for your dissertation, the fieldwork. Could we go into that a little bit about—

03-00:11:26
Clemens: Well, we've talked about the actual fieldwork in 1956 through 1958, the big field parties and the collecting and screen washing. Those were the major activities. The summer of '59 was different in that, well, first of all, there was a drought. So for the first time I saw Lance Creek dry up. I was back in the valley of Lance Creek with Dale Russell, who was helping me, trying to finish the mapping, and tie up the loose ends for my dissertation.

Then Don Savage and his son came out to join us. Malcolm McKenna flew in. Together we started a fascinating trip that took us to western Montana, then up to Alberta where we joined Wann Langston. At that time Wann was on the staff of the National Museum of Canada. He took us around to a variety of the collecting localities for Late Cretaceous and Paleocene mammals. And then as Don would want, on the way back we visited the Hell Creek area in the northeastern part of Montana. Now, I'll admit, part of my bias comes from Don's delight in just going to look at localities and see what was there. On the opposite side of the coin it impressed me about how little we know. How many miles of badlands did we go by that had never been prospected? So as we approached what we know of the fossil record, I think there ought to be a certain amount of humility about how ignorant we are. Yes, we have these beautiful little patches with fantastic information. But there's an awful lot we don't know. When you compare the density of well-studied fossiliferous areas in North America to those on other continents, hey, it's really, I think, unsettling. Particularly when you get into the area of biogeography. We just don't have the records we need. So that was one lesson that came out of my research in the Lance.

The four years of field work resulted in a great expansion of the available sample of microvertebrates. Really little had been collected in that area since John Bell Hatcher's work at the turn of the century. So, through application of the underwater screening technique refined by Malcolm, there was a large amount of new material for Richard and me to work with. For my part, I was able to use the material to bring some sense of the composition and diversity of the mammalian fauna. That gave us a base for comparison with Paleocene faunas.

Richard Estes carried out some fascinating studies of what we call the lower vertebrates. It's a little denigrating way to refer to the fish, amphibians, and small reptiles. He didn't get into dinosaurs.

03-00:16:15
Burnett: The non-dinosaurs.

03-00:16:17

Clemens: Yes. Starting with the work of Arnold Shotwell, who was a grad student at Berkeley in the early fifties, Richard was able to develop a series of paleoecological studies of the fauna. These would serve as a base for later work by Richard, Leigh Van Valen, and others on the pattern of faunal evolution prior to, during, and after the Cretaceous/Tertiary extinction in Montana. So looking back, to me, those were the major contributions of our work on the microvertebrate fauna of the Lance Formation.

03-00:17:11

Burnett: You mentioned that some of this stuff had not been touched. George Gaylord Simpson had done a study and sort of updated some of the fossil nomenclature that had been undertaken by O.C. Marsh and others. But this kind of organization, it is not just the structure of the bones or the structure of the fossils. It's also other things. Could you talk a little bit about what it means to bring in an ecological framework and Richard Estes's work?

03-00:17:59

Clemens: Okay, but first let me talk just a bit about the fall of 1959 when I was able to go back to the East Coast. This was a trip of about five weeks in duration. I went to Chicago and then museums along the East Coast. I was able to see everything that had been collected during the late 1890s and the early 1900s in the way of Late Cretaceous mammals from North America. Secondly, on that trip I met and got to talk with many of the active practitioners in our field. I met and talked with George Simpson, Bryan Patterson, Lew Gazin, and others who had all had pieces of the research action, but based on the early samples. It was really a pleasure. I can remember George and Pat were there in a lab at Harvard. And I started pulling out the mammalian jaws that we'd found. As I did this I heard comments: "Oh, that's the way it goes together. Oh, that's what the association is." So the new material from the Lance provided the basis for moving from considering changes in shape of isolated teeth to thinking about the evolution of major parts of mammalian dentitions.

03-00:19:51

Burnett: So that was remarkable for you. You undoubtedly read descriptions. So in 1959, if you don't have access to the actual fossils or casts of those fossils—could you talk a little bit about the difference between working with the real thing and having a kind of written description?

03-00:20:17

Clemens: Well, working today we certainly have very accurate casts of material. The casting technique is remarkably precise. And there is a tendency for colleagues to exchange casts. So over and above a written description, you have them. Then there have been improvements in photography. With these small fossils, there was always the problem depth of field with part of the object being out of focus. Now there are stacking programs. You take a whole series of photographs at different levels through the specimen. Then the program puts them together and you get beautiful in-focus photographs.

03-00:21:27
Burnett: Almost like a PET scan.

03-00:21:31
Clemens: And then on top of that now we can obtain images and models with CT scanning. Well, as an example, here is a model of one of the fossils that I described in my Lance work. It is a model of the ear region of a Cretaceous marsupial.

03-00:21:53
Burnett: Did you want to show a sample? Sure. All right. Can you show me this—

03-00:21:59
Clemens: Well, here it is.

03-00:21:59
Burnett: Oh, wow.

03-00:22:00
Clemens: This is a bronze cast of a fossil that I described in my study of the Lance marsupials. It's enlarged a number of times. But what it illustrates is, to me, what you can do with CT scanning and now model building. So I think the bottom line is, yes, there's something very satisfying about seeing the original material. But in terms of dissemination of information, you can do so much with CT scanning and with modern photography. These allow you to work at a distance, at least to do your preliminary analyses.

03-00:23:04
Burnett: But at the time it was important to go out to the source and—

03-00:23:09
Clemens: Right.

03-00:23:10
Burnett: —and to go to those major collections. I'm sensing that it gave you some perspective on the work that you were doing. You're working with this dentition and seeing the larger structures or the jawbones and the skulls and so on. You had a better idea.

03-00:23:33
Clemens: The discussions I had with Bryan, George, and others would often start with the teeth, and then the range of topics we discussed would expand. And we'd get into broader questions about patterns of evolution and relationship. One point I think should be emphasized is the small size of the active group of vertebrate paleontologists at that time. Today you couldn't meet all the people working on a particular group of mammals, rodents, or pterosaurs and see all the pertinent material in just over a month. The opportunity for what we'd call networking was there the way it isn't today.

03-00:24:42
Burnett: Right. And it's a small community in the 1950s compared with the paleontology community today, but it's also, I imagine, it was a tiny fraction of the life sciences community. So, for example, even botany or zoology, these were massive communities by comparison, right?

03-00:25:10
Clemens: Quantatively, yes, I have that impression. It was a small group. I think there were certain advantages in that. We've lost them today through gaining a much larger, more diverse group in the vertebrate paleo community.

03-00:25:41
Burnett: Yeah. And when you met George Simpson, did you have a chance to talk with him about your work and did he respond to what you were doing?

03-00:25:55
Clemens: Oh, yes, for a couple of days we sat in the lab at Harvard and talked about the interpretation of this material. We disagreed over a couple of points, but that was fine.

03-00:26:15
Burnett: Yeah, no, of course. It was a conversation. Yeah.

03-00:26:20
Clemens: So that was a high point in bringing my doctoral dissertation work together.

03-00:26:30
Burnett: And you met other experts there, as well? Jepson and Patterson?

03-00:26:32
Clemens: Oh, yes, from there I guess we go on to London or did you want to—

03-00:26:44
Burnett: Well, yeah, one of the things you were talking about is that you were trying to improve the understanding of the diversity of mammalian fauna. You described Simpson's work in the 1930s as kind of cleaning up the nomenclature and the classification of March and Osborne. Could you, by comparison, talk a little bit about how your work was different, just to give some kind of perspective?

03-00:27:18
Clemens: How it was different? In his studies for his doctoral dissertation George did a remarkably effective study of these older collections. Mine differed in that I had much more material and much more complete material. Secondly, it differed because of the development of new hypotheses about the pattern of evolution of the mammalian dentition. Here Pat's work was significant.

03-00:27:59
Burnett: For the record, who's Pat?

03-00:28:00
Clemens: Oh, Bryan Patterson, known to friends and neighbors as Pat.

03-00:28:03
Burnett: As Pat.

03-00:28:04
Clemens: Yes. So the difference was twofold, more material and new ideas. It was great.

03-00:28:18
Burnett: And you mention Richard Estes. Did he finish at the same time as you or were you more in dialogue with him about the work that he was doing?

03-00:28:32
Clemens: Oh, gosh, it was either ’58 or ’59 when he graduated. So through the years during our work in the Lance we had a lot of conversations about what we were collecting, and how our studies were going. And then, as I remember, he went from Berkeley to a position at Boston University. A number of his significant publications came out while he was in Boston.

03-00:29:18
Burnett: Right. Right. But there was a dialogue between you and him about—

03-00:29:21
Clemens: Oh, yes.

03-00:29:22
Burnett: —your work and about ideas that you were applying to your research. And so you complete your dissertation in 1960. You defend.

03-00:29:35
Clemens: Yes.

03-00:29:36
Burnett: And Don Savage was your major advisor.

03-00:29:39
Clemens: He was.

03-00:29:39
Burnett: Yeah. And at that time Don Savage was helping out the geologists at Berkeley with this potassium-argon dating work. He published an article on that later in ’64. But it’s considered to be the first application of potassium-argon dating to geochronology. That’s Bill Glen’s perspective. But given that he was your advisor, did Don Savage’s work in that area have any bearing on your research or was it kind of a separate thing in the background?

03-00:30:26
Clemens: It was separate, in part because I couldn’t find volcanic ashes in the Lance Formation. Yes, Don was working with Garniss Curtis and Jack Evernden. For this project, they were primarily looking at a sequence of fossil localities

in Nevada and some in the Great Plains. There, using the vertebrate fossils, paleontologists had put together an assumed sequence of faunas, looking at stages of evolution, appearance of new taxa, and that kind of data. Don and another graduate student at Berkeley, Gid James, went out, collected ashes that they could relate to these fossil localities, relate stratigraphically to these fossil localities. Basically it was a test: one that proved there was something in biostratigraphy.

03-00:31:42
Burnett: Yeah, yeah, there was. Yeah.

03-00:31:45
Clemens: Was Evernden the lead author? Yes, the paper was authored by Evernden, Curtis, Savage, and James.[1]

03-00:31:55
Burnett: Yeah, that's right.

03-00:31:55
Clemens: In the American—

03-00:31:57
Burnett: I'm not sure where it turned up but it was 1964 that that was published and it was a significant paper. And I guess what it speaks to is the kind of interdisciplinarity that you were speaking of. It's the geologists but it's the ones who were involved with the developers of the spectrometer that did this kind of work. So, there's new technology; there's physicists involved; there's the engineers involved who developed this technology.

03-00:32:26
Clemens: You can't leave out John Reynolds in the Department of Physics in the development of all this. But no, I didn't get involved because, one, there were no ashes associated with the Lance formation in Wyoming. My next project would be down in the San Juan Basin of New Mexico and there are no obvious ashes in that part of the section in which I was interested. So I looked with envy on what they were able to do in other areas.

03-00:33:07
Burnett: But even though these technological advances can be significant and extremely helpful, they're not applicable in all circumstances and that was not the case for you.

03-00:33:17
Clemens: You've got to find a datable ash. Right.

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[1] J.F. Evernden, et al., "Potassium-Argon Dates and the Cenozoic Mammalian Chronology of North America," *American Journal of Science*, 262:2 (1964): 145-98.

03-00:33:22
Burnett: Right, right. So you complete your dissertation, you defend it. The next phase is that you get a National Science Foundation post-doctoral fellowship.

03-00:33:36
Clemens: Yes. I was very lucky to get that, which allowed me to go to London to work with Kenneth Kermack. Well, you can ask the question, why did I go to work with Kenneth?

03-00:33:53
Burnett: Well, could I ask a prior question?

03-00:33:56
Clemens: Sure.

03-00:33:57
Burnett: What program was the NSF post-doc under? It wasn't for paleontology per se, was it?

03-00:34:07
Clemens: I don't think so.

03-00:34:10
Burnett: Was it kind of an exchange program or a scientists' exchange program?

03-00:34:13
Clemens: Oh, gosh, here you're stretching my memory. But at that time there were NATO fellowships for study abroad. In 1959-60, Leigh Van Valen received one of those fellowships and worked at University College London. Mine was a different program, definitely NSF-sponsored. I think it was one of the first years it had been offered, and, again, I was lucky to get it. I chose to work with Kenneth because a couple of years before he had announced the discovery of abundantly fossiliferous fissure fillings, fissure and cave fillings that occurred in southern Wales.

Now, for years prior, one of the major differences that was pointed out between mammals and non-mammals was the structure of the ear region. In reptiles you have a single bone, the stapes in the middle ear. In mammals you have three, a malleus, incus, and stapes. How did mammals evolve their complex middle ear region or how did their—that's an awful way to put it. What was the pattern of evolution—

03-00:36:06
Burnett: That resulted—

03-00:36:07
Clemens: —from a reptilian-like condition, which now we would interpret as the primitive condition of quadripedal vertebrates to this three ossicle condition characteristic of mammals. Most of the work that had been done up to that time focused on embryology and comparative anatomy. Yes, there were a few

advanced non-mammalian forms that were showing the beginnings of the change. But Kenneth and his associates found in the fissures the remains of animals that were caught in the act of changing over the structure of the ear region.

03-00:37:03
Burnett: Intermediate species.

03-00:37:05
Clemens: Right.

03-00:37:05
Burnett: Or varieties, I suppose.

03-00:37:07
Clemens: That was exciting. So I wanted to work with Kenneth, to see what he was doing and get a better understanding of what was in those fissures. Well, first of all, my introduction to Europe on that trip started out with going to the International Geological Congress in Copenhagen. I gave a little paper on what I had done in the Lance. I quickly learned that I shouldn't use the word Paleocene. If you look at the British literature of that time, they do not mention the Paleocene. They talk about the Eocene and sometimes the early Eocene. And after giving my paper, a distinguished British stratigrapher got up and said, "Paleocene? Paleocene? It's a figment of the fertile imagination of George Gaylord Simpson." [laughter] So yes. Things were a little bit different.

Then we went down to Brussels. And this is me, Dorothy, and our two children traipsing around Europe, which had some adventures of its own. In Brussels—

03-00:38:46
Burnett: And that's a heady time, too. Nineteen sixty, sixty-one. That's heating up a little bit in Europe.

03-00:38:52
Clemens: A little, yes. Professor Vandebroek in Brussels held a conference in which he announced a new hypothesis of dental evolution heavily based on embryological studies. Then from there we went to Oxford for a meeting of the British comparative anatomists and vertebrate paleontologists, where George and Pat had to explain why they disagreed with Vandebroek's hypothesis. And that was quite an introduction to Europe.

03-00:39:39
Burnett: People talk about cultures and science. Was the exchange sort of genteel? Was it combative? Was it a little bit of both? How would you characterize those kinds of interactions?

03-00:40:00
Clemens: If you go back to the interchanges between Osborne and Marsh, it was genteel. Gentlemanly—

03-00:40:11
Burnett: —by comparison, yes [laughter]

03-00:40:12
Clemens: Yes. But no punches were pulled, it was straightforward. We discussed this hypothesis, and we disagreed. Yes, it was a good and productive meeting.

03-00:40:27
Burnett: Yeah. It was exciting, I imagine, too.

03-00:40:30
Clemens: Oh, it was. Again, meeting British paleontologists with similar interests I found really enjoyable and stimulating. I made connections, friendships, that would lead to long-term research projects and a good excuse for returning to London from time to time. Kermack settled us in a nice row house north of London, in New Barnet. We had a very enjoyable time because the house belonged to an academic who had gone to Canada on an exchange program. So we inherited his circle of friends in the area.

03-00:41:41
Burnett: Oh, great.

03-00:41:41
Clemens: Yes, it was wonderful.

03-00:41:42
Burnett: They looked after—

03-00:41:44
Clemens: Oh, yes. In fact, when we were in London just last fall, Dot had lunch with one of the women that we had met in 1960. Nice ties. But Kenneth, interestingly, got me involved in another project. The cliffs near Hastings contain a series of marine and non-marine beds, some of them nicely fossiliferous. One area where you find these stones on the beach is near Cliff End, which is adjacent to Hastings. For a long period of time it was regarded as a source of a few early Cretaceous mammalian teeth. Knowing of the development of the screen washing process that we'd used in the Lance and Malcolm had used in Colorado, Kenneth suggested that we go down, go onto the beach, find some of these blocks of fossiliferous rock, and do some screen washing. Now, to break the rocks down you had to use a dilute acetic acid. So in the office I had at University College I had all these children's bathtubs with blocks of rock percolating away in weak acid.

03-00:43:55
Burnett: You're doing heap-leaching as they say in the mining business.

03-00:43:59
Clemens: Okay. Now I wonder about what we were doing. How to separate the bones from the remaining concentrate of small stones? Kenneth realized that there were different densities between the bone and most of the rock particles that we were getting out. So we did a heavy liquid separation using tetrabromethane, which has its drawbacks—yes. All of us involved survived.

03-00:44:32
Burnett: Right, right, right. Minimized your exposure, I hope. [laughter]

03-00:44:38
Clemens: That allowed us to collect a small sample of fossils from the site. Now, the consequence of that—remember it was 1957 that Oakley demonstrated the Piltdown hoax?

03-00:45:00
Burnett: Maybe a bit earlier.

03-00:45:02
Clemens: Okay.

03-00:45:04
Burnett: Yeah.

03-00:45:04
Clemens: Was it in the fifties?

03-00:45:05
Burnett: Yeah, ’53, I think.

03-00:53:06
Clemens: Okay. Well, the collection of fossils from Cliff End in the British Museum was made by a variety of people, including Teilhard de Chardin. Now, Teilhard was implicated in Piltdown hoax at that time. Later, it was in 1980, Steve Gould wrote an article trying to really pin the tail on him. A result of my work was basically to show that the only real mammal teeth from the Cliff End locality were the ones collected by Teilhard. All the rest of the material in the museum’s collections either wasn’t mammalian, or you had real questions about where it came from.

03-00:46:01
Burnett: Wow. So there were these ripple effects of the Piltdown.

03-00:46:06
Clemens: Oh, yes.

03-00:40:07
Burnett: Yeah, there were suspects and they were always concerned with rooting—

03-00:46:13
Clemens: Well, at that time, maybe still, in England there's this game of "fool the expert." There at the British Museum, colleagues told me how kids would come in with bracken fungi that they had stained with ink, and tried to pass them off as new species.

03-00:46:38
Burnett: I guess we're not immune to that here. We have the Francis Drake Plate hoax up in the Bay Area here. I think there's a rich tradition in that kind of pranksterism. That's fascinating.

03-00:46:56
Clemens: So, it was good fun.

03-00:46:59
Burnett: Yeah, that is interesting.

03-00:47:00
Clemens: A very good year. Then again I had another stroke of good luck. In 1961 I was hired at the University of Kansas and joined the staff of the Museum of Natural History and the faculty of the Department of Zoology. The positions I was taking had just been vacated by Bob Wilson, who moved on to take a professorship at South Dakota School of Mines. So moving from University College, which was great in that it gave me a nice quick course in what was going on in zoology, I went into the Zoology Department at Kansas and didn't feel too far out of place, but that was interesting.

03-00:48:10
Burnett: University of Kansas for paleontology is a pretty big deal, is it not?

03-00:48:17
Clemens: It has a very long history in our field. We can mention Barnum Brown. He got his undergraduate degree at KU. When I was doing a history of research in the Hell Creek I found out that the first skull of *Triceratops* to be put on public display was put on display at the University of Kansas. Brown had collected it in the Lance Formation. Oh, Elmer Riggs was another early graduate of KU. He went on to a variety of different research projects. So yes, KU has a rich history in vertebrate paleontology. Bob Wilson had been a very effective, well-liked colleague and teacher, and there were dark clouds about his departure. I came into a situation where there were big shoes to fill. Big expectations.

03-00:49:44
Burnett: Yeah. They were hoping that you could raise the profile of the department and that you could manage the teaching.

03-00:49:50
Clemens: That I could emulate what Bob had been able to do. So I tried. Yes. At that time, the museum's staff in vertebrate paleontology consisted of Ted Eaton,

who made his mark in research on non-mammalian vertebrates, and then we had a preparator, Russ Camp. That was it.

03-00:50:30
Burnett: Right, small.

03-00:50:34
Clemens: The museum had a wonderful complement of mammalogists, herpetologists, ornithologists. The emphasis, not exclusively, was on systematic studies. Among other projects the director, E. Raymond Hall, ran a research program in Mexico and Central America, funded by the US Army. It focused on collecting modern mammals in this area on the grounds that if some foreign power were to release a disease that could be carried by mammals, we ought to have a good record of the distribution of various kinds of mammals in Central America and Mexico.

03-00:51:36
Burnett: So zoology as countermeasures for bio-warfare, bio-terrorism.

03-00:51:43
Clemens: But it got a lot done.

03-00:51:45
Burnett: Yeah, sure.

03-00:51:46
Clemens: The KU collection of vertebrates from Mexico and Central America is amazingly deep.

Physically the campus at KU is along a ridge. At one end you have the museum, at the other end you have the building that held the Zoology Department.

03-00:52:18
Burnett: Really?

03-00:52:18
Clemens: So it was traipsing back and forth between the two. But that really didn't cut down too much on interchange between the museum and department.

03-00:52:34
Burnett: Oh, that's good.

03-00:52:35
Clemens: Which was good. In terms of the academic stimulation, it was great. Now, we talked about Hennig and phylogenetic systematics earlier.

03-00:52:53
Burnett: Yeah. A little bit, yeah.

03-00:52:53
Clemens: A little bit. Okay. That really was, as I see it, being promoted by people at the American Museum. At KU Robert Sokal and Charles Michener in the Entomology Department, and their colleagues had in the fifties explored ways in which you could do quantitative assessments of similarities between organisms with the goals of, one, developing a quantitative basis for classification. Also developing a quantitative basis for deciphering patterns of evolution. Their field became known as numerical taxonomy.

03-00:53:52
Burnett: Did he have in mind using punch cards to crunch numbers, to do that kind of analysis?

03-00:53:59
Clemens: A numerical approach, right. And you mention the Hollerith cards. I remember one experiment that Bob and Jim Rohlf pulled off. Charles Michener, who is a great expert on bees, gave them a series of drawings of different kinds of bees and laid out what he thought the relationships were. They took Hollerith cards, punched them out in some random fashion—punched windows in them—and laid the Hollerith cards on top of the drawings of the bees. They analyzed the resulting patterns and were able to sort of duplicate Michener's subjective interpretation of the relationships of these animals, of these bees, just using a large number of bits of data that were coded black or white. There was all sorts of experimentation going on.

03-00:55:32
Burnett: The potential. Yeah.

03-00:55:34
Clemens: There was a faculty group, the Biosystematists, that would meet once a month for dinner and a talk. There was always a lot of discussion about numerical taxonomy, and what we now refer to as cladistics or phylogenetic systematics. In '63 Bob Sokal and Peter Sneath published their book on numerical taxonomy. There was a lot of discussion going on.

03-00:56:18
Burnett: Absolutely. Who's the director of the Museum of Vertebrate Zoology here—I'm blanking, in the forties, fifties?

03-00:56:34
Clemens: Grinnell?

03-00:56:37
Burnett: His main student who then became director.

03-00:56:40
Clemens: Miller?

03-00:56:41
Burnett: Miller. Alden Miller was developing his own kind of systematics or ornithology that included this incredibly wide range. Because when we think of systematics, in my limited knowledge of this, I'm thinking of morphology, I'm thinking of structure, right? So like counting the number of pistils and stamens in a flower or the length of a beak and things like that and those kind of measurements. But he included things like animal behavior, habitat, food, bird song. There were all these kinds of things in play. This is at the time when molecular biology is growing in strength and Harvard and other places are laying claim to being able to explain almost everything because of the discovery of the double helix and so on. And it seems like cladistics and systematics were these flowering efforts to expand the range of what could be counted in order to classify something. When you're talking about numerical taxonomy, they were kind of experimenting with expanding the range of what could be counted and what could be measured. Is that a fair assessment?

03-00:58:17
Clemens: I'm not sure. What struck me was the interplay between Michener and Sokal. I think it's fair to describe Michener as a classic systematist but collaborating with Sokal, who was more obviously quantitative in his approach. I can't remember them getting into the use of atypical characters like bird song. In my limited knowledge of the area, this comes later.

03-00:59:28
Burnett: Just to go back to your example with Kermack and the ear bones and the transition, and this is more in your area. The transition from reptilian ear bone to mammalian ones. Were there conversations about the adaptive significance of having three ear bones? I imagine they knew what abilities this confers. Is there a different frequency response for having three bones? Does that give you some kind of advantage?

03-01:00:04
Clemens: This really comes later. My recollection is that getting the morphological transition—

03-01:00:20
Burnett: Establishing that first.

03-01:00:21
Clemens: General statements about acuity of hearing were being made, but they did not really get into that in great depth. That would come later.

03-01:00:36
Burnett: Right. Establish that there are these intermediate transitions first and then you can talk about why that would have been advantageous.

03-01:00:43
Clemens: The search goes on. How many times did this modification occur, in how many different lineages? From what I can see now, at least twice you've got the evolution of the mammalian condition, if not more. I can't rule it out.

These wonderful fossils that are coming from China are broadening our understanding. We can talk about those another day.

03-01:01:17
Burnett: Yeah. Well, why don't we take a break and then we can return.

03-01:01:21
Clemens: Okay.

[End of Interview]

Interview #4 March 25, 2015
Begin Audio File 4 clemens_bill_04_03-25-15_stereo.mp3

04-00:00:07
Burnett: This is Paul Burnett interviewing Dr. Bill Clemens for the William Clemens UCMP Oral History Project.

04-00:00:16
Clemens: {inaudible}.

04-00:00:19
Burnett: It's session four and we're here at the Valley Life Sciences Building and it's March 25, 2015 and this is audio file one. So Dr. Clemens, last we left off you were at Kansas still and I'm wondering if you could talk about some of the work that you were doing there, not just in terms of research but also in terms of teaching and education programs.

04-00:00:49
Clemens: The last interview I talked about the work going on with Bob Sokal and Charles Michener. Here the development of numerical taxonomy in an environment where the Hennigian phylogenetic systematics was beginning to be developed at other institutions. I wanted to be sure to mention that that wasn't the only thing going on at Kansas. Charles Leone in the zoology department was beginning to experiment with biochemical immunological techniques for determining degrees of relationship. Go across the street from the zoology building in the offices of the Kansas Geological Survey, there were Ray Moore and Curt Teichert, eminent paleontologists, geologists. There was a chance then to get into that aspect of the field. Talk to people with whom you could bounce off ideas. The program in physical anthropology was an interesting program. Bill Bass was my colleague and also a neighbor in Lawrence, Kansas. He's noted for his body farm.

04-00:02:27
Burnett: Right, of course. Used by the FBI.

04-00:02:31
Clemens: Used by various police agencies. I remember talking with Bill about how long in a certain environment would the flesh remain on a cadaver and all that kind of thing. And then there was Carlyle Smith, who had been involved with Kon-Tiki and, particularly, research on Easter Island. So the environment there was stimulating, interesting people doing some interesting things. Also in terms of teaching I wanted to point out that I arrived at Kansas to take the place of Bob Wilson. Bob had been working for a number of years in the San Juan Basin, New Mexico, focusing on Paleocene and Eocene mammals. The first summer there I went out with Russ Camp, who was the preparator in the museum. We went to various collecting localities that he and Bob had found through almost a decade of work there. Now, a change in the program came from our director, who was interested in getting financial support for a summer field course. Basically it was an apprenticeship program where students from various

universities could come, accompany a field program, learn how to collect, learn how to map, and those kinds of field techniques. He garnered NSF support for this. So for my years at Kansas, I had a summer devoted to work in the San Juan Basin. But at the end of the San Juan Basin work, I always took the opportunity to go somewhere else, usually go north and look at localities in Wyoming and Montana. These trips were intended to give the students a flavor of different field areas and add some material to the research and teaching collections at KU.

So the usual drill at Kansas would be at the end of the academic year—my family and I didn't like summers in Kansas—so they would come out to Berkeley to be with our parents and let the grandparents spoil the kids. I'd go back to Kansas and be in the field for a month-and-a-half or two months before going to Berkeley and joining the family. But there again I fell into a very interesting and rewarding program, an NSF sponsored summer institute for secondary school teachers. And I'd teach for a week in that program and one summer when I got back to Berkeley I took on the directorship of the program. So, summers were this melding of field research and educating students and teachers not only in research techniques but talking about what we were doing and why we were doing it.

04-00:06:55

Burnett: Yeah. We could talk about this almost at any point. When you talk about field techniques, were they standardized by the paleontological community at a certain point or are they somewhat dependent on the expert or the university? Is there a UCMP style of collecting and recording that's different from Cambridge or other places?

04-00:07:32

Clemens: Well, I think there's an American and several European styles. Think of our biological sciences library and those *Triceratops* skulls. How do you get those out of the ground? In America collecting a large fossil involves cleaning off the top and around the sides, building a plaster jacket, like a great big cup, an inverted cup over the fossil. Then trying to dig under it so you can knock the fossil off its pedestal and at the same time turn over the cup. Now, our Russian colleagues, for example, have a different approach to collecting a skull like that, and this in part reflects the kinds of field equipment they had. In Mongolia they had great big hulking military trucks and cranes. So approaching the challenge of collecting one of those skulls, they'd dig around it in a rectangular fashion and fashion a crate that would go around the fossil. Then they would fill the interstices between the fossil and the wooden crate with plaster. So you've got this unit, what they call the monolith. With their great big equipment they came in, broke the monolith off its base, turned it over, and lifted it onto a truck. Yes, there are differences. [laughter] But—

04-00:09:28
Burnett: [laughter] I suppose if they're careful with it when they get it to wherever {inaudible} and they bring it into a lab, if they're careful when they chisel away at it, I suppose that's fine.

04-00:09:38
Clemens: Oh, it's just different styles. Later, I was working in Montana with my colleague Harley Garbani, who was a master of collecting large fossils. Although, we were out there looking for microvertebrates, it was in part field training for the students. So most years we'd look for a large bone or a skull. I'd have Harley show the students how to collect it, which involved a lot of digging on the students' part. But, still, it was an apprenticeship. And you can talk about it, you can read books about it, but there's nothing like getting in with someone who's a master at this technique and working with them.

04-00:10:39
Burnett: Yeah. That's something that other students of yours have said about you, is that you really argued that they needed to be in the field to really experience and to really learn. It was very important that you go out with them and do that kind of work. As you said, it's not book learning. It's tactile. It's site specific often. And there's the physical aspect of removing fossils, but I'm also curious about the meaning of a fossil is very dependent, it seems, on where it's found, right? You absolutely have to be precise about that. Can you talk a little bit about the techniques of recording and cataloguing? What kind of work goes into ensuring that a fossils locality will be attached to that fossil for future reference?

04-00:11:53
Clemens: Okay. First of all, recording the locality. The technology here has changed drastically in the last fifty years. When we first started working in the San Juan Basin and also in Montana there were no topographic maps. So the best you could do would be to get aerial photography of the area and put pinholes in the aerial photographs to show where you collected the fossils. That was the best we could do at that time. Fast forward to today, you go out with a GPS and measure latitude, longitude, and also with these new units, elevation. So that you have a very exact, very precise description of the spot from which that fossil came.

Now, in addition, it's extremely important to determine how the fossil and where the fossil occurred in the geological column. This is one of the bases for a number of us being very disturbed about commercial collectors. Frequently they will collect something, it'll show up in an auction, and they won't tell you where they've found it. So you've lost all that contextual information. There it's a straightforward matter of measuring and describing a geological section and placing the point of occurrence of the fossil in that section. And then section after section, the occurrences can be superimposed on your geological map of the area. We begin to get a picture of where these things are occurring, and, geologically, what's their pattern of occurrence.

Then you move to the interpretation of what does that pattern mean. If you're dealing with something like Pompeii, everything under the ash expired at one time. When you are dealing with a channel deposit it is a different story. Where did the bones and the other fossils in that deposit come from? Were they coming from animals and plants that were living along the stream when the deposit was being formed? Were they coming from slope wash, animals that had died sometime earlier and their bones were washed in? Or were the bones being reworked as the stream moved back and forth in this channel, eroding its banks, and mixing things together?

04-00:15:51
Burnett: Right. Is that maddening because presumably—

04-00:15:56
Clemens: [coughs] Excuse me. I need to—

04-00:15:57
Burnett: Sure. I was going to ask if it's maddening because in the channel deposit presumably you can get a large number of fossils deposited in one spot. You have this bonanza but the origins then have to be worked out.

04-00:16:17
Clemens: And we'll see this coming up when we start talking about the work of Robert Sloan and Leigh Van Valen and a predecessor to the impact hypothesis. Stream channel deposits were very important in the way they built up the record that Bob and Leigh interpreted. We see now there was a misinterpretation. This locality that I'm working on now, I can tell you that the time between the channel cutting and the channel filling was on the order of 500,000 years. Now, just when the animals represented by the fossils in the channel were living is an open question.

04-00:17:27
Burnett: Right. And they could be cut out of rock that was millions of years above other specimens that were washed out from another level.

04-00:17:38
Clemens: And then if you want to throw in a another factor, consider crocodiles. Basically, how does a crocodile keep its rump underwater and keep it from getting sunburned? They pick up and swallow stones. In a modern context they'll pick up rebar or pieces of brick. These are held in the stomach and serve as ballast. So if you've got crocodiles in your deposit you begin to wonder, was this fossil something that a croc picked up far away and happened to die and redeposit in your channel filling? There used to be a beautiful exhibit in the Natural History Museum in London. It may still be there. It showed the contents of a Nile crocodile's stomach; bones, rocks, and a little pile of blue beads.

04-00:18:51
Burnett: Wow.

04-00:18:52
Clemens: And with a typical British—what shall we say—approach, there was little sign by the beads saying, "It is not known whether these were worn when ingested." Lovely. So, yes, there's a whole variety of things you have to record and interpret. It isn't just a matter of going out and picking up a bone and saying, "Wow, here it is."

04-00:19:29
Burnett: Yeah, yeah. And in reading your writings, there's a certain humility in the approach. The appearance of this fossil may be linked to this other deposit. You're very careful about scientific certainty. You want to be certain about your uncertainty, in other words. That seems to be part of your approach that others have said is particular in your case. That as a scientist you are very careful about what you say for sure, about what you—

04-00:20:09
Clemens: You have to be. In a way, that's a wonderful testimony. We have the Miller Institute here on campus that brings young scholars to campus for, what, one-year or two years as a post-doc. One of these wonderful scholars was Anna Kay Behrensmeyer. In her PhD research Kay had focused on this matter of taphonomy. What happens to the carcass after death and before deposition. And she was here for two years. She really got a lot of us thinking about taphonomic history. It's something everyone has to deal with now in terms of the field excavation and analysis of fossil localities.

04-00:21:31
Burnett: Whereas before there was just a lot of collecting of the fossils and then trying to understand the morphological features of the fossils themselves. There's much more attention now paid to where the fossils are found, what the possible conditions of deposition were in order to really date and position that fossil precisely, as precisely as possible.

04-00:21:57
Clemens: I think that's fair. My estimate is that invertebrate paleontologists were ahead of us in really getting into studies of taphonomy and in part had wonderful laboratories in the sense of mudflats with lots of dead individuals. One was a laboratory in Germany up on the North Sea. You could begin to see patterns. It was an early example of this kind of research, which if I'm correct you can trace back to Russian origins, with questions being asked by—oh, gosh, I think it was Efremov who really began to focus on taphonomic questions.

04-00:23:21
Burnett: Okay. And so this becomes part and parcel of teaching, this inculcating a sense of meticulous practice and a humility in your approach to collecting and analysis. But also fun, too, I imagine.

04-00:23:47
Clemens: Oh, yes.

04-00:23:49
Burnett: That's what everyone says, as well, is that there's—

04-00:23:52
Clemens: There's an adrenaline surge when you see, oh, there it is. Yes.

04-00:23:57
Burnett: There's detective work involved, there's puzzle solving. I was reading about screen washing, which becomes a real signature approach of UCMP and you're introducing this to new localities, as well, up in Edmonton and around sites in Edmonton. And I think you wrote that for a hundred pounds of rock screen washing you would be lucky to get one fossil. But a good site, a very good site, you'll get one every twenty-five pounds and that will be a rich deposit.

04-00:24:42
Clemens: Okay. I was focusing on mammal teeth.

04-00:24:44
Burnett: Okay, right. Fair enough.

04-00:24:47
Clemens: And there would be this wonderful background noise of fragments of mammal skeletons, salamanders, of course, fish. The richness of localities definitely varies. I think you screen wash a deposit to the extent that you're getting material answering your research question, so that what might be very slim pickings in one instance would be justified in terms of what you're trying to do. The whole technique, it's over a couple of centuries old, but it was instituted in North America by Claude Hibbard at Michigan, and formerly of Kansas, and then Malcolm McKenna. Malcolm put it on an industrial scale in the size of those operations. And you've got to give Malcolm the full credit for really showing what could be done and encouraging people to use that technique.

04-00:26:29
Burnett: And it's produced extraordinary results. That part of the world has produced such a rich collection that made all kinds of other subsequent research possible and the analysis that you were doing at the time, as well. So just to return back to the summer programs that you established. This was to introduce them to some of these kinds of techniques that you were doing and, to, I don't know, give them a little bit of inspiration perhaps.

04-00:27:01
Clemens: Yes. I remember one student who joined the Kansas field crew and had never been out of Kansas. "What are these Rocky Mountains? Are we driving up there? That's a steep cliff on the other side of the road." There was a chance on weekends to go to Mesa Verde National Monument or Chaco Canyon. Yes. I was also trying to advertise the west.

04-00:27:44
Burnett: Yeah. A sense of wonder.

04-00:27:47
Clemens: A sense of wonder. It's not all flatland with a grain elevator every ten miles. So that was part of it. Yes.

04-00:28:01
Burnett: Yeah. Opening new vistas for young people. Right. And whether it ends up being paleontology or something else, they're being exposed to new things and experiences.

04-00:28:11
Clemens: Yes, that was a lot of fun.

04-00:28:14
Burnett: Oh, great. Right.

04-00:28:15
Clemens: Yes, but then it came time to leave Kansas. Why did I leave? First of all, the attraction of Berkeley. There was a diversity of academic interests at KU but compared with UC Berkeley, the diversity was greater here. There were people at Kansas who were extremely intelligent, productive scholars. Their peers were here, but there were more of their peers in Berkeley. There was the attraction of having a department and museum of paleontology where vertebrate and invertebrate paleontology as well as paleobotany were all in the same group and well-supported by preparation facilities, artists, and so on. All this was in the same building with the geologists and geographers. So those were major attractions for me. And, also, I must say there were family considerations. Both my wife's parents and mine were still living in Berkeley. We profited personally from the Berkeley school systems and wanted our kids to have the same opportunity. There was that interesting consideration of the late 1960s and the early seventies at Berkeley. The "quiet times," if you will, but we figured we'd adapt, and we did.

04-00:30:24
Burnett: Well, you were witnessing that the entire—because you were going back in the summers {inaudible}.

04-00:30:30
Clemens: I saw a little bit each summer.

04-00:30:31
Burnett: There was free speech. These other movements were just multiplying, it seems, at the time. And so you returned. Did you return in the summer of love? Is that right? [laughter] Was that 1967? That may be.

04-00:30:50
Clemens: It may be. I don't know. But we returned and settled here very happily. Our two daughters had been joined by a third daughter while we were in Kansas.

The first semester I was here, taking a class field trip out to the foothills of the Sierras, my son was born. They tried to hold him back until I could get back to Berkeley. It didn't work. [laughter] So we got settled here.

A couple of days ago I was reading an annual report of the museum trying to see how they justified my hiring. What was I supposed to do? Now, R.A. Stirton, "Stirt," had passed away unexpectedly. He had gone to an American Society of Mammologists meeting in Los Angeles and died of a heart attack. So in part I was hired to help Don Savage and Joe Gregory with undergraduate and graduate teaching in the area of vertebrate paleontology, which was a new challenge. I'd been teaching vertebrate paleo at Kansas but to a different group and in different circumstances. A second thing they expected me to do was to help with the computerization of our catalogues. Now, this was a project started in the beginning of the sixties by Bill Berry, an invertebrate paleontologist on the faculty. By the time I got here it was a matter of helping in proofreading and that kind of thing. The die had been cast. We were moving ahead and would move ahead and continue today with that project.

04-00:33:51
Burnett: And so initially I guess there would have been a computing services division at Berkeley that would have mainframes and the museum would get time on that? They would have someone doing data entry or many people perhaps doing data entry.

04-00:34:09
Clemens: I remember we were using Hollerith cards with, what was it, eighty-three columns. So the first challenge was taking your catalog data and, using an awful dictionary of abbreviations, get them punched into the Hollerith cards. And then, yes, there were campus facilities for the actual manipulation of the catalog data. But you look back at it, it was archaic, but it was the beginning. Not too many years later two of our graduate students developed our first website

04-00:35:07
Burnett: One of the first, wasn't it, of its kind?

04-00:35:09
Clemens: I understand there's controversy about where it stands in the first ten. But yes, Rob Guralnick and David Polly, who you'll meet, were instrumental in doing that.

04-00:35:29
Burnett: And I suppose just a succession as the technology changed and people went to mini computers and then later personal computers and backed stuff, backed up on the server. You had to transition the data.

04-00:35:43
Clemens: As I see it, and remember, I was just one of the minor cogs in the machine, the transition really came with expanding the content of the database, going from these awful abbreviations into being able to use full words. Then there was an evolution of the programs used to manipulate the data. We were able to ask questions of some complexity. Where do you find this animal? Or do you find this animal in the Eocene of North America, that kind of thing. And then there were at least two or three generations of programming. Now it's amazing what can be done handling these data. So I think looking at the museum's history, this is one of the important achievements that the museum staff accomplished since 1960. It's really great.

Now, in addition to being a computer expert? No, I only took a course in COBOL when I was in Kansas.

04-00:37:38
Burnett: Well, that was something back then.

04-00:37:38
Clemens: It was something back then.

I was asked to continue my research in the area of Mesozoic mammals. And at that point two of the three volumes on the Lance mammals had been published, and we had that collection here. My first PhD grad student, Jay Lillegraven—and I hope you can get an interview with him—was working up in Alberta. It was 1963 when our colleagues in Alberta held a field conference. A new professor in the zoology department—yes, he was in the zoology department—decided to publicize Al Romer's *Vertebrate Paleo*. On that field conference a specialist on Paleozoic fishes, Stanley Westoll found a mammal jaw. That was the discovery of what turned out to be a major deposit of Late Cretaceous mammals. And Jay, who was a student of mine at Kansas, undertook the study of that deposit and several others that he found subsequently. So now we have the Albertan material that Jay analyzed.

And then in our fieldwork in the San Juan Basin, in addition to collecting more Paleocene and Eocene mammals, we discovered Late Cretaceous mammals. So there's that block of three fossil sites and their faunas. It was beginning to be the foundation for a real study, a broad study of the fossil vertebrates of the Late Cretaceous in the Western Interior.

Also I was expected to work with Dick Tedford, who was at the American Museum, Mike Woodburne, who was at UC Riverside, and Mike Plane, who was employed by the Australian Geological Survey. All three of them had been students of Stirton's. They were involved in research on Tertiary faunas of Australia. I was asked to see to a winding up of Stirton's work in such a way that Mike Plane, Mike Woodburne, and Dick Tedford, could move on. So how do I handle that?

Well, one other thing about my hiring. I left Kansas after six years and forfeited a sabbatical leave. So as part of the package it was agreed to let me take a year off on my second year here and go on leave. It was understood that I had to find the funding for it. So that was the setup. It led to some interesting challenges. They were a very busy first couple of years at Berkeley.

04-00:42:42
Burnett: Were you casting about for various different kinds of funding or to—

04-00:42:46
Clemens: Oh, yes, academics are beggars. Come on. You go for it for different reasons.

In terms of what was going on at UCMP in 1967—the dominant pattern in research involved fieldwork. Don Savage had already begun his work with Garniss Curtis and Jack Evernden on the chronology, bringing potassium/argon age determinations into stratigraphy. He also got interested in applying these techniques to sites in Italy and France. Later he spent a year in France with Don Russell working on the Eocene, the Paris Basin. Joe Gregory really had two major arrows in his quiver. One was the history of science. The other was an interest in the desert southwest. There, he was building on the work of Charles Camp and Sam Welles and his research did have that field aspect to it. Also Wyatt Durham in invertebrate paleontology had an active field program. One of the areas where he was very active and interested was in the White Mountains of California and Nevada and some of its curious early Paleozoic animals. Additionally there was still the spirit and active participation of Ralph Chaney and collecting Tertiary floras. Harold MacGinitie, who had retired, came to Berkeley. He was another paleobotanist, and we were tied in with Dan Axelrod at UC Davis. So, again, there was this field collection based type of research, contrasting with what I see today. What you're finding today is that, yes, this kind of work still goes on, but there are also folk who are not going out and collecting new material. They're going back into collections, finding material that pertains to different research questions or material that was overlooked—not intentionally overlooked. If you're looking for mammal teeth, you find mammal teeth. But just shown recently, if you're not particularly interested in the bones of the ankle they are not regularly picked out of the screen washing residue. One of Greg Wilson's students is now looking at limb bones of animals that lived in the Late Cretaceous and Paleocene that she picked out of the residues. Stephen Chester at Brooklyn College and Jon Bloch at University of Florida came out here about a year ago looking for the ankle bones of *Purgatorius*, an early primate. Going through the residues, they found some, which resulted in a nice publication and commentary about the mode of locomotion of this early primate.

What you're seeing now is a third level. Big databases are being created and made available electronically. There are colleagues who are starting with the databases. They analyze the data and ask questions about patterns of change and patterns of relationships. Looking at what goes on or has gone on at

Berkeley, there's been this gradual morphing, if you will, from going out to find fossils, describing them, and analyzing them, to reanalysis of material in our collections. Now there are analyses of databases reflecting the content of the collections. It's really quite exciting to see what comes out of these different levels. It's not to demean any one of them, but just sit back and enjoy what's coming out of these studies.

04-00:49:24

Burnett: One assumes that the reasons for the shifts include availability of new technologies. So the arrival of big data means that you can do these kinds of analyses. Processing power makes it possible. And so people do it. Another piece of it, I'm sure, is the decades of collections work that made those lab analyses possible. So it's the credit of your generations, before you and after you, that were getting the stuff from the field to make collections based research possible. I'm not asking you to demean or celebrate any particular technique. Are there costs at all involved in doing research just using software analysis exclusively? To put it another way, if you were implementing curriculum today here at UCMP, would you make it a requirement that people go out into the field in order to receive a doctorate in paleobiology or paleontology?

04-00:50:52

Clemens: I think field experience is important. If you're going to be working at that third level you ought to have an appreciation of the sequence of development of your data. We're doing that today. Seth Finnegan, a member of our faculty, this week is with a group of students, undergraduate and grad, on a field trip down into southern California looking at vertebrate and invertebrate localities and dealing with stratigraphic problems. Some of those students probably never will go in the field again, and they'll do excellent research based on databases. But at least they know, they've had the experience, of seeing where their data are coming from. No, I think it's very important, but it need not be four months in the field collecting. An appreciation for what's involved in collecting, and what's involved in the analysis of deposits, are, I think, terribly important.

04-00:52:29

Burnett: So maybe we should take a break.

04-00:52:31

Clemens: Okay.

04-00:52:36

Burnett: This is Paul Burnett interviewing Bill Clemens for the UCMP Clemens Oral History Project and it's March 25, 2015, and this is audio file two. So we were talking about the importance of fieldwork for students in their education, their formation. But fieldwork was also very central to mid-career professors of paleontology. So perhaps you could talk to us about some of the fieldwork and collecting that you were doing at the beginning of the seventies.

04-00:53:13
Clemens: Okay. As I was saying, the research pattern around Berkeley late in the sixties involved going out collecting material related to a particular research question or going out, collecting, and then seeing what research questions were inspired by the collections. Now, this meant going prospecting. In the summer of 1970 Don Savage organized a field campaign. Let's call it a campaign.

04-00:54:04
Burnett: Sure.

04-00:54:07
Clemens: Enrolling Joe Gregory and myself to go out and collect with the goals of finding areas that would be interesting, provide interesting questions and interesting material. We were out for about two months. The composition of the field crew varied. On average there were about ten or twelve of us with students from the department sort of phasing in, and phasing out. The trip went from Berkeley up into western Montana, then up to the Fort Peck region, then back down into Wyoming, winding up at Bitter Creek, which is in south central Wyoming. From there we went on to the Dragon Canyon area in Utah, and then down to the San Juan Basin, New Mexico, where the group made collections at some of the classic localities. Then, on the way back to Berkeley a number of the people stopped at localities in Nevada.

Now, you couldn't make a trip like that today. Most of the collecting was done on state and federal land. We did not have any permits. The government just didn't care provided we didn't light forest fires or that kind of thing. The only contact we had with a government agency was with the Corps of Engineers. At that time the Corps operated Fort Peck Reservoir. The chief engineer was Don Beckman. You couldn't keep him away from fossils. He really was interested, and he wanted to promote research in his area. The big adult *Triceratops* skull in our library was found on that trip in badlands adjacent to the reservoir. How do you get a thing like that back to Berkeley? Well, Don and the Corps of Engineers took care of the job. They picked up the casts containing the skull and took them to their warehouse. Then they boxed them up—

04-00:57:04
Burnett: Did they?

04-00:57:05
Clemens: —and shipped them.

04-00:57:07
Burnett: Really?

04-00:57:07
Clemens: Yes.

04-00:57:08
Burnett: You were joking earlier about the Soviet Union's military trucks and how they dug their stuff out. But as it turns out the military was helpful. Or not the military but the Army Corps of Engineers was—

04-00:57:20
Clemens: Corps of Engineers.

04-00:57:22
Burnett: —helpful.

04-00:57:23
Clemens: Don was. Through the years in our work out there, as long as Don was alive. When he was with the Corps, the Corps was most cooperative. When he retired from the Corps he couldn't keep his fingers out of it. He'd loan us a boat and an outboard motor or find this or that through his local connections.

04-00:57:52
Burnett: Yeah. It's the importance of allies.

04-00:57:54
Clemens: Oh, yes.

04-00:57:56
Burnett: And you need to have folks who can help. It's hard to do this work in these isolated areas. You need contacts, you need friends, you need good relationships.

04-00:58:07
Clemens: Oh, very definitely. And Don is a prime example of not a landowner but still a land controller, like a rancher turning around and just being so cooperative. So that was great.

The collections made on that trip opened up a number of research projects. Not my work in northeastern Montana but particularly in the Bitter Creek area in Wyoming. Don Savage started work there looking at the pattern of change of the vertebrate faunas through the Eocene. For years he was deeply involved in that research. Now Pat Holroyd, one of our collection managers, and, starting this summer, a post-doctoral student will be continuing Don's work on the pattern of evolution related to climate change at the Paleocene/Eocene boundary.

There have been a couple of other research projects that came from material collected on that trip. I'm so glad we did it, the trip was an eye-opener, I think, for everyone who went along. It has fostered a lot of research beyond just the basic description of the animals.

04-01:00:08
Burnett: It was initiated or directed by Don Savage? Because it sounds like a Don Savage kind of project.

04-01:00:21
Clemens: It very definitely was.

04-01:00:23
Burnett: Peripatetic.

04-01:00:24
Clemens: Yes.

04-01:00:25
Burnett: Going from place to place. And it's prospecting work. So it's a different kind of feel to it, where I imagine the project is about sampling. Right? You go to an area where you think you're going to have good finds and you sample and move on. Is that how it works?

04-01:00:50
Clemens: Yes, that's a very fair description. Well, with Bitter Creek, for example, in following summers, going back, and really having a chance to see what could be done and what questions could be addressed. It grew into a multiyear project, but you have to make that first discovery. That was really the purpose of that trip.

04-01:01:43
Burnett: I guess you had some inspiring examples of Harley Garbani and these other folks who just seemed to have a nose for finding these localities. You need geology to sort of know and you proceed by analogy. So if there's this strata on this side of that mountain, it is rich for fossil X, you can reasonably expect to find something like it on the other side. Is that the kind of work that you would do detective work wise?

04-01:02:23
Clemens: That's an aspect of it. Another aspect is to read the geological reports on areas. In the reports of the US Geological Survey, geologists noted the occurrence of fossils. Once they had enough material to establish an age for a deposit they moved on. So just combing through the old literature gives you hints as to where fossils might occur. In terms of old literature we were going back to areas where fossils had been found fifty years or more before. Well, in fifty years you get a lot of erosion exposing additional fossils. It's not as rich as being there as the first paleontologist, but still, you have these hints as to where to go. I think the generality is that you just don't throw a dart at the map—

04-01:03:57
Burnett: Yeah, I know.

04-01:03:59
Clemens: —and go there and start looking. Either the geology is suggestive, or past work indicates there's something there. These are the kinds of things that sort of direct your search.

04-01:04:18
Burnett: And as you said in an earlier interview, you talked about blow-outs and sometimes there's just evidence on the surface that will lead you in the right direction and there are other indications in channel deposits and so on. But I think it's absolutely fascinating the initial detective work to sort of find rich areas. The other aspect of it, I imagine, is that you can return to an old area with new techniques. And I don't know if that applied in your case because you said you weren't finding fossils for your projects necessarily. But you could conceivably apply screen washing techniques to a locality that had just been prospected for big bones and you could find a whole new scale of fossils there.

04-01:05:14
Clemens: Sure, yes. I think in the San Juan Basin you have an example of that. When I was working there in the sixties we just couldn't get a big washing project going. The river that was available to us, the San Juan, runs through a populated agricultural area. We took our washing boxes up there and set them in the river. Curious people came along and asked, "What's this?" and then say, "Oh, here's some wood. I can use it for kindling." We just couldn't get anything going.

04-01:06:12
Burnett: So people would break down the boxes and—

04-01:06:14
Clemens: Well, we'd see them disappear. Now, Tom Williamson and his associates at Albuquerque, truck the fossiliferous rock down to Albuquerque and have a washing facility set-up at the museum. So they're finding new things, getting an idea of the microvertebrate fauna that we couldn't have gotten because of the nature of our project. So, yes, things change. Application of new techniques or the new application of existing techniques can change things around. Yes. That was the summer of '70.

In the summer of '71 I filled my commitment in terms of completing Stirt's work in Australia. Mike Woodburne, one of Stirt's students who was then on the faculty of UC Riverside, and I went to Australia with Colin Campbell, who was a graduate student here at Berkeley, and Mike Archer, a Yank who was studying in Australia. Mike is still in Australia, and become quite a prominent vertebrate paleontologist involved with research on the Riversleigh collections. The Riversleigh area is up in Queensland and includes a whole series of ancient cave deposits of different ages that give us a sample of what was going on up there in warm temperature tropical regions.

But anyway, the four of us met in Adelaide and joined a group from the South Australian Museum. We went out along the Birdsville Track and collected at two major localities that Stirt had found but hadn't really been able to collect representative samples. In a little over a month we collected those samples and returned to Adelaide.

Work in Australia was a new, enjoyable experience. I remember getting to Adelaide and unloading our stuff into the back of a truck. We climbed in, started driving into Adelaide. I looked around and said, “There must have been an escape from the aviary at the zoo. Look at all these birds.” Soon I learned a little bit about the magnificent diversity of the avifauna.

04-01:09:58
Burnett: Can I ask—it can be this example from the Australian work. But you were asked to do it as part of helping close off the research programs that were led by—

04-01:10:09
Clemens: By Stirton.

04-01:10:10
Burnett: —by Stirton. Have there been cases in your career where you got pulled in an unexpected direction? Someone had asked you to do something or you took over for somebody or you taught a new class that you had been asked to do that made a light go on in terms of your own curiosity, your own projects? Did you get influenced in unexpected ways by these kinds of chance occurrences? We can—

04-01:10:50
Clemens: There are a number of these incidents of the unexpected. I’ve talked about Jay Lillegraven and his work in Alberta on Late Cretaceous mammals. You look at his doctoral dissertation, and there’s a second section on the evolution of reproduction in marsupials. Jay introduced me to that area of interest. I really haven’t continued following what’s going on in terms of research on marsupial reproduction, but it set the stage for my current interests in the evolution of developmental patterns of dentitions, an evo-devo approach. You talked with Greg, and I hope he mentioned his time in Helsinki.

04-01:12:06
Burnett: He sure did. Yeah, yeah.

04-01:12:08
Clemens: That kind of work is fascinating. It gives us a whole new perspective on the origin of variation in morphology of teeth and development of the dentition. So yes, you sort of fall backwards into these things, and you never know where they’re going to come out.

04-01:12:36
Burnett: You mentioned evo-devo, evolutionary developmental biology. You talked about searching for funding when you came to Berkeley in ’68-69. They said if you can generate extramural funding you can go and do an academic leave. So we didn’t talk too much about what you ended up doing in ’68-69. So can you talk about that? Yeah.

04-01:13:08
Clemens: Okay. Well, that comes a little later. Let me talk about the summer of ’72 and then we’ll get to—

04-01:13:24
Burnett: Then we can go back to—

04-01:13:27
Clemens: My start-up package.

04-01:13:27
Burnett: Yeah, yeah. That’s right.

04-01:13:30
Clemens: The summer of ’72. Actually, the story starts in the spring of ’72. No, it goes back into the 1960s. Reid Macdonald, a graduate of Berkeley, was the curator of mammals at what was then the Los Angeles County Museum, now the Natural History Museum of Los Angeles County. They had a number of large exhibit halls. In a couple of publications, and I suspect many times verbally, Reid said, “Well, why don’t we have a *Tyrannosaurus* skeleton here? We’re supposed to be a big-time museum. We need a *T*-rex.” William T. Sesnon was a member of the Sesnon family, which became quite wealthy dealing in Southern California real estate and other things. He also was a member of the museum’s board. I’m just not sure why, possibly to get Reid off his back, Sesnon said, “Okay, I’ll fund twelve months of fieldwork so you can go out and find your *T*-rex.” Harley Garbani, when he came back from World War II, became a master plumber. Harley grew up near Hemet, in an area where there were all sorts of archeological materials to be collected.

04-01:15:47
Burnett: And where was this? Hemet?

04-01:15:47
Clemens: Hemet is in Southern California to the southeast of San Bernardino and Riverside. Harley also got interested in collecting fossils in the area and bringing them to the county museum for identification and then donation. Reid hired Harley to go out to Montana to find a *T*-rex. According to Harley he was very specific. “You go out and find a *T*-rex.” Sure, why not, this was the area, the valley of Hell Creek, where one of the two skeletons of *Tyrannosaurus rex* that were discovered by Barnum Brown had been found. That was a logical area to get started. In the course of several summers Harley found, not unexpectedly, lots of material of *Triceratops* and some rather beautiful hadrosaur material, including skeletons of young ones. Also he found his *T*-rex.

Harley and his crews were prospecting the very top of the Hell Creek Formation. In that area the very top is latest Cretaceous in age, but to get from one outcrop to another conveniently you had to go up and cross over some Paleocene strata. In one instance, trying to take a shortcut between one Hell

Creek deposit and another, one of the young men on his field crew happened into an area that was just littered with bone, a Paleocene deposit. And they did a little screenwashing and found mammal teeth. Later, the next spring I got a call from Dave Whistler who was a curator at the Los Angeles County Museum. Dave is a graduate of Berkeley. Dave asked, "Bill, would you be interested in some Paleocene mammals from Montana? Harley's found some. Would you like to go out and see the locality?" So that summer I took two students from here, and we went out to meet Harley. Yes, the locality was just loaded with fossils. This is what we now call a Garbani locality. A wonderful, unique occurrence of early Paleocene mammals in that area.

04-01:19:22
Burnett: And were they so concentrated because there was a channel deposit? What accounted for the fact they were in such high concentration?

04-01:19:28
Clemens: At that exposure you're at the bottom of this massive channel deposit, and roughly the lower two meters are fossil rich. You get higher in the channel there will be little areas where you get concentrations of vertebrate fossils, but the major deposit or the major occurrence is at the bottom of the channel. Here, speaking of the channel, it's a complex of fillings and we don't know the duration of formation of these channel deposits. We don't know what's been reworked into all this. But, still, it's a wonderful insight into what was living in that part of the Western Interior soon after the mass extinction.

04-01:20:56
Burnett: Okay. So it's a band of a couple of million years?

04-01:21:03
Clemens: We can say that between the cutting of the channel and its filling probably 500,000 years elapsed, maybe a little less. Now, note the simplifying assumption: one cut, one fill. That's almost certainly wrong. But, still, when you think about the precision of the age determinations, we're really getting down not to the standards of modern ecology but still cutting things finer and finer. Of particular interest is seeing how the fauna of that area developed, evolved after the extinction marking the Cretaceous/Tertiary boundary. Well, from that introduction you have a field project that continues to go on. Greg Wilson has talked to you about the kind of work he's doing with the mammals. We're getting studies of comparable detail concerning the salamanders, lizards, frogs and turtles. One of the exciting things right now is working with members of the Berkeley Geochronology Center. There, particularly Courtney Sprain, a graduate student of Paul Renne's, has been sampling the abundant volcanic ashes in the Paleocene section. I never thought I would be able to talk about subdivisions of the first million years of the Tertiary. But with the argon-argon age determinations and all sorts of other interesting geochemical analyses, as well as the paleomagnetic analysis, it's providing a wonderful temporal framework in which to analyze the patterns of change of the fauna.

04-01:24:19
Burnett: And you can sort of triangulate between certain kinds of evidence? If the paleomagnetic tells you it's within a certain range and you can get further precision? If you're lacking one really easy tool you can use several different kinds of evidence to come to a reasonable —

04-01:24:39
Clemens: In a perfect world you could, but you're dependent upon what's available in the outcrop. There is a switch in the magnetic field roughly in the middle or near the middle of the first million years. So picking up that change from reverse to normal in a number of sections gives you a nice timeline. Then the initiation of the first part of the Paleocene in this area was reflected in the development of a series of coal swamps. Somewhere to the west was a very active volcanic field or fields. So as the ash was distributed eastward it fell in coal swamps where it was preserved. Where it fell on open ground, it just got blown away and mixed in with the soil. So where we have coals with ash in them, Courtney and her colleagues up at Berkeley Geochron are usually able to get a radioisotopic age determination and they talk about error bars of 10,000 years or 20,000 years.

04-01:26:30
Burnett: Yeah, it's extraordinary.

04-01:26:35
Clemens: It is. Yes.

04-01:26:38
Burnett: Yeah. Very different from what you had to work with before.

04-01:26:41
Clemens: Oh, yes.

04-01:26:42
Burnett: Could you give us a sense of the magnitude of this find in '72 with respect to other discoveries? You mentioned in the late fifties, in '59, I think, when you made that discovery and the work that you did over two summers equaled all of the fossils that had been collected in that area up to that point. So that gave me a real perspective on the importance of the collection that you and others had done in the late fifties. How important was the early seventies find for the collecting of certain kinds of fossils?

04-01:27:27
Clemens: Okay. In terms of sampling—I have to be very careful here. Sampling a series of faunas of earliest Paleocene age in the Western Interior, there are other areas where you get material of this age, like the San Juan Basin or up in Alberta. Now, some colleagues in North Dakota will pooh-pooh this, but I think the material from the area that we have worked since 1972 probably stands as a very significant addition to our knowledge of what occurred right after the boundary. As significant as finding the Lance was to letting us know what was living just before the boundary in Wyoming. Yes. Now, in part this

is the result of—what's it now, '72 to 2015? How many years is that? Almost forty-five years of hard work and a lot of people involved. What, five or six doctoral dissertation research projects have been completed. So a real understanding of what's going on is beginning to be developed.

04-01:29:31

Burnett: Right, right. I guess for perspective, too, the late 1960s is the great expansion of the American research university and the public universities. Enrollments go through the roof. And I imagine that that has an influence on paleontology. You mentioned that you could put all the experts on vertebrate paleontology in a room in the 1950s and they could all talk to each other. But by the 1980s, nineties—

04-01:30:06

Clemens: In 1965, when I was at Kansas, my colleague Ted Eaton and I hosted the annual meeting of the Society of Vertebrate Paleontology. It was a spectacular success. The attendance was over 100. Yes, it was a small profession which had its advantages and its disadvantages. By the seventies more people were getting involved. Paleontologists were finding different kinds of ways to support themselves. It wasn't always, "Well, I have to be at one of the big museums." And in part you were beginning to see the rise in membership. It would really become apparent—oh, I'd have to go back and look at the figures on attendance of annual meetings but my feeling is it's in the eighties when the membership really started expanding.

04-01:31:32

Burnett: Yeah. And there's tremendous education and outreach. UCMP becomes really instrumental in that during the 1970s, as well. And I'm thinking of the natural history in the nineteenth century. Paleontology, which was just natural history then, it was big science, right. It was about discovery of these new worlds and discovery of deep time and all of these things that were new. And in the twentieth century it became somewhat marginalized as the hot wonders of physics, of particle physics, high-energy physics and the life sciences and so on perhaps marginalizes paleontology so it becomes this small subset. I have a feeling that is not very well substantiated by the historical record but I have a suspicion that in the seventies there's a kind of a recrudescence of paleontology in the public mind, of a fascination with dinosaurs. It never went away but it seems to have become more significant and then just grew and grew.

04-01:32:54

Clemens: Well, certainly the asteroid hypothesis contributed to that growth of interest. I'd have to go check to see what was going on in the seventies. We don't have records of what kinds of magazines were available in grocery stores to—

04-01:33:17

Burnett: I'll do some research and get back to you on that. I know from my own childhood that I had enough dinosaur books when I was a kid in the mid-

seventies and can testify to the importance of it in that aspect of the popular imagination for young kids.

04-01:33:39
Clemens: Yes, and there has been some research by sociologists and developmental psychologists about why kids love dinosaur names. I really haven't followed enough to comment on it. Let me move onto this start-up package.

04-01:34:13
Burnett: Yeah, sure.

04-01:34:17
Clemens: The international aspect of my work goes back to the Army when Dot, my wife, and I were able to visit a number of museums and meet a couple of the paleontologists then active in Europe. Then there was my post-doc in London. So when I came up to using this one-year off after spending a year here in Berkeley I said, "What the heck, let's go back." Two things caught my interest. One was the work that Percy Butler had been doing. Percy got started in the 1920s. He was really interested in the development, the evolution of developmental patterns in mammalian dentitions. Although there had been in some of the theories of the late-nineteenth and early-twentieth century, a little bit of embryology involved in trying to understand the development of teeth, it really hadn't gone anywhere. Percy was looking at developmental patterns from largely a descriptive viewpoint. On one hand he was looking at the modes of occlusion of upper and lower teeth in primitive mammals. But also there was a thrust in looking at the embryology of teeth in modern vertebrates, particularly mammals. A number of studies had been based on pig embryos. When did the developing tooth bud, become fixed as going to develop as a premolar or a molar? Once fixed could you excise the tooth bud, turn it around, and develop in the same pattern except reversed in orientation?

One set of experiments and observations intrigued me. If you look at the dentition of bats, particularly the small bats, the microchiroptera, they have very high cusps and a very complex occlusal pattern in the adult. Well, what Percy and one of his students were able to show is that that occlusal pattern started to develop in the tooth buds, the germs, of the upper and lower teeth, even though they were physically separated. So that by sacrificing young bats at different stages of development and making models of the developing teeth, they found the models occluded nicely at whatever stage of development. Now, what was controlling this, the correlation between upper and lower dentitions? It wouldn't be until later that we really got a handle on what's going on, but I found that the correlation was an intriguing aspect of Percy's work.

Then with Kenneth Kermack and his colleagues, again getting back, they were going into the fossil record and looking at an animal called *Peramus*, which was one of the early forms. It was a late Jurassic animal, say 135 million years old. It was just beginning to show the development of a complex interlocking

between upper and lower teeth. There was material in the British Museum (Natural History) and some material up at Oxford that pertained to this study. So I worked on that with Bob Mills (J.R.E. Mills), who was an interesting colleague of Kermack's. He was a practicing dentist. In fact, taught dentistry at—oh, gosh, I've forgotten the name of the college but there in London (Institute of Dental Surgery, University of London). Bob was really interested in occlusal patterns. Well, here's a guy with experience in orthodontics. If he didn't get the occlusal patterns right, the patient let him know about it. He was extremely perceptive in that area.

The second NSF post-doc really paid off in terms of both developing an interest in development and getting involved more deeply with the fossil record of the Mesozoic mammals in Europe. A number of years later the biogeography of Mesozoic European mammals was the subject of my research when I received a Guggenheim Fellowship. And a variant on that bought the Alexander von Humboldt senior scientist award. So chatting with my wife, she noted , "Okay. Two themes run through your professional work. One is devotion of summers to the field, except on summers when we're overseas and then you have that theme going." And, I must say, these themes have been and continue to be very rewarding.

04-01:42:52

Burnett: And so the Humboldt Prize was in recognition of part of the research that you were doing on the paleobiogeography of European Mesozoic mammals?

04-01:43:07

Clemens: I picked some ancient collections, ancient in the sense of when they were collected. Some material came from the area around Tübingen and the material from Switzerland came from an excavation in a vineyard near, Schaffhausen, there on the northern border of the country. Both needed to be reanalyzed, and those were the research projects supported by the Humboldt.

04-01:43:52

Burnett: And the prize committee sort of identifies the contribution that's made. What do you think you brought from your long research in completely different eras—now you're talking about Triassic mammals and your area of expertise is mostly the Cretaceous and early Tertiary. What is your Clemens way of seeing that brought new blood to this story of Triassic mammals from Germany and Switzerland do you think?

04-01:44:40

Clemens: You'd have to ask them. At Munich they had a long interest in the Solnhofen deposits. The first fossil of *Archeopteryx* discovered is in their collection. It's a feather but it's the first fossil of that bird-like dinosaur to be found. I brought something different to the institute, a wild-eyed American from Berkeley. [laughter] But no, the year before I was given this award—I won't say I was interviewed—I met the director of the institute [Bayerischen Staatssammlung für Paläontologie und historische Geologie], Professor Dietrich Herm at a

paleontological congress in the United States. We talked about the possibilities of working at Munich for a year. I think that they wanted someone with different research interests and they got it.

04-01:46:05
Burnett: Yeah, yeah. You offered a new perspective on this period and on those mammals.

04-01:46:14
Clemens: I must say that the Alexander von Humboldt Foundation, when they give an award, they really give an award. This program was set up in recognition of and thanks for the Marshall Plan. It was set up in such a way that I never applied; my colleagues in Munich asked me. Therefore, the stipend was tax free.

04-01:46:49
Burnett: That's nice.

04-01:46:51
Clemens: They provided health insurance. For the children there was *kindergeld*. And then, as we will see later, when I went back to Bonn, again the Humboldt Foundation provided support. Although not for as long a period, it was generous and came with real hospitality.

04-01:47:18
Burnett: Yeah. Yeah. I've heard in many different domains of science, from Americans and Canadians who go over there, that they're well looked after.

04-01:47:30
Clemens: Oh, yes.

04-01:47:32
Burnett: They know how to do things right. And during your Guggenheim Fellowship, this is the kind of work you were doing that allowed you to produce that edited volume with Jay Lillegraven and others.

04-01:47:51
Clemens: And Zofia [Kielan-Jaworowska].

04-01:47:53
Burnett: And Zofia. *Mesozoic mammals: The First Two-Thirds of Mammalian History.*

04-01:47:58
Clemens: Right. You have a copy.

04-01:48:00
Burnett: Yeah. I've got one right here. And it is striking and it does give an overview. It shows, I think, how new a lot of this research was and that there hadn't been a kind of global overview of the state of mammalian paleontology across the eras and that this was an effort to bring some sense to it.

04-01:48:26
Clemens: It was something new.

04-01:48:28
Burnett: And George Gaylord Simpson participates in this a little bit. There's an extraordinary graphic here. It's a chart that has, and I'm hoping I can get this in the camera shot here. It's of 190 million years of history and on the top left you can see—this is in the fifteen million years. There's this research that is in western North America and there's this big black splotch or slab and that's the area that you and others had contributed in collecting. You realize how patchy the history of mammalian fossils is going back 190 million years. There are three patches in 190 million years lasting about ten million years each in the world. One is in Asia, another is in Europe and the other is in western North America.

04-01:49:39
Clemens: Fortunately the patches are beginning to be connected. There are dots in between them thanks to the work of a lot of colleagues particularly in Asia and South America. With that book there's a bit of a story behind it. Jay was the instigator. This is the kind of compendium he likes to assemble and does very well. Jay and I talked about the project. At the time of writing, what was the Asian record? There was the material from Mongolia picked up by field parties from the American Museum of Natural History in the late twenties and thirties. We knew that the Russians had gone into Mongolia after World War II and there were a few publications about their discoveries. Unfortunately they were poorly illustrated, and it was hard to get someone to translate the Russian. So what do we do? If we're going to put the volume together we can handle literature from Europe, from North America, and the literature on the old Asian collections. What about these new collections? After the Russians went into Mongolia and did some collecting, Zofia Kielan-Jaworowska, at the Paleontological Institute in Warsaw, was able to get permission to run a couple of expeditions into Mongolia and found some remarkable specimens.

04-01:51:53
Burnett: And when was this? When was she doing this fieldwork?

04-01:51:55
Clemens: In the seventies. The early seventies. And maybe the late sixties, too. So I had the Guggenheim, which included research on paleobiography. There was a program run by the Smithsonian using what was called corn money. This included the money the Polish government paid for imports of wheat. With approval to go to Poland, you were given a stipend in zlotys that you could use to support yourself while you were doing your research.

04-01:52:43
Burnett: It was a version of Public Law 480, the kind of—

04-01:52:46
Clemens: I'm not—

04-01:52:48
Burnett: There's a lot of grain that the United States had, corn and so forth, and in exchange, a developing country, instead of paying for it, they would pay in local currency into an account and then Americans and others could use that. Yeah, so a similar kind of thing.

04-01:53:12
Clemens: Well, that would have been the program. So, what the heck, I took advantage of it and spent a couple of weeks in Warsaw studying Zofia's collection and getting to know her. Then it was obvious, bring her into this project for the Asian end of it. I must admit, in '79 when I was in Munich, part of my time was spent proofreading pages of this book. But that contact and others with Zofia through the years has been wonderful. Yes, it's too bad, Rich Cifelli, a colleague, was planning to pull together a volume honoring her on her ninetieth birthday, but she passed away just a couple of weeks ago.

04-01:54:20
Burnett: Oh, no.

04-01:54:20
Clemens: A month before her ninetieth birthday.

04-01:54:22
Burnett: Wow, wow. But a long and illustrious career.

04-01:54:25
Clemens: Very definitely.

04-01:54:26
Burnett: Yeah, yeah. Before we finish up for this time, I think it's worth mentioning one of your students, David Archibald, began his research in the summer of '73. Do you want to talk about that a little bit and about what he was working on and then that would be a segue to our next session?

04-01:54:53
Clemens: Okay, previews of coming attractions.

04-01:54:56
Burnett: Exactly.

04-01:54:57
Clemens: Right. Now, for the story, we're going to have to jump back to the beginning of the 1960s. Bob Sloan and Leigh Van Valen worked a series of localities near Fort Peck Reservoir. These are localities that we now know are of Late Cretaceous or early Paleocene age. Bob and Leigh did initial descriptions of these localities and their faunas. But what's most significant, I think, in terms of our story is that they developed a hypothesis about the extinction of dinosaurs. It involved a gradual change in climate triggering the extinction of the dinosaurs through changes in the environment and the ecology. So, when we started work in another area around the Fort Peck Reservoir, that was the

dominant hypothesis for extinction of dinosaurs. Bob and Leigh would expand their hypothesis to include changes in the marine realm, and expand it again to be global in application. When the impact hypothesis came out, amongst vertebrate paleontologists, Bob and Leigh's interpretation was the standing hypothesis. So now, that ought to whet your—

04-01:57:20
Burnett: Pardon me?

04-01:57:22
Clemens: That ought to whet your appetite.

04-01:57:22
Burnett: Yes. Yes, it does. Well, should we leave David Archibald's research to the next time?

04-01:57:30
Clemens: I would.

04-01:57:32
Burnett: Okay. Let's do that, then. Okay.

04-01:57:33
Clemens: It ties in with Bob and Leigh's work as some of the first questions being raised about what they had done and what they had hypothesized. So, no, we'll get to Dave.

04-01:57:51
Burnett: Okay, all right.

04-01:57:51
Clemens: Okay.

[End of Interview]

Interview #5 May 7, 2015
Begin Audio File 5

05-00:00:06
Burnett: This is Paul Burnett interviewing Bill Clemens for the UCMP Bill Clemens Oral History Project. It's May 7, 2015 and this is our fifth session. And the last time we talked we were just getting into talking about David Archibald's arrival as your graduate student and the beginning of his research. Can you talk a little bit about the research that you were supervising with him?

05-00:00:35
Clemens: Okay. I think we need to go back to the 1960s to set the stage for what was going on in Montana when David arrived. It was an interesting situation. Bob Sloan and some of his colleagues at the University of Minnesota had been coming out to Fort Peck Reservoir to do various kinds of research, training of students, and, as usual, coming out to discover and collect a dinosaur skeleton for a local museum. The attraction was dinosaurs, yes. While they were working in Garfield County, they found some mammalian material but not much. At the SVP meeting in 1961 Bob presented a report on what they had accomplished. This was typical at that time. At the SVP meeting many gave a "This is what I did last summer," kind of talk. In the audience was Leigh Van Valen, who was then a graduate student at Columbia and the American Museum. A couple of years earlier, when I was finishing my PhD, I had visited the American Museum and seen a curious collection that they had received. It was a mix of Late Cretaceous vertebrate fossils, dinosaur teeth and that kind of thing, and Paleocene mammal teeth. I wondered why the mixture? The fossils were supposed to come from one locality. Leigh saw the same collection and also wondered. The collection had been made by an interesting guy, Darwin Harbicht.

Now we have to go back to the Depression and the construction of the Fort Peck Dam. The workforce got up to about 6,000 workers plus their families. They lived out in the open, if you will, in the prairie of eastern Montana. Now, what did they do? Little towns popped up with dance halls and saloons. Initially, Harbicht, who had worked with Barnum Brown earlier, was hired as a geologist. He was in an office that was responsible for getting the riprap, the stones that would armor the dam. Harbicht decided that, well, here he was in the area where Barnum Brown had collected the second *Tyrannosaurus* skeleton. He found it just up the valley from the dam site. So Harbicht started giving lectures on paleontology, particularly about fossils found at the dam site. He even ran weekend field trips. About one of them, the local newspaper reported that , "On Sunday afternoon over a thousand people were out looking for dinosaur bone."

05-00:04:36
Burnett: Wow. The combination of there being nothing to do and—

05-00:04:42
Clemens: And here he was offering something that really appealed to folk. One of the discoveries they made was this little collection of mammal and dinosaur teeth. In the late thirties and early forties, George Simpson was one of the curators at the American Museum. He was given the job of dealing with this collection. The war came along and he could not go out to Montana. After the war he scheduled at least two trips to eastern Montana but both times something happened and he never got there. Okay. Next Leigh Van Valen enters the scene.

05-00:05:43
Burnett: This collection's kind of dormant. It's kind of untouched.

05-00:05:46
Clemens: It's sitting in a cabinet in the American Museum. At the 1961 SVP meeting Leigh heard Bob Sloan's talk about his work in the Fort Peck Reservoir area. According to Bob, who recounts this in considerable detail, Leigh wrote him and asked, "Next summer when you go out can I come with you and can we go looking for this Harbicht locality?" Bob said yes. The next summer they joined up and went over to McCone County looking for the locality. There they ran into Donald Beckman, who was the engineer in charge of the Fort Peck Reservoir, which was under the jurisdiction of the Corps of Engineers.

05-00:06:42
Burnett: Was he the man who was very helpful to the—

05-00:06:44
Clemens: Oh, yes.

05-00:06:45
Burnett: Yeah. He was a big champion of paleontology.

05-00:06:48
Clemens: Yes. How did he and a couple of his coworkers and their families spend Sunday afternoons? Often they would get a boat, go out on the reservoir, stop somewhere, have a picnic and look for fossils. The key locality was Bug Creek Anthills, which was discovered by Don Beckman's daughter, Donna. Well, Bob and Leigh started working with Don. Don, who was just the most enthusiastic and wonderful guy, started showing them what they'd found. That led Bob and Leigh to the Bug Creek Anthills.

So, during the sixties Bob and Leigh spent several summers around the Fort Peck Reservoir collecting. As a result there was a massive collection of fossils, particularly from the Bug Creek Anthills locality. In their analysis of that collection there are a couple of themes that come out. First of all, obviously, the question of what killed the dinosaurs; why are they extinct? Leigh went farther in terms of developing his ideas about evolutionary patterns and processes and his ideas about competitive exclusion stem from this work.

05-00:08:39
Burnett: Farther than Sloan did?

05-00:08:40
Clemens: Yes. What Dave and I inherited in the way of an interpretation, and what was for me attractive to get out there and do my own research with my students, was the picture that Bob and Leigh put together. First of all, in terms of the geology, I didn't realize until much later how complex the channel deposits can be. There was a river the caliber of the modern Missouri River that flowed through the area during the latest Cretaceous and earliest Paleocene. So you've got small to massive channel deposits cutting through one another. Unfortunately many of the fossiliferous deposits are on the tops of hills. So you can't put them in a stratigraphic sequence. They just sit up there.

What Bob did was to try to organize their temporal sequence according to the depth of cutting of the channels. So the depth of cutting of the Bug Creek Anthills channel was greater than the depth of cutting of his two other major localities, Bug Creek West and the Harbicht Hill locality.

05-00:10:52
Burnett: So the depth would set the lower limit of what could have been washed out of strata?

05-00:11:00
Clemens: This would be trying to establish the ages of the fillings where you found the fossils. Secondly they looked at the percentage of dinosaur remains in each deposit. Now, basically this was done by looking at the taxonomic diversity. How many species of dinosaurs were represented in deposit A or Bug Creek Anthills, how many in Bug Creek West and so on. They found that the taxonomic diversity of dinosaurs decreased through that sequence: Bug Creek Anthills, Bug Creek West, and Harbicht Hill. This promoted the idea of a gradual extinction of the dinosaurs in that area.

Jumping ahead, both approaches were wrong or flawed. With channeling it's not the depth of cutting that is important. It's the age of the overlying bed that caps the channel filling that says something about the ages of these deposits. None of these three channel deposits are clearly capped. In terms of taxonomic diversity, it decreases as you go through that sequence of three localities, so does the sample size.

05-00:13:16
Burnett: You can't really conclude much on the basis of—

05-00:13:18
Clemens: Right. Now we see those flaws in their analysis, but during the sixties it was the dominant hypothesis for dinosaur or for faunal evolution in that area of the Western Interior.

05-00:13:44
Burnett: But that must not have been the only hypothesis of rate of extinction based on these channel deposits. They had other strata. Like they had rock strata and there was evidence of gradual extinction. No? No, there wasn't?

05-00:14:07
Clemens: Yes.

05-00:14:08
Burnett: There wasn't at all?

05-00:14:09
Clemens: This is one of the things that Dave ran into, Dave Archibald. Because of what we were finding over in Garfield County, you didn't see that gradual change. You saw a Cretaceous fauna changing a bit, then a Paleocene fauna. No intergrade.

05-00:14:37
Burnett: And quite a gap, I understand. We're getting ahead of ourselves here.

05-00:14:43
Clemens: Yes, we are.

05-00:14:44
Burnett: Right. But before you hit that iridium layer there's no record of dinosaurs for three meters in some of these localities?

05-00:14:52
Clemens: In many of these localities, yes, there will be that degree of separation. In some it's a bit closer. But nowhere in the Western Interior has a partial dinosaur skeleton blanketed by the impact layer ever been found. There's always a gap of some kind. And, boy, you can write a tome on the various rationalizations for that gap.

05-00:15:29
Burnett: Yeah. It's maddening. As we will see.

05-00:15:33
Clemens: As we will see, but back to Bob and Leigh. Another aspect of their analyses, and I suspect Leigh was the major player in developing this, goes back to Arnold Shotwell, who was a grad student here in the 1950s. He carried out some really interesting studies on community structure as documented in the vertebrate fossil record, trying to use a variety of features, mode of preservation, abundance, to determine which animals were living close to the site of deposition and which animals were living at a distance and only rarely getting preserved. Using this kind of approach, Richard Estes, with whom I worked in Wyoming, looked at the non-mammalian vertebrates from Bug Creek and he did this in what was the stream channel bank fauna like—

05-00:17:26
Burnett: So almost like paleo-ecology.

05-00:17:27
Clemens: It is paleoecology. Leigh used this kind of an approach and argued that there were three communities you had to deal with. One was the aquatic, okay, the fish and other obviously fully aquatic kinds of vertebrates. Then a near stream, if you will, community. This was the community that included the Paleocene aspect mammals. Then a distal community. This is the one that included the dinosaurs. So Leigh envisioned this three-fold arrangement.

Now, during the sixties there were a number of people looking at the broader question of mass extinction. Norman Newell at the American Museum was an invertebrate paleontologist. He noted the contemporaneity of marine regressions, drainage of continental areas, with mass extinctions, Dan Axelrod and Harry Bailey wrote an influential paper. Dan was up at Davis. They argued that what was going on at the end of the Cretaceous was a change in climate, that not only was it getting cooler but also it was getting less equitable. The loss of equitability was something that they emphasized.

05-00:19:43
Burnett: In terms of diversity of species?

05-00:19:45
Clemens: Equitability in terms of temperature.

05-00:19:47
Burnett: Oh, okay.

05-00:19:48
Clemens: Is it Saigon, where the difference between winter and summer temperatures is one degree or something like that.

05-00:19:56
Burnett: Right, exactly. Okay.

05-00:19:58
Clemens: So going from a very stable climate to one that showed greater changes in—

05-00:20:07
Burnett: Season to season?

05-00:20:08
Clemens: The maximum and minimum temperature.

05-00:20:10
Burnett: Sure, sure.

05-00:20:12
Clemens: This makes some sense. As Californians we have a good idea of what oceanic circulation does in terms of affecting our climate. So Leigh and Bob argued that what they were documenting in their sequence was a decrease in temperature. The terrestrial community was driven southward first, leaving behind the river bank, if you will, the proximal community. The distal

community included the dinosaurs; the proximal included the Paleocene aspect mammals. So this was their explanation, their hypothesis for what they thought they were seeing in the fossil record in McCone County. So there we were. When I went out to Montana in ’72 and a year later when Dave joined us that was the dominant view. As I mentioned earlier, Dave found it didn’t match what we were seeing and what he was discovering in the faunas in Garfield County. Yet we were only sixty or seventy miles apart.

05-00:22:07
Burnett: And it didn’t match in what sense? It was more sudden? You’re finding more sudden changes?

05-00:22:14
Clemens: More sudden.

05-00:22:18
Burnett: Relatively.

05-00:22:20
Clemens: There wasn’t a gradual change. You were either dealing with a Late Cretaceous dinosaur dominated fauna or the dinosaurs were gone and you had Paleocene mammals. Now, of course, things get reworked a bit. So even in localities that are probably deposited a million years after dinosaur extinction you’ll occasionally pick up a water worn dinosaur tooth. And you have to deal with this. There’s no FDA looking to insure the purity of your fossil collections.

05-00:23:11
Burnett: Right, right. No, you’re at the mercy of what you can find, absolutely. And the limited nature—and we’ll talk about that too—but scoping out just how limited it is. That is just part of what became articulated later, is that you have to know how little we know to make the claims that we’re making. In the history of science there’s this theory-ladenness of observation: what a scientist observes is shaped by their training, by their methods, and their tools. You’re not just completely receptive to what nature has to tell you. You come with frameworks. And so it’s been claimed, specifically for vertebrate paleontology, that there was a predisposition towards seeing a gradualist explanation going back into deep history, of natural history, to Charles Lyell’s uniformitarianism. Right? That all the change that you see is the result of everyday actions operating gradually over millions of years, and so a predisposition *not* to see catastrophe, which was the other competing explanation that was rooted in biblical scripture in part, right? That the earth went through a big flood or a big volcanic disaster. You’re painting a different portrait, looking more at the local level of the 1960s and the seventies, that paleontology, in the localities that you were working in, there was debate between a gradualist perspective and something that framed it, not in catastrophist terms, but in a much shorter timeframe.

05-00:25:14
Clemens: Okay. Let me ask you, how are you using the word “catastrophist?”

05-00:25:21
Burnett: Well, so I guess there’s an old explanation and a modern one. But catastrophism would have been those who felt in the nineteenth century, eighteenth and nineteenth century, that there was either a giant flood or a giant volcanic eruption that wiped out every species that was there before, that is now found in those fossil beds, and replaced it with new species, and that was perhaps created by God, [an explanation which] later became secularized.

05-00:25:56
Clemens: Okay, that’s one way, a valid way to approach it. In my own thinking the question is, are we dealing with some kind of extensive environmental upheaval that has its effect over a very short period of time?”

05-00:26:33
Burnett: On the order of a hundred years as opposed to a million years?

05-00:26:36
Clemens: Sure. In thinking about what we’re seeing today in terms of climate change—they’re arguing about when does the Anthropocene begin? Does it begin with the Industrial Revolution? Does it begin with the first deposit of broken coke bottles? This kind of argument. But let’s just say that climate change does, over a matter of a few centuries, cause a mass extinction. Is that catastrophe?

05-00:27:28
Burnett: From a [modern] geological perspective I would say yes. Yeah.

05-00:27:34
Clemens: It would look that way.

05-00:27:36
Burnett: It would look that way, certainly in terms of the fossil record.

05-00:27:38
Clemens: Okay, we’re really getting ahead. My disagreement with a lot of the arguments, the hypotheses that are being mooted today, is that they assume that a massive mass extinction, a real mass extinction, requires a massive catastrophe, a very short-term event. If you want to put a little aside on it, it’s sort of like a character in the Mikado. Remember the Lord High Executioner of Titipu? Yes.

05-00:28:28
Burnett: I remember the—

05-00:28:29
Clemens: “Short sharp shock on a big black block.”

05-00:28:33
Burnett: Really instantaneous.

05-00:28:35
Clemens: Really instantaneous. So yes, I think as we get into the eighties and nineties a lot of this will come out. But in terms of David's work for his dissertation, which was essentially finished in the seventies but not published until the early eighties the question remained.

05-00:29:12
Burnett: Yeah. I think he says '77.

05-00:29:14
Clemens: Yes. Oh, gosh, I haven't gone back and reread all his papers, but the picture in my memory is this curiosity of, well, it's happening this way over at Bug Creek but it's happening another way where we're working in Garfield County. Why?

05-00:29:51
Burnett: And not across the board? Not a unified extinction?

05-00:29:56
Clemens: In terms of looking at extinction of dinosaurs, that area of Montana, although it's being challenged, still holds the most complete sequence documenting faunal change prior to and immediately after the Cretaceous-Paleogene boundary. If you go to Europe or Asia it is a matter of Cretaceous here, something in the Tertiary there, and a big gap in between. So when David started work, he had Leigh and Bob's studies but was in a new area in the sense of having such a complete sample. That was one of the reasons that I really got interested when Dave Whistler called me up. Dave, a former student at UC, told me that Harley Garbani and his crew had found an earliest Paleocene fossil locality. Okay. Here's the work that Leigh and Bob had been doing. I'd been in the Hell Creek country before. Okay, let's go up there. First of all, here's my "Savage" background. We did not have a good sample of the Paleocene fauna from the northern Western Interior. We've got a little stuff from the San Juan Basin. So fill in that gap—

05-00:31:57
Burnett: Let's go get it.

05-00:31:58
Clemens: —in the collection.

05-00:31:59
Burnett: Right. This is the Don Savage approach of like find the—

05-00:32:01
Clemens: The Savage approach.

05-00:32:02
Burnett: —localities and fill things in.

05-00:32:06
Clemens: So that was a real attraction. It was obvious that there was more to be done in terms of understanding the geology and a better chance of doing it than I had down in the Lance Creek area where you had limited outcrops, lots of area covered by grass or wheat fields, while there in the valley of Hell Creek and along the Fort Beck Reservoir there are massive outcrops of bedrock. Yes, let's get in there and see what's going on.

05-00:33:05
Burnett: Yeah. And that calls for more of a geological, biostratigraphical bent to be able to work on that kind of outcrop.

05-00:33:15
Clemens: And that was, and it continues to be, an aspect of vertebrate paleontology at Berkeley. People come here and look amazed at our collection. Well, don't you have all your fossils of *Tyrannosaurus rex* in one place and the hadrosaurs here and the condylarths there? No, we keep them together organized by collecting localities, starting out with the biostratigraphic interest. What animals were living together? What does it tell us about their age? Then as we got into, say, the Shotwellian kind of approach of looking at communities. You have a heck of a time reconstructing the collections from a particular locality as they're stored in the American Museum, because they're stored systematically. So the collection storage pattern dictates not too much, I hope. It does—

05-00:34:44
Burnett: It shapes.

05-00:34:45
Clemens: It shapes the kinds of questions you can easily address.

05-00:34:49
Burnett: Sure, sure. And how unique is UCMP in that respect?

05-00:34:54
Clemens: We're in the minority in my experience. Many museums will have a dinosaur storage area and a ground sloth storage area and patterns like that that are dictated by the size of the material.

05-00:35:23
Burnett: Wow, okay.

05-00:35:23
Clemens: Yes.

05-00:35:26
Burnett: You see the exigencies of the institution can really have an influence on the kind of work that's done, as well.

05-00:35:31
Clemens: There are some collections that are arranged the way ours are. But I would think the majority, at least in my experience, the majority of the museums that I've worked in tend to have this biological-systematic approach.

05-00:36:03
Burnett: Right, right. So we were talking about Harley Garbani's discovery of a possibly large collection of Paleocene fossils and that this set a new stage. Was that something that David Archibald took advantage of or was that part of a larger research project?

05-00:36:31
Clemens: First of all, it was one of the major attractions in the early 1970s. One of the major attractions for setting up a long-term field study program in that area. I'm going to be honest. Look, for my doctoral dissertation research I worked in Wyoming. For a couple of reasons, primarily the limitation of outcrop, that wasn't a place to go back to. While I was at Kansas my fieldwork was focused on the San Juan Basin, which was fine. It served well in terms of a training ground of students and some research. But it was dry, and I couldn't get a screen-washing project going.

05-00:37:52
Burnett: Right. So there's a resource issue in the actual production of the fossils.

05-00:37:58
Clemens: Right. Tom Williamson is now at Albuquerque. He's whipped the problem because he trucks rock from the San Juan Basin down to Albuquerque where he's got a great big washing facility. Okay. I didn't have that and wasn't going to truck rock to Lawrence, Kansas.

05-00:38:21
Burnett: Are there other possibilities apart from using water to do a similar kind of—like some kind of gravity separation? Or is that just too risky? Like because miners use agitator belts to separate out material. But do the fossils just not have any sort of specific gravity that would permit that or is it just too dangerous to—

05-00:38:46
Clemens: You have to disaggregate the sediment, and there's where the water comes in. Once you've got it disaggregated, yes, you can go after other characteristics of the fossils to pull them out. In the work at Cliff End in England, once we broke the sediment down with acetic acid, then we used tetrabromoethane to separate the fossils from the stone.

05-00:39:30
Burnett: Right. So a leaching operation.

05-00:39:32
Clemens: Well, no. There it was taking advantage of differences in mass. I can remember down at the University of Texas Ernie Lundelius had a wind tunnel. He was collecting cave sediments, lots of dust and fossils.

05-00:39:58
Burnett: Blow them off.

05-00:39:359
Clemens: Blow off the dust, yes. [laughter] Why not?

05-00:40:04
Burnett: That's fascinating.

05-00:40:06
Clemens: You've got to be inventive, right?

05-00:40:09
Burnett: But for your purposes, water was essential for the kind of fossils and the kind of aggregates that you had and so you needed to get to a source of water. And the Garbani find was close to a water supply?

05-00:40:24
Clemens: Oh, yes, there were stock ponds. The ranchers and the sheep and cattle didn't object to a little more mud in their pond.

05-00:40:38
Burnett: Excellent. [laughter]

05-00:40:38
Clemens: [laughter] Yes. I needed an area to work not only for my research but provide projects for students. And the area there in Garfield County just proved ideal and continues to support all sorts of new and interesting research questions. It isn't the same old "go out and find stuff and describe it."

05-00:41:23
Burnett: Right. Well, there's something unique, at least at the time, about this Paleocene locality that Garbani found, in that it was the best that you knew of for studying this transition, looking across that Cretaceous-Paleogene boundary. So can you talk about how research then developed around that, especially David Archibald's work and the work that you were doing in this period.

05-00:42:00
Clemens: Okay. Well, David came to Berkeley from Kent State with definitely a background that was strong both in biology and geology. We came into this area around the site that Harley had found and where he'd collected a number of remarkable dinosaur skeletons or partial skeletons. Basically the dinosaur hall at the Natural History Museum in Los Angeles is Harley's hall.

05-00:42:55
Burnett: And he's this remarkable collector with this incredible nose for finding these things.

05-00:43:00
Clemens: Yes, and I was so lucky to have him work with us for so many years because when it came to collecting he was a great practitioner and teacher. That made a real difference. Yes. So what were the first challenges? Well, we looked at that locality and a couple of others where Harley had picked up a Cretaceous mammal tooth here or there. The first thing that became apparent was this is complex geology. These coal beds are lenticular, they phase in and they phase out. There was a real need to understand the geology at that detail. Now, through most of the settlement era of that part of Montana—this would be from the nineteen-teens particularly through the thirties—the way the law worked was that you could homestead a parcel of land but the terms varied as to whether that land was defined as coal bearing or non-coal bearing. So there was this emphasis on the US Geological Survey to go out and survey coals. Okay. Hey, great. We'll have these wonderful maps. Well, Bill Roher who was with the Survey, said, "Look, I've mapped your area. The rules we were working under were that we map commercially valuable coals. So if the coal isn't regularly more than," what was it, "a foot and a half thick or have a certain BTU value, ignore it." So we had a crude picture of the geology. Bill was great in showing us what he had done.

One of the challenges that you find Dave really meeting nicely in his dissertation is mapping in detail the coal beds through this area. The second part of his dissertation research Dave focused on Cretaceous and earliest Paleocene mammals. Yes. I've sort of reserved the Garbani locality for myself, although hopefully haven't stopped the research of my students. But early on we found a locality that's even older than the Garbani and still earliest Paleocene in age. Dave, with a certain sense of humor, looked at it as something of an equivalent of the Bug Creek localities and named it Worm Coulee. So we now have the Worm Coulee localities.

05-00:47:14
Burnett: Great name.

05-00:47:18
Clemens: He did a great job because that was, and still is, a very early Paleocene vertebrate locality. It can be directly related to Late Cretaceous localities yielding dinosaurs, the proper mammals, and so on. So that between his detailed geological mapping, which we benefited from for years, and his studies of these latest Cretaceous and early Paleocene local faunas, he was able to speak to the pattern of dinosaur extinction as it's recorded in Garfield County.

05-00:48:19
Burnett: And what were some of his basic conclusions about that extinction? Was it fairly complex, I imagine?

05-00:48:32
Clemens: In the dissertation, no, and, remember, this is pre-asteroid. Things will change in the eighties. We'll get to that.

05-00:48:50
Burnett: I think it's important to know the kind of state of vertebrate paleontology. What vertebrate paleontology was saying about the dinosaur extinction just prior to the extinction hypothesis.

05-00:49:05
Clemens: Well, certainly for us, we had the Sloan-Van Valen hypothesis. We had the observation of a changeover without a gradual pattern of change in between, which might be explained by a gap in the fossil record. I think it was, for many people, a non-question. Glenn Jepson wrote a fascinating article for the Princeton alumni journal in which he catalogued all the hypotheses he could find about the causes of dinosaur extinction, things like the lack of fern oil and consequent constipation and psychotic suicidal factors. Oh, he had really combed the literature. Recently Norm MacLeod wrote on the history of study of mass extinctions. In terms of the vertebrate paleontology community, other than the Sloan-Van Valen hypothesis, there was little going on just prior to the asteroid hypothesis. I may be overlooking some, and I'm sorry. Really it was Norman Newell and others, invertebrate paleontologists and geologists who were in the forefront of study at that time. Otherwise it was either a non-question or a question worth ignoring.

05-00:51:30
Burnett: Right, right. You were looking at the fossils that you did find and trying to establish relationships both between fossils that you found and between the fossils and their localities, right, and developing some kind of tentative explanations of how they lived, not necessarily how they died.

05-00:51:57
Clemens: Right.

05-00:51:58
Burnett: So that's kind of the state of things. That you have developed some really rich localities, richer than have ever been found before in that precise area that would become a matter of debate in the eighties. You're finding out more and more about how creatures lived before and after.

05-00:52:23
Clemens: Yes, I think that's fair. Take Harley, for example. When he was employed by the Natural History Museum in Los Angeles he collected interesting dinosaur material. It wasn't, "Well, no, I'm not going to waste my time on these smaller fossils because I've got to get a big monstrous thing for the hall." So he had collected the beautiful small skeletons of juvenile animals, fragmentary

material that documents the pachycephalosaurs, the bonehead dinosaurs. You find the dome of one of these things, that's not an exhibit. But Harley would say, "Hey—"

05-00:53:38
Burnett: It's interesting.

05-00:53:38
Clemens: It's interesting, let's take it in. Yes. So Harley and others really were contributing more to our knowledge of the large vertebrates of the Late Cretaceous, the dinosaurs, as they sort of—I won't say it, but they were weaned away. But no longer was there this real emphasis on filling exhibit halls, which was clearly dominant during the late 1800s and the early 1900s.

05-00:54:26
Burnett: Right, right. Well, it sounds like Harley Garbani worked closely with you and with other folks in the paleontology community, so that he was not just a collector, he was aware—this is a question. He was aware of what was interesting from a paleontological perspective. Or are you saying he had his own taste in terms of—

05-00:54:57
Clemens: No.

05-00:54:57
Burnett: No.

05-00:54:59
Clemens: He was frequently asking questions. Here is this odd piece of bone. Does it mean anything? Are you interested? This is something that I haven't seen before. Is it going to be worthwhile? We had to educate him. For exhibit purposes, turtles aren't very important. So Harley, as he had prior to working with us might comment, "Yes, if there's a turtle, okay, there's a turtle." Howard Hutchison, a long-time member of the museum staff who was really interested in turtles and I educated him. So he started picking up turtles.

05-00:56:08
Burnett: So there was that back and forth, that exchange of knowledge?

05-00:56:11
Clemens: Oh, yes.

05-00:56:12
Burnett: And that made him a better collector for paleontological purposes.

05-00:56:18
Clemens: Right. And he was very sensitive to and amenable to being taught, a great guy.

05-00:56:30
Burnett: That's great. Right. Let's take a break and we'll come back.

05-00:56:33
Clemens: Sounds good.

05-00:56:39
Burnett: So let's switch gears a little bit and talk about moving from the field and the research that was going on there to the maintenance of the ship.

05-00:56:50
Clemens: The maintenance of the ship, what was going on?

05-00:56:52
Burnett: What was going on at UCMP, your teaching responsibilities, some of the interesting work that you did in teaching and in the maintenance and administration of the ship, so to speak.

05-00:57:05
Clemens: Well, of course, the end of the sixties and the beginning of the seventies were tumultuous times here on campus. There are others who can tell a more informative story about the overall campus picture. I think for the museum and my own personal work the position of the Earth Sciences Building on the north side of campus had a couple of interesting effects. One, we were out of close range of Sproul Plaza and—

05-00:57:56
Burnett: The protests.

05-00:57:57
Clemens: —the protests and similar events. Although, you learned very quickly that if you want to do something on south side of campus you did it in the morning.

05-00:58:11
Burnett: Because it was almost a daily occurrence or it was a daily occurrence?

05-00:58:15
Clemens: At times it was almost daily and often involved tear gas. Now, you could sense the gas in the morning and you would realize something had happened the previous day. But here I'm thinking of two other things in terms of the challenge of teaching at that time. What do you do when you're teaching a class and students say, "I want to take your class but I don't want to come to your lectures because I'm afraid to come on campus."

05-00:59:02
Burnett: Oh, my goodness.

05-00:59:04
Clemens: Personal threats to students. One year when I was teaching the introductory paleo course my teaching assistant was Dennis Bramble. Dennis went on to a very distinguished career at University of Utah. Dennis was really concerned about this. Ours was a lecture and lab course. So he volunteered to teach the lab early in the morning over in the Earth Sciences Building when the campus was quiet. Well, I decided that, okay, I'll go along with Dennis, and so I

offered lectures, weekly lectures, at my house. For that semester, once a week a number of students would come up to the house and I'd go over the major points that I wanted to cover in the lecture. It was fun.

05-01:00:28
Burnett: How many students would come?

05-01:00:31
Clemens: It would vary, a dozen to two dozen.

05-01:00:39
Burnett: Was your house close to campus?

05-01:00:40
Clemens: It's up on Spruce Street by Cragmont School. There have been some acquaintanceships made then that have lasted. In fact, one of the students just recently contacted me. He's retired, living, I think, up in Oregon. Coming back to Berkeley he wrote and asked, "Will you be around? I'd like to see you."

05-01:01:11
Burnett: Oh, great.

05-01:01:11
Clemens: Great. The other challenge in terms of the disruptions was that for a couple of years I could count on at least one lecture being disrupted. My wife got , after me one year saying, "Why are you so grumpy about this class?" I said, "Well, I have to write a new lecture." "Why?" "I don't think there's going to be a demonstration this year." [laughter] Yes, but it—

05-01:01:56
Burnett: So it was disruptive in the sense that access to the building was prevented or protesters actually entered the classroom?

05-01:02:03
Clemens: I can't remember an instance when protestors got into the building. It was just the turmoil on campus.

05-01:02:24
Burnett: Students would either be participating in them or they would stay home.

05-01:02:28
Clemens: Be staying out of the way. Yes.

05-01:02:31
Burnett: Intimidated. Yeah.

05-01:02:31
Clemens: Also the challenges of having so many police on campus.

05-01:02:47
Burnett: So it had a negative impact on getting people to class at any rate.

05-01:02:54
Clemens: One of our students, Larry Barnes, who has gone on to be a great student of the evolution of whales, was here in the 1970s. At that time there was a whaling station out at Point Richmond and they brought the dead whales into the station. Here the general processing took place. But what do you do with a whale head? We've got some magnificent whale skulls here and up in MVZ [Museum of Vertebrate Zoology] that came from the Richmond whaling station. At least one of ours was brought over, taken up to the Botanical Gardens, and buried to allow the bugs to take care of the flesh. One day there was a demonstration going on and Larry was coming back from the Richmond field station. He was walking from the Earth Sciences Building down to MVZ, carrying his tools with him. Now, what happens when you have a student with blood stained clothing—

05-01:04:22
Burnett: Crowbar.

05-01:04:23
Clemens: Well, machete.

05-01:04:25
Burnett: Machete.

05-01:04:26
Clemens: Big knives. Walking across campus.

05-01:04:31
Burnett: With police and—

05-01:04:33
Clemens: The story is that he was intercepted by a couple of the sheriff's officers and a campus cop. When Larry told the story the campus cop said, "Oh, yes. Okay. Look, get down to MVZ and then keep off the campus for a while." So, there were all sorts of different challenges in those days.

05-01:04:58
Burnett: Yeah. Right. When was there a sort of die-back in the protesting—

05-01:05:09
Clemens: Oh, there was. Yes.

05-01:05:10
Burnett: —frequency? By the mid-seventies or the early seventies it had tapered off quite a bit?

05-01:05:14
Clemens: Oh, gosh. In my experience, when it happened it happened abruptly. I would guess that was in the mid-seventies.

05-01:05:26
Burnett: Yeah. After Vietnam had completely wound down.

05-01:05:28
Clemens: Yes.

05-01:05:30
Burnett: Yeah. Makes sense.

05-01:05:35
Clemens: The whole issue, set of issues, made us rethink how we teach. In terms of the museum, it had an interesting impact. We were then up in the Earth Sciences Building, or now McCone Hall. One of the rooms was devoted to a sort of general lounge. Xerox machines are just coming in, and the department was replacing an older one. Well, what do you do with an old Xerox? It worked pretty well, but it was limited in capacity. The graduate students wanted to take it over. The agreement was that, okay, we'll put it up in the lounge, we, being the museum and department, which were together at that time. We will take care of the maintenance of the machine, but the students had to buy the paper and the ink for it. Well, where does that come from, that money? Out of their pockets in part. But also a couple of them became enterprising and said, "Look, would it be okay if we set up a series of four or five Saturday classes for kids? Have them in the Earth Sciences Building, and maybe ask for a donation for each kid." Well, completely illegal but it worked.

05-01:07:53
Burnett: Yeah. Oh, yeah, absolutely.

05-01:07:57
Clemens: Here, the position of the building is on the north-side, close to the edge of campus. People would come on campus that far but not go much further. So this went on. And then the students had an idea, well, if this is working why don't we do an open house? Bill Berry was the director and chair of the department and museum. Let me get the date right. Yes. In nineteen seventy-six, we held our first open house. In development of the program the whole staff and students in the department developed special exhibits. For example, actually prepared a bone so people could see how it was done. It was reasonably well advertised. So on this weekend in April, according to the annual report the estimate is that we had 600 people come to the open house. The next year Bill Berry said, "Okay, fine, on a nice April weekend let's do it again." But the difference here was, and this was significant, the previous year we brought back from Montana a fragmentary skull of *Tyrannosaurus rex*, part of the snout and a couple of nice lower jaws. Mark Goodwin organized some newspaper publicity about this discovery and got an announcement in the *Chronicle*. As I remember, on the first page there was a little note about our open house, "Come to Berkeley and see partial skull of *Tyrannosaurus rex*." The annual report said we had 3,000 visitors at the second open house.

05-01:10:49
Burnett: Wow. That weekend?

05-01:10:50
Clemens: Yes.

05-01:10:51
Burnett: In a single weekend.

05-01:10:52
Clemens: The building was just packed.

05-01:10:55
Burnett: Yeah. That's phenomenal.

05-01:10:57
Clemens: Fortunately, one of the visitors was not the fire marshal. But this began what has become a major public outreach program for the museum. In the fifties, in the sixties you wouldn't see that. Later these open houses were absorbed into Cal Day.

05-01:11:36
Burnett: Right, right. And in the 1980s the university really goes into overdrive on fundraising and getting private donations and so there's a whole institutional revolution that focuses on attracting the public and getting public interest and getting funding support for things. It's no surprise that that would eventually get incorporated into that. But a valuable piece of it because it elicits that public fascination with dinosaurs, but also with the work processes, too. I think they seem to be interested and drawn to the processing work that you were doing and the collection work and there were demonstrations about that, as well.

05-01:12:31
Clemens: Oh, yes. The picking micro-fossils is always popular. I accused Mac Laetsch of copying us with Cal Day. If you've met Mac, he was the Vice Chancellor at the time. But yes, he acknowledged our success and Cal Day got started and goes on. It's just wonderful how many people come on campus for that event. Another aspect of the changes in teaching in the seventies was the development of new courses. For a number of years Don Savage had been offering a seminar for archeologists and physical anthropologists. In the seventies as interest in faunal context, zooarcheology, if you will, was developing. Under Don's leadership this grew into an interdepartmental course. We contributed training on identification of bones. Our colleagues in physical anthropology, they included Desmond Clark, Glynn Isaac and Clark Howell, and then later Tim White. They participated and trained us on butchery patterns, the Schlep Effect, the kinds of things they do in their interpretation of faunal remains. I'm told it was Desmond Clark who really championed bringing Ethiopian students to the campus and educating them. Many years later, in the nineties, when I went to Ethiopia, I was meeting people who had taken that class. The course built up this wonderful long-term association with Ethiopians and research in Ethiopia. Currently Mark Goodwin is involved in work over there. We keep away from fossil humans.

Yes, definitely. I think the first dinosaur remains from Ethiopia were found by one of our groups. One of the sites that Mark and his colleagues worked yielded Triassic vertebrates. This reaching out is important. It's not just what we do which is important but with whom we cooperate.

05-01:16:26
Burnett: Yeah, sure. These partnerships are extremely valuable. What was the course called? Do you remember? It's paleoanthropology. Was that kind of the emphasis?

05-01:16:40
Clemens: No, I've forgotten the name. It was an interdepartmental course, an Interdepartmental Studies course. I won't say it was by invitation to the students, but major professors made sure that their students took it. Now, in order to teach the course you have to have animal bones to work with. Basically the format that we used was to show students how to identify the various major elements of a vertebrate skeleton, primarily tetrapod. Fish are another kettle of fish.

Then, secondly, we started doing comparisons with bones from animals that can be identified from other criteria, like say weasel bones. Well, what this is leading up to is that during the seventies we had a definite program of collecting carcasses of modern mammals or partial skeletons. They'd be cleaned up in our dissection lab.

05-01:18:37
Burnett: The cleaning up was part of the course.

05-01:18:39
Clemens: No, this was—

05-01:18:40
Burnett: No, it was in advance. Okay.

05-01:18:41
Clemens: In advance. Then the bones would be stored in terms of their element. So all the humeri that we had in this collection, they are stored together. So if you taught a student how to identify a humerus in general terms, then they could go to the comparative collection and start trying to find a match or something close. So both in terms of teaching those courses and in current research, this collection, what we call the element collection, is just a magnificent resource.

05-01:19:35
Burnett: It sounds like comparative anatomy.

05-01:19:38
Clemens: Yes, it is.

05-01:19:38
Burnett: It is. It's like morphology basically. Yeah, yeah.

05-01:19:44
Clemens: The pattern up in the Museum of Vertebrate Zoology in terms of their collecting was not very helpful. For so long it was, well, we collect the skin, the skull, but leave the feet in the skin. But what about the rest of the skeleton? Usually it was not collected. So that you can't address this kind of question, identification of isolated bones, immediately using the MVZ collections. Although this is changing, they have very few complete skeletons and their skeletons are ordered assuming that you know what taxon you're looking for. So building the element collection was another exciting development going on in the museum during the seventies.

Another project that got going with—again, it was with graduate student support and promotion – was the origin of the journal, *PaleoBios*, which was a museum publication. We're now all electronic, the journal is part of the university's eSCHOLARSHIP program. It's a nice venue for peer reviewed articles. In the early years it did not have a wide circulation, but that is rapidly changing. Now, if you want to get something out into the literature it's a quick, nice venue to use.

05-01:21:46
Burnett: And there were other public outreach elements for UCMP during this period. What is the Friends of Fossils? Can you talk about that?

05-01:21:58
Clemens: Oh, sure. We talked about it earlier but not by name.

05-01:22:03
Burnett: Oh, okay. Okay.

05-01:22:05
Clemens: This was a group, again in the seventies, tied in with the open-house program. We had a delightful secretary-receptionist, B. Gail Brown, better known to everyone as Beagle.

05-01:22:30
Burnett: That's great.

05-01:22:21
Clemens: She was the motive force behind Friends of Fossils, and an amateur paleontologist joined her in developing this program. For several years they brought in lecturers. Steve Gould gave a lecture for Friends of Fossils when he was here. We have a magnificent specimen of an Irish Elk, which attracted Steve. According to his work, it has the widest set of antlers that he could find, and he had gone through a number of museum collections and Irish manors. Bob Bakker was another lecturer. So Friends of Fossils went on for several years as a fundraising and public outreach vehicle for the museum.

05-01:24:02
Burnett: That's okay. No, that's okay.

05-01:24:04
Clemens: Going through the annual reports, it's interesting. The reports from the various members of the faculty note quite a bit of activity in talking to gem and mineral clubs, speaking at the Berkeley Breakfast Club, and other kinds of little events.

05-01:24:39
Burnett: Yeah. That add up to being a lot of essential—

05-01:24:40
Clemens: Yes, but you've got to coordinate them. I think this is what we see, particularly when Judy Scotchmoor took over the public education program—well, she didn't take it over, she created the public education program. These things could be harvested and a lot added to them.

05-01:25:10
Burnett: When was that about? Roughly?

05-01:25:17
Clemens: Eighties. I'll get to it farther on because we should talk about the museums at Blackhawk.

05-01:25:32
Burnett: Right, out in the—what is it? San Ramon? [ed: the Blackhawk Museum is in Danville, CA]

05-01:25:44
Clemens: Out there. And it wasn't anything—

05-01:25:47
Burnett: Yes. Well, Don Savage went on an expedition. It doesn't fit with—

05-01:25:55
Clemens: Go ahead.

05-01:25:55
Burnett: Well, I wanted to ask about it because it's under the auspices of the UCMP that he undertakes this trip. Can you talk a little bit about—

05-01:26:06
Clemens: Yes, Don took advantage of what's the University Research Expeditions Program and ran at least one, maybe two, projects out at his field research area in Wyoming. In Eocene there was this animal called *Coryphodon*, think of a rhino-sized beast. One of the sites that Don found was really a catastrophic collection of skeletons of these animals. One of the suggestions is that they came to this stream to drink, died or were killed there. A lot of carcasses fell in the water, decayed, and then the bones were washed together. That was the focus of these expeditions. They gave us a remarkably large sample of the skeletons of these beasts.

I'd argue that after World War II, yes, there was some public service; there was some public education. But what you're seeing in the seventies and eighties is really an expansion and a maturing of both the educational and the public outreach programs, setting the stage for what happened in the subsequent decades.

05-01:28:40
Burnett: Was it two-way, as well, because there's the universities that are reaching out to the public. You mentioned some amateur groups. Are there citizen societies and associations that reach out to the university to partner? Or is it more from the inside out?

05-01:29:02
Clemens: From the inside out. In paleontology, particularly today, we've got the problem of commercial collecting.

05-01:29:19
Burnett: It hasn't always been a problem? Or has it just gotten so much worse?

05-01:29:24
Clemens: The magnitude has gotten so much worse. A *Tyrannosaurus* skeleton for six million dollars.

05-01:29:33
Burnett: Who's buying a T-rex?

05-01:29:37
Clemens: Well, for that one I'm told it was a combination of Coca-Cola, McDonald's, some private donors, and the California State University system.

05-01:29:57
Burnett: Okay. I had in my mind a billionaire who wants it for his or her pool yard or something.

05-01:30:05
Clemens: Oh, the last purchase I know of, the purchaser was a museum in the Netherlands. You can't be a museum today, a natural history museum, without your *T-rex*.

05-01:30:19
Burnett: And how many t-rexes have been discovered total? Complete skulls? Complete—

05-01:30:25
Clemens: Oh, it's getting up in the two, three dozen. Yes.

05-01:30:26
Burnett: Okay, yeah. But even back in the sixties, seventies there were just a handful of them.

05-01:30:31
Clemens: Yes.

05-01:30:35
Burnett: The public enthusiasm has a dark side? Is that what you're suggesting?

05-01:30:44
Clemens: Yes, definitely. Mark Goodwin's quite adamant about this. People come in, bring a fossil, and say, "What is this?" Part of our job is to tell them what it is, if we can. And then the next question is, "How much is it worth?" No, we don't make—

05-01:31:15
Burnett: Appraisals.

05-01:31:16
Clemens: —appraisals like that. "You mean, you won't appraise it, even if I give it to you and I can take a tax write-off?" No.

05-01:31:27
Burnett: So the motivations have changed from the days when your father brought fossils in.

05-01:31:32
Clemens: Sure.

05-01:31:33
Burnett: Yeah, yeah. It's a different kind of motivation perhaps.

05-01:31:36
Clemens: And then you get the, "Well, if you won't take it I'll put it on e-Bay."

05-01:31:42
Burnett: And you're like, "Good luck, then." [laughter]

05-01:31:44
Clemens: Good luck. Right.

05-01:31:48
Burnett: We are going to be talking a lot about public interest in paleontology and paleontological discoveries and theories and perhaps how that shapes some of the debates. Science doesn't take place in a vacuum.

05-01:32:07
Clemens: No, it doesn't.

05-01:32:11
Burnett: I think we're probably going to leave this for next time.

05-01:32:14
Clemens: Let's do.

05-01:32:20
Burnett: One of the things that happens, of course, in 1980 is this paper by Luis and Walter Alvarez about the hypothesis that an asteroid caused the extinction of the dinosaurs sixty-five, sixty-six million years ago based on their findings of this iridium layer. So we're going to spend some time talking about that—

05-01:32:46
Clemens: Very definitely.

05-01:32:46
Burnett: —and its impact. But we were talking off-camera about the impact of the impact hypothesis and the degree to which this fits in to a kind of ready-made narrative that is out there in popular conceptions of science. That there's a single explanation for something. There's kind of an Occam's razor approach, that the simplest explanation—

05-01:33:14
Clemens: Oh, very definitely. Yes.

05-01:33:15
Burnett: —is almost invariably the best. There're questions of status. Luis Alvarez, who is this very important Nobel Prize-winning scientist in physics. There are issues of scientific authority. There are issues of media attention to this phenomenon. And historians have talked about it as the impact hypothesis fits into this story of extinction which almost drowns out the scientific interest in these fossils, the scientific interest in the kinds of questions that you were asking. So at that moment when this paper is published, there isn't an immediate response, it seems, from the paleontology community. Can you talk about what your response was or your reaction to it when you first heard about it?

05-01:34:40
Clemens: That's a nice segue to the next interview.

05-01:34:47
Burnett: Sure, sure.

05-01:34:53
Clemens: What month was it that that paper came out?

05-01:34:57
Burnett: I'm not sure of the exact month but it's 1980. I think it might be March.

05-01:35:01
Clemens: Was it that early?

05-01:35:03
Burnett: I'm not sure. I'll have to get back to you on that.

05-01:35:07
Clemens: Okay. Well, I first heard about it in a seminar up in the Earth Sciences Building when they announced their hypothesis. As I remember, that was prior to publication.

05-01:35:35
Burnett: So you did have an immediate reaction to it, I suppose?

05-01:35:38
Clemens: Oh, sure. Because the paper really isn't about dinosaur extinction. It's about their evidence that the iridium layer or the iridium anomaly was produced by the impact of an extraterrestrial object, an interesting argument. Then at the end of the article, oh, and this occurred at the time the dinosaurs became extinct so it must be the cause. Dinosaurs were added as a tail to their hypothetical kite, but it was a tail that would attract attention.

05-01:36:31
Burnett: That's how it begins for you in your encounter with it here on campus.

05-01:36:35
Clemens: Yes. And I must admit that for a number of years I actively looked for accounts of anomalously high concentrations of iridium in geological situations, and there are lots of them. As we find out more about iridium it's a mobile element. It's characterized as one of the noble elements, yet it's been found in chemical combinations. Bacteria can move it around. But anyway—

05-01:37:34
Burnett: Right. I just wanted to get the story of just the very first encounter that you had with this idea and what would become a publication later. So we'll leave that for next session and we'll talk about it.

05-01:37:50
Clemens: Yes. Put the burr under the saddle.

05-01:37:52
Burnett: That's right. That's right. There we go.

05-01:37:54
Clemens: Okay, good.

[End of Interview]

Interview #6 June 2, 2015
Begin Audio File 6 clemens_bill_06_06-02-15_stereo.mp3

06-00:00:07
Burnett: This is Paul Burnett interviewing Bill Clemens for the Bill Clemens UCMP Oral History Project of the University History Series. It's June 2, 2015, and we're here in the Valley Life Sciences Building and this is our sixth session. So last we left off you were just starting to talk about David Archibald's research. And one of the things that David Archibald wrote—he's one of your students, of course, that we interviewed in this, part of this project. He wrote that before all of this controversy got started around the impact hypothesis, starting in 1980, up until the 1970s the K/T boundary wasn't much of a concern. And people usually marked it as being when the dinosaur fossils stopped. That was kind of a rough and ready approximation. Because there were other fish to fry. There were other concerns. And he started doing a lot of mapping work for you and he—

06-00:01:25
Clemens: As part of his dissertation, yes.

06-00:01:27
Burnett: Right, as part of his dissertation. And he made some discoveries about the disappearance of dinosaur fossils in the record and its relationship to other rock strata. So could you help us set the scene in terms of what you and other researchers were doing prior to the impact hypothesis in terms of mapping out the kind of geostratigraphy and biostratigraphy and in terms of understanding roughly where and when organisms died out and where and when they flourished.

06-00:02:16
Clemens: Okay. We need to go back. I'd agree with David that the Cretaceous-Paleogene boundary or Cretaceous/Tertiary boundary as recognized in the terrestrial fossil record hadn't really been an object of deep research prior to the impact hypothesis. In the sixties you had Norman Newell, the invertebrate paleontologist at the American Museum of Natural History. He was concerned with the marine record and pointed out that the mass extinctions were correlated with major regressions of the oceans. Okay? I think it's fair to say that didn't have much influence on what folks were doing with the terrestrial record. In terms of research in the 1900s, up to 1980, people used a formula developed by a paleobotanist, Roland Brown. He was an employee of the US Geological Survey. The Survey, starting in the teens and continuing into the twenties and thirties, was charged with mapping and evaluating coal and oil resources. A little later their roles expanded to think about water: water power for generation of electricity, water for irrigation.

So Brown went back to an observation or a hypothesis developed by W. R. Calvert and basically argued that to find the Cretaceous/Tertiary boundary, you went out, you found occurrences of dinosaurian fossils and traced them

up the stratigraphic column. The first lignite above the last dinosaurian fossil marked the Cretaceous/Paleogene boundary, and assumed that the dinosaurs became extinct at the same time throughout the area. For the kind of work they were charged with doing, this turned out to be a crude but effective approach to establishing the position of the boundary in the northern Western Interior.

Then in the sixties you get Bob Sloan and Leigh Van Valen and their work around Bug Creek. Leigh and Bob, I have to say, were misled by a misinterpretation of the stratigraphy and developed a hypothesis that the extinction of dinosaurs was gradual. They explained it in terms of an ecological pattern with the dinosaurs living distally from the river courses. The condylarths and other new mammals that were coming in, they lived closer to the river sources. Again, unfortunately that fell apart when we got a better idea of the stratigraphy. But, again, I stress that in the 1970s most of the mapping that had been done in the Hell Creek and Tullock would be regarded as unacceptably crude today.

Now, this is where Dave made a major contribution. In a limited area, he really got in and looked at the stratigraphy in detail. He began to establish the pattern of intermittent deposition of lignite and identify the problems of interpreting ages over distances of miles. So as we came up to the announcement of the asteroid hypothesis, Dave had determined that in the valley of Hell Creek and its tributaries in Garfield County, the extinction appeared to be abrupt. An abrupt replacement, what was going on? You'd go over into McCone County to the east and you had Leigh and Bob's picture of a gradual pattern of replacement. Was this some kind of environmental difference reflecting some kind of ecological difference? If you look at the Mississippi drainage today and all you were to look at was life right next to the river, you would get a very different picture from the diversity of life up on the prairie well away from the rivers.

06-00:09:22
Burnett: So were Sloan and Van Valen, were they mistaking reworked fossils for intact fossils? Is that part of the issue?

06-00:09:35
Clemens: Part of the issue is that they were looking at channel deposits. As soon as you're dealing with channel deposits there's the problem of time averaging, reworking older fossils into a deposit. Your second source of fossils would be the dead animals lying on the surface, and then the living animals that died and their bodies fell or were washed into the stream. You'd have to deal with the fact that in any of these deposits there's time averaging.

The other error—most of these channel deposits, including all that Bob and Leigh looked at, are exposed either on the tops of hills or in areas where there is soil cover that doesn't allow you to see the top of the channel. It's the strata

on top of the channel that tells you the age of the channel filling, not the depth to which the channel is cut. Bob, in setting up what he thought was the stratigraphic sequence of these deposits, focused on the depth of cutting, and that's what led him astray. So currently we're caught with this problem. The abundant collections or assemblages of fossils come from channel deposits, but you've got to realize that time-averaging is always a problem. So to me that was where we were in the spring of 1980 when we first heard about asteroids and that kind of thing.

06-00:12:01
Burnett: Right. And Archibald wrote that—and one other aspect of his research, too, is sort of marking the last evidence of intact dinosaur fossils, which is not necessarily completely related to his primary research. But he found that a full eleven feet below this lignite layer, which then is roughly coterminous with what becomes the iridium layer.

06-00:12:31
Clemens: Some of them are, yes.

06-00:12:33
Burnett: Right. Okay, right. [laughter] In each case we have to be very careful about—

06-00:12:37
Clemens: Yes, we do. [laughter]

06-00:12:37
Burnett: —what we specify. In this book that he wrote later in 1996 on the extinction debates, he wrote that book to signal what the limits were and are of what we can know for certain about extinction. So, intact fossils are reliable because we know that we've got articulated skeletons, where the bones are together. We know that they haven't been moved around by the elements over the millions of years—or the beasts or whatever, that taphonomy has not happened. And so those are reliable but they're reliable ten feet below that marker of the mass extinction. And so that's the area of play that we're talking about to some degree, right?

06-00:13:36
Clemens: To some degree it's significant, the so-called three-meter gap. Well, with the asteroid hypothesis, you hypothesize the development of a cloud of dust, particulate matter blocking out the sun, and marked by a small concentration of iridium, remember we're talking about parts per billion. Then there is an unfossiliferous gap below it. In theory you would argue that, okay, if the extinction was caused by the generation of that dust cloud or associated acids and what have you, there ought to be places where you would find articulated remains of dinosaurs blanketed by impact debris.

06-00:14:45
Burnett: A Pompeii effect.

06-00:14:46
Clemens: A Pompeii, yes, and I still don't know why, but it's out there. Using one bone is really dangerous. Don Lofgren, Carol Hotton, and Tony Runkel wrote a paper in *Geology* describing a channel filling in the Tullock. It's a curious filling. In most of these fillings, you find sand-sized particles. There may be little clay balls, particles that have been ripped up from the bottom or the sides of the channel. But in this one there are these great big blobs of clay. Things like this of clay streamlined, indicating that they've been washed some distance, probably short. Their interpretation, which I think is good, is that a Paleocene river cut into a bank of Hell Creek Cretaceous siltstones and what you're looking at is the residue from the collapse of a bank. Now, the discovery they made was rather neat. In one of these big clay balls there was a dinosaur vertebra.

06-00:16:50
Burnett: Intact?

06-00:16:51
Clemens: Intact. Well—

06-00:16:52
Burnett: Intact-ish.

06-00:16:54
Clemens: Intact-ish but easily identifiable. Carol Hotton looked at the palynology of the clay and found that it was Late Cretaceous in age. So, a bank of Late Cretaceous deposits contained a dinosaur vertebra. In the Paleocene, the bank was eroded and collapsed and you get this thing reworked into a Paleocene channel deposit. That's an extreme example. Still, just shows the care you have to take.

06-00:17:32
Burnett: Yeah, absolutely. That would be very misleading.

06-00:17:35
Clemens: There is another factor that you have to watch out for. Occasionally up in the Tullock at this locality we call the Garbani locality, every so often you find a rather worn tooth of a dinosaur. What's going on here? Maybe I have told this—

06-00:18:00
Burnett: Tullock is post-boundary.

06-00:18:03
Clemens: Post-boundary, yes. That deposit, as far as we can tell now, was formed something like 700,000 years after the boundary. Where are these dinosaur teeth coming from? Well, Clemens' hypothesis number twenty-three here. One year when I was in England I went to Cambridge where Hugh Cott was the Professor of the Department of Zoology. One of his many contributions was his detailed study of crocodiles, particularly the Nile crocodile. He

pointed out how Nile crocodiles living down by Alexandria went upstream to get ballast, if you will.

06-00:19:06
Burnett: Right. Yeah, you had told us about that.

06-00:19:08
Clemens: I guess I've told that story before.

06-00:19:10
Burnett: Yeah, but that's absolutely fascinating as one other example of how other organisms move things around as part of their lives. And microorganisms, too, can alter fossils. There seem to be all kinds of ways in which the record can be quite deceptive.

06-00:19:37
Clemens: Yes. I think in the sixties and seventies we were rather naïve about the nature of the vertebrate fossil record. We were just getting into the field of taphonomy, which has burgeoned beautifully. It gives us an increased awareness and perception of what we're looking at in the way of data. But this is a nice way to segue into the impact hypothesis.

06-00:20:20
Burnett: Sure.

06-00:20:24
Clemens: If you read the first paper which came out in June of 1980 the authors make the statement that basically paleontologists, as they look at the fossils, are looking at the consequences, indirect evidence of what happened. That it's the physical changes; there is where you find the real cause. So there is this dichotomy between the fossil record and your record of, in their case, impact, in the case of others, volcanic activity. To me that's been the longstanding error.

In the 1990s I taught in the introductory biology class and my section was on evolution. People would ask me, "Why do you spend a lecture or two out of your fifteen talking about plate tectonics or talking about changes in ocean basins?" Yes, changes in the physical environment are darn important. But also, in terms of biological evolution, groups can become extinct through competitive interaction or dealing with changes, say, in the flora. There's a biological aspect to it. Oh, I can remember Luis [Alvarez], in one of our discussion sessions, getting up and saying, "You know, dinosaurs lived for over a hundred million years, why should they have become extinct?" Dale Russell, a paleontologist from Canada who was visiting Berkeley, modeled what a dinosaur might look like if it had survived. It was bipedal but no tail and had a sort of inflated head and eyes. If you dressed that thing in a white shirt, a red tie, and a blue suit, and turned it loose on Columbus Circle in Washington it might not cause too much consternation among the passersby. [laughter]

06-00:23:22
Burnett: It would pass for a lobbyist? Is that what you're saying? Maybe?

06-00:23:24
Clemens: Well, pass for something.

06-00:23:26
Burnett: An expert in some field.

06-00:23:31
Clemens: So getting into this I think you have to say that a lot of issues were being dealt with as we got into the debates about the asteroid hypothesis. There was an attack on the view of the principle of uniformitarianism, and it was argued that if you espoused uniformitarianism you were wrong. Well, in the Devonian, I think it would be appropriate to assume that water ran downhill the way it runs downhill today and moving water would cause erosion. By 1980, sure, there's plenty of evidence of sporadic volcanic activity. I don't think the devastation that can come from the atmospheric effects of volcanic activity was really appreciated, but there was no record of impact of extraterrestrial objects. Meteor crater, the Barringer Crater, an argument was going on as to whether that was impact-related or the product of volcanic activity.

06-00:25:29
Burnett: Well, to go back to your earlier quotation of Alvarez, that he said the dinosaurs were these successful organisms. What is it that seemed to kill most of them off or all of them off in one fell swoop? And I think that one of the things that Archibald wrote about was that the extinction is almost the rule, not the exception. It's extraordinarily exceptional for things to survive for a very long period of time. So that's the reality for 99.-whatever percent of organisms in earth's history. So it's not "why did they go extinct;" it's "why didn't it happen sooner?" [laughter]

06-00:26:11
Clemens: Why did they survive? Yes.

06-00:26:13
Burnett: Right?

06-00:26:14
Clemens: Why do we have horseshoe crabs or things like that? No, I think that's a very good point.

06-00:26:25
Burnett: And there are any number of explanations in the course of geologic time why organisms go extinct. But perhaps we should go back to your encounter with this hypothesis. We started to talk about that last time. You went to see a presentation of the paper. And in its original form it was this discussion of the iridium layer and it was found at these—

06-00:26:58
Clemens: At Gubbio and in Denmark, both marine sections. Yes.

06-00:27:02
Burnett: Yeah. And over time I think they found it in other places to make the hypothesis more robust. But that was the initial claim. And you said tacked at the end of it there was this suggestion that this bolite had come from outer space and caused all this devastation. So your reaction to it was it didn't seem that relevant to your work. I'm putting words in your mouth; I don't mean to.

06-00:27:39
Clemens: Yes, you are. [laughter] Maybe they're all quotations, which is good.

06-00:27:45
Burnett: [laughter] So why don't you tell me about what your reaction was and then how the seminars unfolded, how there were these meetings at Berkeley. How did that transpire?

06-00:28:02
Clemens: How did that transpire? Hmm. Okay. Think of Berkeley late May, springtime, beautiful warm weather. I think it was Walter who presented a seminar or a talk based on the paper that would come out in June outlining their argument. He said something about the data that they had, which again was basically drawn from two marine sections. And by the way he added, this is the way we got rid of dinosaurs. Now, at that time there wasn't the recognition that birds are also within the Dinosauria in terms of evolutionary relationships.

Honestly I can't remember whether I was talking to Walter or to Frank Asaro, who was the chemist in their group that included Luis and Walter Alvarez, Frank Asaro, and Helen Michael. But in talking to either Walter or Frank I said, "Look, we're working out in the Hell Creek and Tullock. Why don't I collect some samples for you across what we think is the boundary and see what happens." Fair enough.

That summer, this would be the summer of '80, we went to what's now called Iridium Hill and collected a four-meter section. Now, the way the sampling was done then, Frank wanted us to work in ten-centimeter intervals. Once you got the surface stuff removed, take a ten-centimeter interval, bag it, and just go through the section in these aliquots of ten centimeters each. So we did that and brought them back to Berkeley.

In the fall Helen Michael and her husband and Dale Russell went out to the area around Bug Creek and dug a series of trenches, doing similar kind of sampling. They didn't find iridium in their trenches. Now we have a pretty good idea of why they didn't. There at the K/T boundary you don't have the development of lignite. So as the iridium rich dust came down it would get blown around, incorporated into the soil. Remember, you're talking about a couple of parts per billion.

Well, during the 1980-81 school year I heard nothing about the samples. Then we went out in the field in the summer of ’81. We had no telephone in our camp. Cellphones weren’t a thing of the time. The way to contact us was through the Engdahl Ranch. I guess it was near the middle of our field season. Jane Engdahl stopped by the camp and she said, “There’s this guy, Frank Asaro, and he really wants to talk to you. He really wants to talk to you!” So I called up Frank from the ranch. He told me that they’d gone through some of our samples and at two levels they had found measurable amounts of iridium. Okay. Could we go back and sample those two levels and do it this time in terms of two-centimeter intervals? Fine. We went ahead and did that at Iridium Hill. Later Jan Smit would come out and look at the layer, and I think demonstrated that there was also shocked quartz, which really is important.

06-00:33:43
Burnett: Yeah. That’s the stressed quartz crystals that are evidence of a tremendous amount of stress from an impact, right?

06-00:33:49
Clemens: Basically what they indicate is the crystal was put under tremendous pressure and then suddenly the pressure was released. That is my understanding of why these fractures develop in the crystals. Okay. So, unfortunately Bruce Bohor and Don Triplehorn beat the Alvarezes to the punch and announced the discovery of an impact layer ten miles from where we were sampling.

06-00:34:35
Burnett: So they got scooped.

06-00:34:36
Clemens: Yes. If you want to get into that. Let me put it this way, basically in working with the Alvarez group, there was certainly some friction, but also a certain amount of collaboration, if you will. Not in the sense of working together on a paper but in—let me check—it was 1983 when we organized a field conference. I had the numbers, I think it was thirteen members of my field crew and twenty-six members or participants came in. We ran them through a three-day sequence of looking at various sections. Now, Walter was there as well as Bruce Bohor and Don Triplehorn, several members of the USGS, Malcolm McKenna and Zofia Kielan-Jaworowska. So we had paleontologists there. Leo Hickey was there, so we had a paleobotanist in addition to vertebrate paleontologists. The year before Dave Archibald had teamed up with Ev Lindsay and Bob Butler, who had and would continue to do a lot of paleomagnetic studies. Ev and Bob had worked in the San Juan Basin. So I think it was ’79 that they came up and started collecting samples for paleomagnetic analysis. These were published in those early years and they attended the conference.

06-00:37:25
Burnett: Was that dating evidence? Paleo-magnetic evidence was to show the dating of the rocks?

06-00:37:35
Clemens: The change in magnetic field doesn't occur in regular fashion. The goal here was to see how the change from a reversed period to a normal period was recorded in the San Juan Basin. Where was it in our sections? We used this change to correlate the two.

06-00:38:07
Burnett: Right. You're syncing them basically.

06-00:38:09
Clemens: Yes. But as it turns out now it's what we call C29R, the twenty-ninth, counting backward, reversed period. The K/T boundary, defined by the impact, occurs within C29R. So getting the C29R to twenty-nine normal boundary doesn't tell you much about the age of the Cretaceous/Tertiary boundary. But it is proving to be very useful in establishing contemporaneous levels in various sections, particularly those that don't have volcanic ashes in them.

06-00:39:14
Burnett: Right, right. And this material was presented at that conference?

06-00:39:20
Clemens: The paper had come out before the conference. And it was a—conference. We were out in the field and we were having fun.

06-00:39:32
Burnett: And so was there an exchange? Did Luis Alvarez learn about paleontology, paleontological techniques?

06-00:39:49
Clemens: No, Luis wasn't there. It was Walter.

06-00:39:50
Burnett: It was Walter, sorry.

06-00:39:50
Clemens: Yes. There was a lot of talk in the field and in the evenings. The town of Jordan at that time had three bars. The participants favored one called Kemp's. Kemp's had a stage and a piano where Walter exercised his great talents as a pianist and a singer.

06-00:40:19
Burnett: Wonderful.

06-00:40:20
Clemens: And we had a great time.

06-00:40:22
Burnett: What did he sing?

06-00:40:25
Clemens: Well, I can't remember the—

06-00:40:28
Burnett: Jazz standards or—

06-00:40:29
Clemens: I look back at that conference, a couple of errors on our part were pointed out. I think people who hadn't worked in the area began to see what we were up against, and what the potential might be. So I thought it was a very fruitful encounter.

Now, during, I guess it was '81, we had these every-other-week conferences. Luis and Walter, Lowell Dingus, Dale Russell and I were involved in these. Some of the other graduate students would come in. But often these were confrontational. Though we learned some things from the exchanges, I can think of one really vicious attack that Luis delivered on me, claiming that he was going to destroy my academic career. I think he was a little ticked off because I had applied for and just received the Miller Professorship, which gave me a year to work on my research.

06-00:42:34
Burnett: Well, that's intimidating for anyone to say that. But he was a powerful person on campus.

06-00:42:43
Clemens: Oh, definitely.

06-00:42:47
Burnett: That's a kind of anger, I would think. What precipitated that? Why was he so frustrated?

06-00:43:01
Clemens: I think it was because I wouldn't agree with him on some point. It could have been a major or a minor point, but the lack of agreement with his point of view bothered him in no uncertain terms. As you'll see throughout the remainder of his life, "There are those incompetent paleontologists, stamp collectors like Bill Clemens."

06-00:43:38
Burnett: This real denigration of your work.

06-00:43:40
Clemens: Oh, trying to, yes, which is too bad. Being able to discuss an issue and agree to disagree I think is really wonderful, but to go into the attack mode isn't. But let's get away from that.

06-00:44:06
Burnett: Okay. Sure, sure.

06-00:44:11
Clemens: Okay. One point I'd like to record is the two camps weren't just sitting in two castles throwing things. There was a reasonable amount of interchange.

Secondly, as we got into this debate, the obvious struck me. The more different kinds of information you have the more it will illuminate the problems you're trying to deal with. This started out with bringing Ev and Bob in to do the magnetostratigraphy. In the eighties, early eighties, Carol Hotton joined us in the field. Now, Carol was a graduate student with Jim Doyle at UC Davis. Palynology was her area, and I agreed to basically support her in the field. So I got a palynologist looking at that aspect of the plant record. Dave Fastovsky, who had gotten his master's here at Berkeley, then went on to Wisconsin to work with Bob Dott. Dave was interested in looking at matters of sedimentation. The vexatious problem of channeling was really becoming a burr under our saddle. And so, again, it was this relationship of not being the major professor, but I financially supported Dave's work in northeastern Montana. For me it was a good investment because he knew what we were doing and was familiar with what we were calling localities and so on. So that was another facet.

Then with my own students, Nancy Simmons looked at the multituberculates, these rodent-like forms and their evolution across the boundary. Laurie Bryant, another grad student, got interested in what we call the lower vertebrates: fish, amphibians, and reptiles other than dinosaurs. Now, we were developing these big samples using screen washing. Given my interest and the interests of people like Dave Archibald, we were sorting through the residue that came out of the screens, getting the mammals, leaving the rest but keeping it. So Laurie, with the help of Howard Hutchison and Dave Archibald, basically looked at these samples, and tried to identify what kinds of vertebrates other than mammals and dinosaurs were present. Now, in terms of the museum, at this time we were cataloguing on an electronic database. What Laurie was able to do—first of all, rather than having to enter all the data at a terminal within the museum, she developed a method for using other computers, one at home, to enter data into an electronic format and then load it into the—

06-00:49:17
Burnett: The mainframe.

06-00:49:19
Clemens: —mainframe. Secondly, she and Howard developed a series of analyses so that for the first time we were able to say, "Here we have the following kinds of—at this stratigraphic level we have the following kinds of salamanders. A little bit higher we get a new one or we lose one." That kind of analysis provided this wonderful picture of the change in the other groups in the fauna. Now, the one area in terms of research out there that I was unsuccessful in filling was what we call a megafloral record based on fossilized leaves. Jack Wolfe, with the Survey, came out twice and did a little collecting. For some reason the project just didn't stick with him. Later, and this would be I guess in the early nineties, Leo Hickey came out. He made a couple of major collections of leaves from various levels in the Hell Creek and Tullock. Leo was at the Smithsonian then. I guess it would be in the eighties. The material

was shipped to the Smithsonian just in time for Leo to go to Yale and take a faculty position. So the collection got sent up to Yale. About all that's been done with it is publication of a simple floral list. Leo's student, Kirk Johnson, really struck it rich working roughly contemporaneous beds over in North Dakota. But one of the gaps, and it's still there, is what are the similarities and differences between the floras, roughly contemporaneous floras in these two areas. So there's still opportunity for a lot of things to be done, to add new data, significant new data.

06-00:52:13

Burnett: And it's entering a period, too, where the computerization begins to accelerate. I suppose some of the computational, analytic stuff happens a bit later. But would you say that most of this research and most of these research projects are extensions of work that were ongoing prior to the impact hypothesis? In other words, what was the impact of the impact hypothesis on these kinds of research projects? Was it incidental? Was it a diversion?

06-00:53:00

Clemens: No, I don't want to quote it because I'll misquote it, but Leo Hickey wrote a commentary after Luis died and talked about the man and then said, "In spite of it all, the impact hypothesis stimulated a whole variety of different lines of research." Sure, magnetostratigraphy was developing in the seventies, and bringing it into dealing with the impact hypothesis helped drive the field. The radioisotopic age determinations were important. With Jack Evernden, Garniss Curtis, Don Savage, and John Reynolds here on campus, here was a technique searching for problems. We tumbled to the fact that there are really datable ashes there in the Tullock and, what is it, 1993, when the paper by Swisher and Dingus and others gave us our first set of admittedly crude potassium-argon age determinations. With the sedimentology, that's not my field, but I got new insights from reading Dave Fastovsky's papers. He was looking at the sediments in a way they hadn't been looked at before and contributing to this picture of trying to reconstruct the environment, the fauna, the flora of this area through the boundary. Now, in terms of the Berkeley scene, in the seventies I got to know Jack Horner. I first met him, gosh, years earlier when he was a preparator at Princeton. We got involved when he moved back to Montana where he was born. Well, you want stories, don't you?

06-00:55:51

Burnett: Sure, why not.

06-00:55:52

Clemens: Okay. Each year we would collect something big. We were involved in collecting a dinosaur skull, a ceratopsian skull that had been discovered by a rancher. Glenn Childers, who was the state representative for that area, brought out a young woman, an archeologist from Helena in the state government. Towards the end of our showing her what we were doing and that kind of thing she said, "You ought to go up to Choteau. There's a rock shop there that has lots of little dinosaur bones." And fine, here I am from

California stretching the budget, stretching the time to work in the east. Hey, but Jack, Jack's here. And so I told him about that rock shop. Well, he went to the rock shop and saw the baby dinosaur bones. That led to the discovery of Egg Mountain. Neat, that was the beginning of what's been a very long-term cooperation between Berkeley and Museum of the Rockies with Jack.

What did it do in terms of the impact hypothesis? Well, Jack pointed out an area up on the very northcentral Montana where you could get microvertebrates that were five to six million years older than the oldest ones we could find in eastern Montana. So Mark Goodwin took on that project and here we were getting, a sample collected in the same way, of an older fauna. We could begin to see the patterns of change.

06-00:58:28

Burnett: And that seems to be the key difference. Whereas the Alvarez group was interested in proving the extinction and finding different ways to prove it, one of the things that you stated in your previous interview with Bill Glenn, you talked about "patterns of survival and extinction of vertebrates fully falsify the hypothesis that an impact caused a series of environmental catastrophes embodied in the Dante's inferno scenario." And the Dante's inferno scenario is the description of the consequences, the assumed consequences of an asteroid impact. But the key there is talking about patterns of *survival* and extinction. So you're interested in the development of organisms across this boundary. Those were always the questions for you.

06-00:59:28

Clemens: Patterns of survival and extinction permeate the whole argument or whole discussion as far as I'm concerned. There are others who would not worry about that. Let me give you another Berkeley example that speaks to that. Okay. In the impact hypothesis it is argued that the impact generated debris, a dust cloud that blocked out the sun. Now, they argue about was it three months, one month, ten days. But there's this theme of darkness and cold causing the extinction of the dinosaurs.

Well, on the topic of Berkeley connections, Charles Repenning was a geologist for the US Geological Survey. He took a number of courses at Berkeley. He did not want to get an advanced degree but wanted the background. I got to know Chuck early on in the seventies when we were working up in Garfield County. If you look at Dave Archibald's publication, particularly the geological map, the northern part of the map is based on topographic mapping. The southern part of the map or the southern sliver is traced from aerial photographs. The maps of that area hadn't been produced. Well, Chuck, what a guy, he put in a memo to the mapping division of the Survey saying, "There's important research going on out there. Please put a priority on completing these maps." Within a couple of years we did have topographic coverage of that area. How did this work? Okay, another Berkeley connection was Wann Langston.

06-01:02:00
Burnett: Sorry, what was that name again?

06-01:02:02
Clemens: Wann Langston. He had been my TA in introductory paleo. Wann was then at the University of Texas. Now, in Houston, Shell Oil had its library of collections of fossils, well cores, and that kind of thing. They got into a, "let's clean house, do we really need all this?" mode. They had some material from the Colville River, which is up on the North Slope of Alaska to the west of Dead Horse, and to the east of Point Barrow. The fossils had been collected by one of their geologists, a fellow by the name of Robert Liscomb. Just looking at the bones you would not think they were very old. If you work in that area you'll find bones of mammoth, bison, and other Ice Age vertebrates. They may be stained but they aren't highly permineralized. It was Chuck who first saw Liscomb's collection and recognized their identity. Wann went down and confirmed that this collection from one area that Liscomb had made, consisted of dinosaur bones even though they were stained and had been lightly preserved like those of the Ice Age vertebrates. Well, Wann tried to get the USGS to support an expedition to go up there. I don't know why his proposal was turned down. Chuck got after me, and I put in a proposal. It wound up in the office in Menlo Park and George Gryc was the senior geologist there.

06-01:04:37
Burnett: At the US Geological Survey?

06-01:04:38
Clemens: At the US Geological Survey. I was told George Gryc was the number two man in terms of the USGS hierarchy. And with Chuck's help we put together a proposal for a quick trip up to the Colville River. Now, to get permission to work on this land, which was within the Naval Petroleum Reserve, we had to have Alaskan cosponsors.

06-01:05:21
Burnett: And what year was this now?

06-01:05:25
Clemens: Was it '86?[2] But getting folks to work with up in the north wasn't hard at all. The Allisons, Carol and Ned, were Cal graduates and they were on the faculty at the University of Alaska. So we teamed with them. Don Triplehorn, who was also at the University of Alaska, came along. But George Gryc, sort of looking at the makeup of this group, noted it's going to be USGS money, "Someone from the USGS ought to be there." Well, my daughter Diane had just finished her degree in geology at UCLA. She had received a National Association of Geology Teachers fellowship. This award was made in

[2] The initial expedition to the North Slope in Alaska was in 1985, followed by a period of extensive collection from 1987-90.
http://www.ucmp.berkeley.edu/education/alaska/uam_ucmp_collaboration.html Accessed 5/3/2017.

cooperation with the USGS. So she had spent about nine months at Menlo Park helping Mike Diggles map in the Sierras. As she puts it, “One day Mike came in sort of looking askance at me.” He said, “George Gryc wants to see you in his office.” So she became our USGS representative.

06-01:07:26
Burnett: Wonderful.

06-01:07:26
Clemens: It was great.

06-01:07:27
Burnett: In the family. [laughter] That’s great.

06-01:07:34
Clemens: We went up, found what we now call the Liscomb Bonebed, and got an impression of what was going on stratigraphically. We tied in with the USGS geologists who were working in the area. Unfortunately they didn’t have a vertebrate paleontologist in their particular office. So, on the basis of that collection I was able to get, gosh, what was it, four years of NSF support from Polar Projects and to really work on that fauna. Now, what’s important about the fauna in terms of the asteroid impact hypothesis? Those animals were living well above the paleo-Arctic Circle. Well, there’s debate. Was it eighty degrees north or eighty-five degrees north? Whatever, it was well north of the paleo-Arctic Circle. Fine. We found more dinosaurs. Later we would find mammals and fish, but no crocodiles, no turtles, none of the other vertebrates that are so common down here below the paleo-Arctic Circle. So your argument would be dinosaurs could survive several months of darkness where these other animals couldn’t. Or the critical factor might be the cold. But cold and darkness as factors causing the extinction, the quick extinction of dinosaurs, I think that’s falsified. Very recently a group of Russian and Belgian paleontologists have been working over in Siberia. They’re finding a fauna with essentially the same composition. So the only way to argue it is a variety of different kinds of dinosaurs could survive darkness and cold more extreme than the limits of turtles, crocodiles, and salamanders.

06-01:10:22
Burnett: Right, right. And just to refresh my memory. The dinosaurs are endothermic or most of them are? Is there still debate about that?

06-01:10:37
Clemens: There’s debate about that.

06-01:10:45
Burnett: Would they have to be up there if you were going to make that stick?

06-01:10:49
Clemens: Well, okay, you’ve got two questions going. One, the way I read it, and I’m not biased, the prevailing opinion now is that dinosaurs, including the birds, had some kind of endothermy. Probably the endothermy of non-avian

dinosaurs was not the extreme endothermy you find in birds and mammals. Those processes evolved independently. Your picture changes if you start thinking about all these fuzzy things that we're getting today in the way of dinosaurs. Imagine *Tyrannosaurus rex* in vibrant plumage. It would be great. I think the most telling argument that we had to counter was, okay, sure, you've got a long winter but you also have a long summer. So these Alaskan dinosaurs, all they did was migrate up there in the summer and eat a lot. When it started getting dark they migrated to the south. When we discovered a microvertebrate locality, we were finding the teeth of hatchling dinosaurs—about a millimeter across their bases. This is the size of teeth of hatchlings you'd see at Egg Mountain. They were breeding up there. How in the dickens does this work out? One way pointed out was that we reconstruct the dinosaurs all wrong. The females had pouches in which to carry their young. [laughter] Okay.

06-01:13:04
Burnett: But it complicates the picture and it is potentially a kind of rebuttal to the claim that the winter occasioned by the impact, if it threw out all these—

06-01:13:18
Clemens: The nuclear winters came, that was very early, came out of Ames from a group of four guys who were graduate students of Carl Sagan. You got the nuclear winter hypothesis, which became the nuclear Indian summer hypothesis. Yes, okay.

06-01:13:44
Burnett: Yeah. And it's around the same time, right, that they—

06-01:13:48
Clemens: I think it would be '82, '83.

06-01:13:49
Burnett: Eighty-two. Yeah, yeah.

06-01:13:53
Clemens: That's just another indication of all the things that were going on. This was stimulating.

06-01:14:01
Burnett: It was generative. Yeah. Yeah, absolutely. So why don't we take a short break?

06-01:14:07
Clemens: Sure, let's do it.

06-01:14:10
Burnett: So one of the things that we wanted to talk about a bit more was the kind of popular reception and popular representation in the press of the impact hypothesis and how that played out. How was it received in the press? What was said about the Alvarez hypothesis?

06-01:14:40
Clemens: I think the press played a major role in terms of the reception of the hypothesis, and here I think Elisabeth hit the mark.

06-01:15:10
Burnett: Your daughter. Elisabeth Clemens.

06-01:15:11
Clemens: My daughter, Elisabeth Clemens.

06-01:15:12
Burnett: Historian of science, yeah. Sociologist.

06-01:15:16
Clemens: A sociologist at the University of Chicago now. Debates within disciplines don't really catch the public attention. When you get an interdisciplinary debate going there's a possibility of broader interest. Then bringing in the press to popularize the debate even gives it more advertising. Right off the bat the press was appraised of the asteroid hypothesis. Luis had a lot of friends that he cultivated among the press and so you began getting these articles. In preparation for this interview I was looking at my files. I kept clippings of newspaper articles and by 1983 or 1984, the file was about an inch and a half thick, and this is just what I just saw. I think that file is the one that includes an issue of *Time* magazine. The whole science section, a lengthy science section, was devoted to the impact hypothesis or the Nemesis hypothesis. Folks like me, who weren't caught up in it, were quoted as saying negative things. The debate over the asteroid hypothesis generated a lot of public interest. And then it came at a time when there was political emphasis on this topic. Imagine you as an academic going to an annual meeting and having someone from inside the Beltway come up after your talk and say, "You shouldn't be saying those kinds of things. It's unpatriotic. In fact, you're putting America in danger!" What?

06-01:18:12
Burnett: Well, this is the beginning of the 1980s.

06-01:18:17
Clemens: Well, end of the 1980s and we're getting the Strategic Defense Initiative.

06-01:18:22
Burnett: Yeah, Star Wars, yeah.

06-01:18:23
Clemens: The Star Wars. And over and over again you hear the comment or the observation, "But we've got to have these missiles up in space to stop the missiles from Russia. And, by the way, we can also knock out asteroids like the one that killed our dinosaurs." [laughter]

06-01:18:52
Burnett: Had you been approached or are you just saying hypothetically there are voices like that out there in the press who were saying those kinds of things?

06-01:19:02
Clemens: Well, the incident at that meeting was real.

06-01:19:06
Burnett: Oh, my God. [laughter]

06-01:19:11
Clemens: I think I just bit my tongue and walked away. But no, he was serious. The threat of asteroids that was a way to get money for Star Wars.

06-01:19:28
Burnett: Wow.

06-01:19:28
Clemens: Different time.

06-01:19:36
Burnett: Wow. That's interesting that [Luis] Alvarez's early career was in ground control radar. He had had this long career in physics that had associations with the military-industrial complex and here it is again. [laughter]

06-01:19:55
Clemens: And if you read—

06-01:19:56
Burnett: This fuels—

06-01:19:58
Clemens: I've forgotten which thing I was reading about Edward Teller, but he noticed that. Yes, he had the support of Luis Alvarez. There we go. These were fascinating times.

06-01:20:17
Burnett: Well, I think Elisabeth Clemens noted in her article about this that one of the tabloid articles was—this might have been a kind of distillation or a composite of several headlines. But the headline was "Missiles from Space Killed our Dinosaurs!" So there's this kind of connection.

06-01:20:39
Clemens: Oh, yes, yes. Anything to raise money. Well, that's too crude. But yes, the dinosaurs did get involved in the lobbying and fundraising.

06-01:20:52
Burnett: Yes, they did. They were enrolled in the cause.

06-01:20:54
Clemens: I wonder if they had a Super PAC.

06-01:20:56
Burnett: They might have. A little bit before that time. So the appeal in the press is that it's a dramatic story, right? It's a catastrophe. Gradual evolution over millions of years is already not immediately accessible to large numbers of people. When you say, "Well, hold on a minute, there's *many* possible explanations for this," that's not necessarily as appealing and certainly harder to present in a brief article. So the nature of the media itself favors a kind of simple, punchy, incredibly dramatic catastrophe, right?

06-01:21:47
Clemens: A couple of months ago I was talking with David Perlman, the veteran science correspondent for the *San Francisco Chronicle*. You echoed his point beautifully: dead dinosaurs sell newspapers. Yes, that kind of hook really appeals to the general reading populace.

06-01:22:18
Burnett: Notwithstanding that orientation, though, UCMP and you had done a lot of public outreach and had been pretty successful in generating excitement about your research. Can you talk a little bit about, in these years, what you were doing to promote the kind of research that you were doing?

06-01:22:49
Clemens: Okay. Well, it was 1961. The museum and department moved from the attic of Hearst Mining Building into the Earth Sciences Building. We shared that building with geology and geography and stayed there until, gosh, I've forgotten when we began the move to VLSB but it wasn't completed until '95. And there was a different world up there. And in terms of public outreach, although Don Savage favored it, really it was Bill Berry as director of the museum who really promoted public outreach. We started a program of annual open houses.

06-01:24:04
Burnett: Yeah, you did talk about that before.

06-01:24:08
Clemens: They proved immensely successful. The statistic Bill put in the annual report for, I think it was the 1983 open house, this is one day, over 3,000 people. Thank goodness the fire marshal wasn't one of them. But yes, there was emphasis on that. Kevin Padian worked with the graduate students on a series of lectures for young people. Yes, groups could book tours where they were taken behind the scenes. The preparation lab was always a draw. We had an organization, the Friends of Fossils. Not very effective, but still, it was a fundraising outreach. This was a strength of the department and the combination of the department and the museum in terms of outreach. Outreach just became an extension of teaching.

06-01:25:42
Burnett: Yeah, yeah. And off campus, as well, right? Or to other campuses? Well, others have talked about the development of the website, and that comes later.

06-01:25:56
Clemens: Yes.

06-01:25:59
Burnett: But we talked about the supportive instruction at other campuses. Other UC campuses or other campuses in general?

06-01:26:10
Clemens: In general, other UC campuses. When Bruce Tiffney wanted to start a course on paleobotany at UC Santa Barbara he was loaned a teaching collection. Dan Axelrod, who was at UC Davis, as he retired, what do you do with Dan's very extensive leaf collections that had been the basis for a whole variety of papers? We absorbed them. We've absorbed collections from Riverside and UCLA, and loaned material to Cal State San Diego. So, yes, the museum has and is playing this role of trying to support teaching and research at other institutions. And maybe in our last round we can talk about the Welles Fund and the other funds that we're using now to bring people to Berkeley for research projects using our collection.

The one real difference is, of all things, a dissection lab. When we were up in the Earth Sciences Building, Don Savage started answering the requests of anthropologists and archeologists who wanted to learn how to identify bones of animals other than humans. What kind of environment were they living in? What were they eating? So he started a course, at first it was informal, trying to teach the folks from anthro how to identify the bones of modern animals. Basically the approach is you teach them how to identify the common elements—what do vertebrae look like? What does the humerus look like in general? That kind of thing. Then once you've identified your specimen as a humerus, how do you find out the humerus of what? Well, this kind of approach, kind of teaching, led to the accumulation of a series of skeletal elements. If you get up into the teaching storeroom we have a circus elephant up there. It stands on its left front leg and its right hind leg. The opposite legs have been taken off and went into the element collection, stored according to anatomical element.

And through the eighties particularly, there was this emphasis on getting the skeletons of modern animals, cleaning them, then putting them into the skeletal collection organized according to body part. And as we were teaching archeologists working in North America, not suddenly but gradually we joined this wonderful community of Africanists: Desmond Clark, Clark Howell, Glynn Isaac, and Bob Roddin. They wanted their folks given the same kind of training but on African mammals. So they obliged and brought dead African mammals over and we cleaned them and put them into the collection. And Don's efforts through this sort of informal seminar led to a series of interdisciplinary courses that brought vertebrate paleontologists, anthropologists and archeologists together. And it was great fun. I learned all about the Schlep Effect and what to look for in the way of butchery marks on

bones. We taught them how to distinguish between a cow and a bison and that kind of thing.

06-01:31:48
Burnett: A real exchange. It sounds really exciting.

06-01:31:48
Clemens: Oh, and it was so stimulating. It really led to a community of scholars, which was neat.

06-01:32:02
Burnett: Yeah. Absolutely.

06-01:32:04
Clemens: Now, when we moved down to VLSB [Valley Life Science Building at UC Berkeley], well, there's a dissection lab in the building that's basically run by MVZ [Museum of Vertebrate Zoology]. Our element collection is still out there and used heavily. So that was a product of the eighties when we were in the Earth Sciences Building. Lots of fun.

06-01:32:37
Burnett: Oh, absolutely. I want to spend some time talking about your own personal research and some of the opportunities you had during the 1980s. You mentioned earlier briefly that you won the Miller professorship for '82, '83 academic year and also you were able to engage in some travel outside of your normal expeditions. So maybe we should talk about some of those opportunities.

06-01:33:16
Clemens: Okay. The Miller was a wonderful appointment. At that time the Miller professorship was a yearlong, academic year, nine months appointment. You were expected to be on campus but you were expected to only teach graduate students. You were relieved of all other teaching responsibilities. What was neat was your salary remained with the department.

06-01:33:58
Burnett: That is great.

06-01:33:58
Clemens: So when I was on the Miller professorship, we had Bob Fields from the University of Montana come in. He was a Tertiary scholar. A.E. Wood from Amherst, he was a "Mr. Rodent" of that era. There were two leading scholars on rodent evolution and he was one of them. And then Bob Savage from Bristol visited. We have a fascinating South African cave collection and Bob was interested in the southern African mammals. In terms of my development, the Miller give me a year to work on research relating to what we were finding in eastern Montana, and it brought three fascinating scholars into the department. Of course, they were required to give seminars, weekly seminars. So the benefit to me and our students was just fascinating.

06-01:35:14
Burnett: And you could continue to supervise your own graduate students during that time.

06-01:35:18
Clemens: Yes, and I did. Now, my own graduate students, Dave had finished. It was ’77, ’78 when he went to Yale. One of the students who came in was Zhe-Xi Luo from China, and a year before him Miao Desui. What occasioned all this? Clark Howell, Malcolm McKenna, and Don Savage organized a tour bringing—there must have been close to twenty members of the staff of the Institute of Vertebrate Paleontology and Paleoanthropology in Beijing. President Nixon had just begun to open the doors. They came over and they visited here in Berkeley, a fascinating group. They had their minder with them. When we had a dinner up at our house, he delighted in showing my older daughters how he could pick up five peanuts at one time with his chopsticks. The group went on to New York. I think there was a stop maybe at another institution, but I can’t remember. But I must mention Minchen Chow, who was the chief organizer from the Chinese end. He made an invitation to all of us who had served as hosts, “If you can get yourself to China, we’ll take you around wherever you want to go and look at localities.” So Malcolm and Priscilla McKenna and Dorothy and I got ourselves to Beijing and had a trip that first took us up to the outer part of Inner Mongolia. There was an interesting connection there because Malcolm, coming from the American Museum, brought with him Xerox copies of Roy Chapman Andrews notes about their collections from this part of Mongolia. Andrews’ field parties did a lot of collecting there because after they came out of Beijing and got to Erlian they would have to stop and wait until they got their visas from the Mongolian authorities allowing them to go farther. So Malcolm had Roy Chapman Andrews notes. Between the end of World War II and the Communist takeover, the US Air Force flew that area extensively mapping.

06-01:39:07
Burnett: Right. Of course.

06-01:39:09
Clemens: Of course. So we had copies of these maps, and it was great fun. Our Chinese colleagues would take us to places where the Russians had collected. Later the Chinese had made collections there. Then we’d see if we could match the locality with one of Roy Chapman Andrews’ localities. And what came out of this was a listing of synonyms of locality names. A locality was called this by Andrews, the Russians called it this, the Chinese called it that. Okay, that was good fun and provided a valuable tool for future research.

For the other part of our trip I asked to be able to go down to southern China, one to see a Cretaceous/Tertiary section, which I’m glad I saw. It wasn’t that informative. But also I wanted to go to the karst there by Guilin, the beautiful limestone mountains and all that. My interest in that area was basically from my work in Wales. The early Jurassic mammals I had worked on in the sixties

came from cave deposits in an ancient karst topography. Now, today in Wales there is too dang much grass covering the area and you just don't see or appreciate the complexity of these caverns or slots that are eroded in the limestone. So going to Guilin, it was an eye-opener, and just beginning to get a feel for what the early Jurassic topography and the environment in Wales might have been like.

06-01:41:20
Burnett: Right, right. And that's your signature, too, is that you need to be at the field site, you need to examine the locality to really appreciate what you might find there, right? This is absolutely central.

06-01:41:36
Clemens: Yes, yes. Okay. And then, oh, what happened in the eighties with me?

06-01:41:43
Burnett: Well, you got a leave in the mid-eighties to go to Munich.

06-01:41:53
Clemens: Oh, that was a three-month appointment. Yes, going back to work with Volker Falhbusch and clean up some things that I'd left undone.

06-01:42:13
Burnett: And when was the last time you were there?

06-01:42:16
Clemens: That was when I had the Alexander von Humboldt award.

06-01:42:21
Burnett: The Humboldt fellowship, yeah.

06-01:42:21
Clemens: Which was late seventies. So it was a quick visit in the winter.

06-01:42:35
Burnett: Not that pleasant. But did you get to tie up the loose ends of that research?

06-01:42:39
Clemens: Yes, and it also helped set the stage for going to Bonn in 1990 and '91. That was a full year there. Yes.

06-01:42:57
Burnett: Right. At the Paleontological Institute.

06-01:43:01
Clemens: At the University in Bonn. Yes.

06-01:43:03
Burnett: At the beginning of our interview you mentioned how important it was to have these contacts through travel. That you had worked in the UK and you had spent time at these places. Was this a continuation of that enrichment or

were there specific things that you were looking for to complete when you went to Bonn, for example?

06-01:43:35
Clemens: No, Bonn was an eye-opener. Wighart von Koenigswald was the professor there. Okay. I'd known Wighart for decades, actually I think I first met him when he was a graduate student in Munich. He was working on research involving enamel microstructure, and that intrigued me. So basically I spent the year learning the craft of preparation and analysis of samples of teeth, and working with Wighart on a couple of papers about enamel microstructure. This involved thinking about the development of teeth, a topic that I had worked on with Percy Butler and done a little investigation there. We were beginning to get an idea of Hox genes and their roles in control of development. That would be 1990, yes. Fuzz Crompton was promoting this kind of study. A student of Percy's, Moya Smith, was looking at development of teeth. So yes. That was a personal education. I thought it was great. I don't know why they did it.

06-01:45:45
Burnett: Why they did the study of teeth?

06-01:45:47
Clemens: No.

06-01:45:47
Burnett: Or why they let you—

06-01:45:49
Clemens: NSF gave me a mid-career grant for one semester. Mid-career in1990? Hey, I'm all for it. [laughter]

06-01:46:03
Burnett: Well, they saw that you had some potential in you yet to develop further. Yeah, yeah.

06-01:46:11
Clemens: Yes. The combination of that grant, support from Alexander von Humboldt Foundation, and a little sabbatical salary and we had a beautiful year there.

06-01:46:22
Burnett: And understanding more about the development of teeth will help you in the identification of fossils at different stages of growth?

06-01:46:40
Clemens: Not so much that, although that would help. I was asking questions in the evolution of dentitions how are the size and the position of the cusps determined. One of the things I'm trying to deal with now with one of the Paleocene animals is variation in the morphology of their molars. They have upper molars with a small ledge around the base of the tongue side of the tooth. Now, remember, it's a time-averaged channel deposit. In the sample,

you can find examples of the same tooth, the second molar, and some have the small ledge, others don't. How variable is this in terms of development? It appears that the most variable part of the crown is the base of the crown. So here, trying to make an honest statement about the work of some of my colleagues who say, "Well, is not having this cingulum or ridge a basis for distinguishing a new species from those that have it?" Is that really appropriate? What's the significance of the various crests, bumps, and lumps on teeth?

06-01:48:43
Burnett: Right. Evolutionarily speaking.

06-01:48:45
Clemens: Evolutionarily speaking. And how they are produced and developed. There's a wonderful lab in Helsinki, Jukka Jernvall is the professor there. The lab is really getting some interesting information on development of teeth. The problem is they're using mice, which have a very specialized dentition. Fortunately they began branching out to look at animals whose dentitions are more of what we think is a primitive morphology. It's an exciting field right now.

06-01:49:46
Burnett: We got out of order a little bit here. You became interim chairman of the department or director of UCMP in 1987 and you also, during that period, '87 to '89, you were elected as a trustee of the California Academy of Sciences. So why don't we save that for next time and we can talk about work into the 1990s.

06-01:50:10
Clemens: Sounds like a good idea.

06-01:50:11
Burnett: All right.

[End of Interview]

Interview #7 February 4, 2016
Begin Audio File 7

07-00:00:00
Burnett: This is Paul Burnett interviewing Bill Clemens for the Bill Clemens UCMP Oral History Project. And this is our seventh session and it's February 4, 2016. So that has been a while since our previous session and so some—

07-00:00:24
Clemens: It certainly has. I think the readers of the history need an explanation. Back in May when we had our last interview my wife was in the midst of chemotherapy for pancreatic cancer. One night she fell, broke her leg, blood clots formed and settled in her lungs. She basically went downhill from there and passed away the first of October. So between May and February there have been a lot of things going on. I must say that the cards expressing sympathy and condolences really have been heartwarming. They also reflect the role that she has played through all the sixty years we've been together. When we first came back to Berkeley, it was those quiet times in the sixties. But we were just in the habit we had started in Kansas, of inviting students, visitors, up to our home for lunch or dinner. As the years went by and the children started leaving home, there were bedrooms becoming vacant. So we hosted several, primarily graduate students who were visiting Berkeley. We put them up for a week or ten days. Then the next development came when all the children were out of the house and the cat passed to her just reward; we had the freedom to travel. With professional meetings and travel abroad, Dot made all sorts of friends and contacts. Some of the cards came from people who had only known her in terms of seeing her at professional meetings year-to-year. Of course I'm sorry to see her pass, but it was rewarding to see how many lives she touched in a positive way. Yes.

07-00:03:08
Burnett: And in the interviews with the students, too, Zhe-Xi Luo talked about how, when he arrived here, that you guys put him up and looked after him. He said that was so important to him. Well, that will be part of the oral history. [laughter]

07-00:03:27
Clemens: Yes. [laughter]

07-00:03:28
Burnett: You can read all about it. It was clear that she had a tremendous impact on the community and lent further emphasis to the kind of social nature of paleontological work, it seems. I mean, this is what everybody talks about.

07-00:03:51
Clemens: Oh, really? Yes.

07-00:03:53
Burnett: And I can speak as someone who's interviewed people in different sciences. And there is something fairly unique about the field sciences and perhaps something about Berkeley here and the field researchers. Something, going out on the field, but also at Berkeley, this sense of community, that this is—and others in the interviews have talked about it as a kind of family. And that may be in part due to her way of being in the world and interacting with folks.

07-00:04:32
Clemens: I can confidently say that she contributed. It's not the whole story. It's the general milieu here at the museum. We are a community, and there's concern about one another and what's going on. As visitors come through to work on the collection they get caught up in this. So the network just keeps spreading and spreading. It's wonderful. Yes.

07-00:05:12
Burnett: Right, right. And that's how new knowledge develops, too, along the way, right? This is definitely how science works in a number of ways. So now we're in the late 1980s and we had last left off talking about your time in Bonn. But if UMCP and paleontology is a family, there's also an administrative side to this.

07-00:05:55
Clemens: Oh, there is. Yes.

07-00:05:57
Burnett: And I won't draw any analogies to families but there's certainly some administrative work to do. It's part of the larger university. It's part of the University of California. And there were a number of changes afoot leading toward the end of the 1980s. And you assume an administrative position.

07-00:06:22
Clemens: I did. Let's see, the years were 1987 to '89. The planning for the reorganization of the departments had already begun and the decision had been made to renovate this building.

07-00:06:47
Burnett: The Valley Life Sciences Building?

07-00:06:48
Clemens: Valley Life Sciences Building. And the decision had been made to move almost all the natural history museums into this building. These included the Museum of Vertebrate Zoology and the two herbaria. The Essig Entomology Museum was to remain over in Wellman Hall. When I came in to the interim chairmanship and directorship there were a number of jobs to be done. Also a number of things were in place that I had to work with or work around. Gosh, going back to the 1920s, I guess, there had been a Museum of Paleontology and a Department of Paleontology. I was thrown the challenge of separating the two. Okay, with faculty, they would go into the new Department of Integrative Biology. Staff would stay with the museum, but what about

equipment? There had to be decisions made about shared equipment. For example, in the old Earth Sciences Building, which is now McCone Hall, we had quite a nice metal and wood shop. Now, would it be brought down here to VLSB or would the equipment be merged with a similar shop in one of the other museums or departments? That kind of decision had to be made. There were issues that were quite contentious.

Then, of course, the big job was planning for move of the collections. Now, out in the research collection, the material, most of it, is in boxes without covers. So in an earthquake you would get shaking back and forth, you didn't have to worry too much about things being shaken out of the boxes. But in this move, of course, everything had to be bagged. That required a couple of years of planning and then hiring students to bag collections. Oh, quite a workout. One of the advantages of coming down here to VLSB was the opportunity to have compact storage, in other words, these rolling carts, the storage cabinets on rolling bases. Okay. Up in the Earth Sciences Building our collections were scattered around different parts of the building. Who was going to be the drum major who saw that material from one room went to a particular area of the new storage and so on? All this had to be planned out, and the material secured for transport. Then it took about six weeks for the movers to move everything down here and get it into the proper cabinets. Then we had some money left for unpacking, but not enough. So it's an interesting index. I can go out there and work most days looking through the collection, and everything's unpacked. Then I find a little corner of a tray where the material hasn't been taken out of the baggies, which to me speaks to the extensive use of this collection. If you're going to use it, you're going to unpack it, and there's so little that's left unpacked.

07-00:12:04
Burnett: That's tremendous.

07-00:12:06
Clemens: I think it's a tribute to the utility of the collection.

07-00:12:09
Burnett: Can we get a sense of this operation? Are we talking about hundreds of thousands of specimens?

07-00:12:15
Clemens: Yes. It depends on the way you count them. We can talk about millions of specimens if you talk about the little forams, these microscopic marine organisms. But yes, with one truck that would carry, I would guess, twelve rolling cabinets the size of this guy—the truck had to go up to the building, get loaded, come down here, be unloaded. Over six weeks, about. So just—

07-00:13:03
Burnett: Back and forth.

07-00:13:03
Clemens: Back and forth. Yes.

07-00:13:05
Burnett: Was there any assistance offered by the university or whoever, expertise, in these kinds of large scale moves? Were you guys responsible for how you would tag and organize the transfer of specimens? There's a kind of expert who deals in moving objects.

07-00:13:31
Clemens: Okay. At one level, yes, we were responsible for telling the movers to take this and put it there. With some of the larger material, and the exhibits that we had in the hallways up in the Earth Sciences Building, they hired fine arts movers to do the preparation and the move. Unfortunately, even though there were exhibit cabinets, as you know, in the hallways of VLSB, funds ran out so a lot of these exhibits were taken to off-campus storage and we're only, with some of them, beginning to get them back on display. Other exhibits have been put on loan.

07-00:14:36
Burnett: Well, as with the books at the library, most of them are off-site. There's just no way to store things on this campus given the size of the collection. I imagine it's comparable. What proportion roughly do you think are off-site? Specimens?

07-00:14:58
Clemens: Off-site storage. What, we have four floors in the Campanile, largely material from the tar pits. Also some of the research collections from oil companies that have gone extinct. There's ARCO or—

07-00:15:20
Burnett: Asarco?

07-00:15:21
Clemens: Oh, I've forgotten the name of the company. It was a California company (Atlantic Richfield Company)

07-00:15:30
Burnett: Oh, no, I'm trying to think. An oil company?

07-00:15:34
Clemens: An oil company. We inherited a lot of their samples of foraminifera and other marine invertebrates that they used in directing drilling and developing their fields.

07-00:15:52
Burnett: That's amazing.

07-00:15:57
Clemens: We currently have storage out in Richmond sharing the same building as the Bancroft Library.

07-00:16:11
Burnett: Right. The NLRF, yeah. Yeah.

07-00:16:14
Clemens: One of the collections we inherited was or is the collection made by the US Geological Survey in Alaska. The USGS is moving out of this kind of research. So this collection was moved up from Menlo Park, and we were able to get grant funding to completely modernize its curation. This includes photographing specimens so that the pictures could be put online. That's all going on out at Richmond. So there's really a satellite group out there taking care of that material. Recently funding has been brought together to make use of the collection of tar pit material. I don't want to give a picture of dead storage. There are live people out there making use of it and improving it.

07-00:17:49
Burnett: It's active. Absolutely. That was my question. So for the Campanile tar pit specimens, those can be requisitioned by active scholars? They can get access to the specimens to do research?

07-00:18:07
Clemens: Sure.

07-00:18:09
Burnett: The fact that they're stored, it means they're stored and processed so they can be accessed and used.

07-00:18:18
Clemens: In fact, there is this project going on right now to improve the curation of the material. By improving curation I mean making sure everything gets numbered, and that catalogue number goes into our online catalogue. Now, the identification of a particular specimen may be crude but someone wanting to come here and look at material, "How much do you have of my favorite tiger?" "Go to the catalogue." You'll get an idea. We don't guarantee accuracy, but you'll get an idea as to whether it would be worth your while to come and work at Berkeley.

07-00:19:15
Burnett: Right, right. And in addition to the planned deliberate field prospecting and careful collection and processing and then curation, this inheritance process can yield other challenges. You suddenly get stuff from a defunct oil company, you suddenly get something from the US Geological Survey and you have to find money for it, you have to figure out what it is and how it fits into modern nomenclature or modern best paleontological curatorial practice. That's an additional challenge you have on top of the work you normally do and the way you probably prefer to work, I imagine, right?

07-00:20:07
Clemens: Just to add to that, for many, many years Dan Axelrod was a very active paleobotanist at UC Davis. He collected a lot of material in California and Nevada. When Dan retired academic programs changed at Davis. What do

they do with the collection? Well, we became the repository for that wonderful research collection, but it needed to be curated in the sense of put into the catalogue so people knew what we had. The vertebrate paleontology collection at Riverside, is another example of what we call an orphaned collection. On the other hand, a paleobotanist at UC Santa Barbara, Bruce Tiffany, started a program of instruction in paleobotany. He borrowed material from us so he had a teaching collection. We're getting into playing the role of sort of the, if you will, the central library for the university system.

07-00:21:40
Burnett: Yeah. And in that case it's almost like you're a capacitor for research, so that if something gets extinguished here you can store it up and deliver it to another part of the UC system when there's demand for it.

07-00:21:52
Clemens: We can.

07-00:21:54
Burnett: So that's an important role to have. So, in those roughly two-and-a-half, three years, '87 to '89, this was the overwhelming preoccupation of the directorship? Because you were acting director and then director?

07-00:22:13
Clemens: I started out as chair of the department and director of the museum. The chairmanship disappeared with the formation of Integrative Biology. Both were interim positions. So I was interim director of the museum through '89 and then Jere Lipps came from Davis and was appointed to the IB faculty and became the director. So I was able to give him the pleasure of the big move. [laughter]

07-00:22:57
Burnett: That's right. There was a lot waiting for him when he got here. And is he, Jere Lipps, of the—did I have this right—Signor-Lipps Effect? Is that the same—

07-00:23:09
Clemens: That's Phil Signor and Jere Lipps who developed that very powerful mode of interpretation of the record. And Jere retired from Berkeley, and immediately went down to the Fullerton area. He is now director of the Dr. John D. Cooper Archaeological and Paleontological Center, which is allied with CalState Fullerton. Their major responsibility is dealing with the material that's collected during construction. The zoning, building laws are such that archeological and paleontological sites have to be salvaged in a major construction project. What do they do with the material? So the Cooper Center is now taking over that responsibility. It's great after years of just stuffing the fossils in warehouses. It's being used. Yes.

07-00:24:28
Burnett: And to have a top person in there organizing it, that's a really great gift to that program. And so it was a tremendous challenge, obviously, to plan to lay the

groundwork for this and you had to work with a bunch of people in the museum to make this a job that Dr. Lipps had a little bit easier than it might otherwise have been.

07-00:25:04
Clemens: Well, Bill Berry started the process. I carried it on as it evolved, and tried to set the stage so that Jere wasn't completely blindsided by what he found here.

07-00:25:24
Burnett: And the creation of integrative biology was part of a long process, according to some, according to the people who put it together, to bring the life sciences at Berkeley up to date because they understood that it kind of lagged behind the molecular biology revolution in other universities. So coming from the life sciences it was this idea to leapfrog ahead to a new paradigm of organization of the life sciences. I hope I'm not misinterpreting what they wanted. What does that look like from paleontology? What does that shift look like? How did that serve paleontology? How did that perhaps hinder paleontological research? What were the benefits? What were the costs?

07-00:26:29
Clemens: Benefits and costs. Well, one of the benefits certainly was coming down and being closely integrated with colleagues in biology and botany. I think a major loss was the loss of close contact with the geologists. You've sort of seen this in the evolution of the kinds of work and teaching that are going on in paleontology. Now, what I've seen in the last, oh, five, ten years is that while we've lost—not lost—well, our contact with geologists in what's now Earth and Planetary Sciences has diminished in scope. Where it's building up is with the Berkeley Geochronology Center. The remarkable developments in radioisotopic chronology really fit right in with our interests in the tempo of evolution. Suddenly they're providing the kinds of numbers we need or want. So right now I work in cooperation with Paul Renne, the director of BGC, and one of his talented students, Courtney Sprain, who's actually now working in eastern Montana collecting ashes that can be clearly related to fossil localities. It's a wonderful association. In terms of other pluses and minuses, I don't sense any thing I'd say were major positives or negatives. There have been some happenstance situations that turned out to be very, very helpful. When we moved down here the situation in the old Earth Sciences Building was the faculty members had separate offices, and maybe a small, adjacent lab. Our graduate students were in—I'll call them communal offices. We went to some length to see that the graduate students were mixed according to their research interests, that there was an invertebrate paleontologist, a vertebrate paleontologist, a paleobotanist in every room. There just through the conversation about what they were doing, they would get input on what was going on in the various facets of the field. We came down here, and the building was designed in another mode with the professor, your lab, and then a big lab for all your students were a unit. So getting communication between people in one lab with people in another was a challenge. But here I think I was very lucky because I wound up on the fifth floor down at the east end of

the building, right across the hall from Clark Howell and Tim White, physical anthropologists. In all this reorganization they had decided to join Integrative Biology. It was that connection that was really helpful as I got into research in Ethiopia. Clark had been there for years and really knew the ropes of working in Ethiopia. So I had his wonderful advice and support.

07-00:32:03
Burnett: Space is so important. And in this day, of course, we're talking about the development of online access for UCMP and so the Internet is an incredible tool for scientific research. And at the same time the story keeps coming back to place and space, the ways in which where people do their work in relation to one another matters to the science. And if I'm not mistaken you said that that was deliberate at McCone Hall or at the Earth Sciences Building, that you organized it so that the graduate students from different branches of paleontology would have exposure to one another.

07-00:32:54
Clemens: Very definitely. At times there was a little screaming and yelling, but, it was the pattern. At least from my viewpoint, I think the students benefited from it.

07-00:33:22
Burnett: So it's interesting, then, that the purpose of integrative biology was to reorganize the life sciences along this molecular level and ideally sort of break down boundaries from these hitherto-siloed areas dealing with the life sciences. But you're talking about something different, that the space was rather siloed, that you had a professor and a branch of research with his or her lab followed by the students and then another one and another one but they were not talking to each other.

07-00:34:00
Clemens: Well, okay. This architectural plan you'll see repeated over in the extension to Valley Life Sciences building. The molecular biologists organized their architecture that way. Now, I haven't been that deeply involved with any of them to see how they promote communication between labs. So I really can't comment on that. They do have seminars; I've been over for a couple. But it was that architectural pattern that dictated what was done over here up on the fourth and fifth floor.

07-00:35:00
Burnett: And so it's during this time that you did your sabbatical at Bonn.

07-00:35:08
Clemens: Nineteen ninety-ninety one, right.

07-00:35:10
Burnett: Nineteen ninety-one, so you finished your time as interim director and this process is underway with Dr. Lipps in charge. You go away for that. We did talk a little bit about this and we'll come back to it when we talk about your research. But we were discussing things earlier and one of the things that

happened when you came back from Bonn is that because of the integration with integrative biology your responsibilities changed somewhat. Can you talk a little bit about what was different for you when you came back?

07-00:35:55
Clemens: When I came back. Well, of course, with the beginning of the development of Integrative Biology, we had to revise curricula. Who was going to teach what, what was going to be taught, and that kind of thing. When I got back from Bonn it became apparent that the new tradition was that senior professors should teach in the undergraduate introductory biology course. Our responsibility was Biology 1B. Okay, Biology 1B was taught in a fifteen-week semester. Three faculty, senior faculty, were responsible for teaching in each semester. The way it broke down was that you had your five weeks to teach. Fortunately I was teamed up with colleagues, Vince Resh and Lew Feldman, who were experienced in this area. I hadn't taught in a Biology Department since I was at Kansas. So just coming up to speed was a challenge.

Also there was the problem of increasing enrollments. When I started with the introductory biology we had teaching labs that were designed for about twenty to thirty students. With the increased enrollment they had to pack more students into the labs, which meant some revision of lab content. Also, as the enrollment increased we had to find auditoria that were large enough to hold the class. This meant moving around. I taught in Dwinelle, then in Wheeler Hall in Wheeler Auditorium.

07-00:38:55
Burnett: And these are the turn-of-the-century large auditoriums, aren't they?

07-00:39:01
Clemens: Oh, and it was a challenge. Wheeler at that time had no blackboards. So they brought in these portable rolling blackboards. You had to be very careful as you started writing on them. If you wrote with too much force the blackboard would start moving. [laughter] We wound up teaching in the auditorium here in VLSB. They were just beginning to televise lectures using a handheld camera. There was an interdepartmental scuffle over hard wiring the camera in the auditorium to the university system. So instead each lecture was taped. There was a student hired to take the tapes up to Cory Hall, where they were put on the university web system. Now, several times the student would have to study for a midterm at the same time as I was giving a midterm. So a tape or two didn't quite get up there on time. [laughter] I have a long-time friend, David Potter, who taught at the Open University in England. There they televised the lectures. Talking to David about the care that was taken in preparing charts and so on, practicing, made what we were doing here look really pioneering, to be polite.

07-00:41:33
Burnett: And this was available on the—I'm not quite familiar with this. This is pre-Internet basically, right? And so it was—

07-00:41:44
Clemens: I think so.

07-00:41:45
Burnett: Yeah. Because you wouldn't have been able to stream anything like that. So that would have been on Berkeley's kind of cable access?

07-00:41:53
Clemens: That kind of thing. I never worked the other end of it. But yes, students could bring up a taping of a particular lecture and go through it.

07-00:42:09
Burnett: But that didn't prevent students from going to class because you had 200 students in a class in the intro—

07-00:42:16
Clemens: Three to four hundred.

07-00:42:18
Burnett: Three to four hundred.

07-00:42:19
Clemens: The teaching schedule called for three lectures a week. There was a very nice tradition that the lecturer would drop in on every laboratory section. So we were teaching, what was it, two labs Monday through Thursday. Lew and Vince were great at this and schmoozing with the students. I wasn't as adept as they were. But I took time each of those four days. On Friday we had an afternoon meeting with the GSIs to introduce them to the material they would be presenting the next week. So really every spring there were five weeks when I did nothing else.

07-00:43:28
Burnett: Right. It's an intensive immersive experience.

07-00:43:32
Clemens: Very intensive. I think it worked out well. I'm going to be very interested to see what happens as they increase the student enrollment at Berkeley. No sign of any increase in staff budgets. In fact, they're talking now about a new integration of the biological sciences and the College of Letters and Science integrating with the folks in—oh, gosh, what's it called, the old ag division.

07-00:44:28
Burnett: Natural Resources?

07-00:44:28
Clemens: Natural Resources. So why not have those integrated, and we can save all sorts of money?

07-00:44:37
Burnett: Terrible. I guess this is also happening at a time, and we're talking about the present day, this enthusiasm for online courses and the university is providing

lectures for free and there's this question about what is the product of a university education. Do you think those intro lecture courses, combined with labs, that that is an important instructional approach that should be preserved? The in-person experience of being taught by someone, whether it's a lecture format or a seminar format? How do you see that? Does that need to be preserved or should it be mixed with other things?

07-00:45:37

Clemens: Okay. The present system offers the opportunity for the instructor to bring in clips of lectures presented online or assign them as additional resources. These young students are coming out of high school. In high school they've had a teacher with whom they could talk. Okay. There's got to be an appropriate transition. Having a lecturer there who may be using, hopefully is using, some of these teaching tools I think really is necessary, as are discussion groups. If you have discussion groups you've got to have graduate student instructors to run them. Getting farther on into more specialized courses, personally I can't see a course without an instructor. Maybe that's my limitation. I don't know. There's got to be the personal contact. With many of these textbooks that I was using late in the nineties, they'd have frequently asked questions and answers to them. Fine. But what about the infrequent oddball question you get asked? It's important to be able to answer the student's inquiry about the oddball question as it is to discuss the predictable question.

07-00:48:00

Burnett: And there's a feedback element, as well, I imagine, that the oddball question, every once in a while, a student's question, even if it's very oddball, can sometimes stimulate the professor. It's probably less common in an intro course but certainly when you get to graduate students, it's a matter of course that graduate students influence the direction of research and the kinds of questions that you ask.

07-00:48:27

Clemens: Certainly they do.

07-00:48:28

Burnett: It's a feedback loop, a feedback mechanism for learning and for the professors themselves. But it is a system that is supposed to very rapidly transition a student from the intro course, which is this kind of feeder course. It's a weeding-out course in some ways. And that second and third and fourth year the courses are much, much smaller ideally and it's for the students who have decided to major in that area. And so people have always been fairly easy, I think, on that intro course, saying, "Well, it should provide a stimulus to further research for those who are interested in it or further coursework. But for those who aren't there's going to be a lot of people who drop off on the wayside. So it's not so important to deliver that personal touch to those folks."

07-00:49:35

Clemens: The personal touch has to be there. Thinking back, some of the situations I had to deal with, students coming in who clearly weren't able to or predisposed to think in terms of biology. Yet their parents wanted them to be doctors, and they were under parental pressure. It was obvious that this area wasn't for them. How do you counsel? Well, I can think of a number of times I had to do that. I don't know how successfully. It's self-serving, but I think you can't get away from having human teachers in an institution like this.

07-00:50:58

Burnett: Well, I hope that that continues. But one of the things that has come out of the interviews with your students, your graduate students, is the way in which—and I don't want to get too far afield here—but the way in which you use the field as a teaching laboratory. And some of those who are interviewed talked about this as a turning point for them, that your explanation in the field was very crucial to their real deep comprehension of what was at stake in the work that they were doing. And I think that's something that you've continued to champion the importance of, is fieldwork. Does the field research expand at this period? Does it stay the same? Does it contract? How do you maintain the quality and the quantity of graduate field research in the eighties and nineties?

07-00:52:22

Clemens: Gosh. Okay. I was lucky. I think I got my first NSF grant to support the work in Montana early in the seventies. The last one was in the nineties. So there was the funding to take students out there. Now, the museum contributed a great deal through the years. Funding was a combination of NSF money and museum money, a little funding from other sources, National Geographic for special projects and that kind of thing. What I'm seeing, the trend is more and more students are entering the field. The proportion of them who are field oriented is decreasing but the number, total number, I think is staying pretty constant. It depends upon the university, college or museum and the interests of the faculty or curators, but there are still students going out in the field. One of the things that is changing is that, how shall I put it, the scope of the field project is having to be reduced because the scope of the research questions is changing. You can no longer say, "There's an interesting fauna out there. Go out, collect it, describe it, and put it in context." That doesn't cut it these days. On the other hand, getting experience about where the material is coming from is valuable. Adding to existing collections in the sense of doing stable isotope studies, radiometric or paleomagnetic studies, are valuable contributions. Now in many of these projects the students take an existing collection, go out to the field, add to it, and get the experience about where it came from. They add new research techniques, and they've got an interesting project.

07-00:56:01

Burnett: And it's also, I guess, a function of the integration with the life sciences, not just here but at other universities. If you look at the teaching opportunities for graduates in the eighties and nineties and two thousands, there are teaching

opportunities within biology departments, right? They're finding their feet there because they have also learned all kinds of analytical techniques in doing phylogenetic research and that kind of stuff that fits in with a program in biology. And that can be their bread and butter, in a sense. If the research is more collections based it's also partly a function of that shift, as well, I imagine.

07-00:56:59
Clemens: I don't know if you've sensed it in your interviews with my students, but did you notice how many of them are now in medical schools?

07-00:57:07
Burnett: Yeah.

07-00:57:10
Clemens: I can remember a dean at Howard Medical School calling me up and talking about Daryl Domning. He was coming up for tenure and the dean said, "Well, Daryl's got all these positive reviews from the students. He's a team player in the department. But he works on sirenians. What are sirenians?" Daryl is a outstanding person in the study of these mammals. [laughter] And, of course, he is. Yes.

07-00:57:52
Burnett: Right, right. But they don't necessarily know a lot about what is happening in the field of paleontology, even though—

07-00:58:04
Clemens: No, they don't. We try and encourage our biologically minded graduate students to first take a course in human anatomy. Secondly, if they can, become a GSI or specifically a GSI in anatomy so that they can really handle the material. A number now have made use of that talent, teach in medical schools, and then go off and do their own research on dinosaurs or whatever.

07-00:58:36
Burnett: Well, a number of historians of science have gotten positions in medical schools, as well.

07-00:58:43
Clemens: Oh, really?

07-00:58:43
Burnett: Yes, yes. If you have at all an interest in the history of medicine they encourage you to go in that direction because there is that support and there is that interest there. So these are the big centers of gravity of funding at major universities. It's important for people to recognize where that money comes from and those connections can be made and that's served paleontology or some of the paleontology students well, I think. Because there's other administrative work that you've been doing.

07-00:59:24
Clemens: The nineties were—

07-00:59:27
Burnett: The nineties were heavy—

07-00:59:27
Clemens: Heavy, right.

07-00:59:28
Burnett: —in administration. But before we leave Berkeley there is this consolidation of the life sciences into Integrative Biology. But this is also, in the early nineties, a period of budget cuts at Berkeley. And you weren't director at that time. But as a witness to that how did that impact the work that you were doing and the work of your students and the general climate in the department?

07-01:00:03
Clemens: Oh, gosh. I think for me, and remember I was a curator and so sheltered in part here in the museum, for me it was a concern about graduate student assistance and teaching. Was there going to be enough money so that you could have a teaching assistant in a particular course? And there were constraints there. If you couldn't have a full-time assistant, perhaps there might be funds to hire someone to help with reading exams. There was where it affected me. In paleontology you don't have the expenses of teaching a biology lab, where you have to have new animals every semester, and what kind of constraints there were there I don't know. You felt that there wasn't a lot of loose change around campus.

07-01:01:35
Burnett: But the reorganization, that was a deep investment and that was planned over a long period of time. So even with the budget cuts, that money had already been earmarked? They didn't cut into it more as the early nineties—maybe that's not your area so much.

07-01:01:58
Clemens: You have to think of two budgets. Each museum has its own budget. The museums answer to the Vice Chancellor for Research. Integrative Biology answers to a dean in the life sciences. So I think the museums have a bit of wiggle room there. We'll try to do it on the departmental budget, but, if it's really important, maybe we can find some money in the museum. We used that kind of maneuver.

07-01:02:56
Burnett: Well, I guess in 1994 there was a big reorganization into a large consortium of the Berkeley natural history museums and that was seen as a way of becoming more efficient, I suppose.

07-01:03:08
Clemens: More efficient and effective in speaking to the Vice Chancellor for Research. Speaking with one voice can be louder than three or four small voices.

07-01:03:26

Burnett: Very true. So at this time, at the very same time that there's all this activity on campus, there's two other levels of administrative participation. So in 1988 you're elected as a trustee of the California Academy of Sciences. Can you tell us a little bit about how that evolves for you? Because you're not just a trustee for long. You eventually go up the chain, as it were. So can you talk about how that evolves for you?

07-01:04:04

Clemens: California Academy of Sciences, situated over in Golden Gate Park in San Francisco, had long been a place I was taken as a child. Later we took our children. I had contacts with some of the curators in the academy. Jacques Gauthier, one of our graduates, became a curator of herpetology at the academy. Lowell Dingus worked there designing their paleontological hall. I forget whether it was Lowell or Jacques who asked me to come over and give a series of lectures about paleo to their docents. That was fun. But I think that was the introduction that was needed, and I was invited to join the trustees. The trustees group is interesting. It's atypical because the bylaws of the academy require that six or seven of the trustees be scientists working preferably in the Bay Area. The remaining trustees, and I think the maximum now is thirty-some, but it varies, are members of the community with interests in the academy. As trustees of museums, you are expected to be sources of funds. So you've got this fascinating interplay between the scientists and the community members coming from very different fiscal and social backgrounds. It was fun.

After coming back from Bonn I was elected president of the trustees. Now there are two senior positions in the trustees. The chairman of the trustees and, unfortunately it's almost always been a chairman, is responsible for the administration, the finances, the hiring of the executive director and so on. The president is responsible for representing the curators and the scientific program. So basically during those years I was arguing for, one, increasing the salaries of the curators and their staff. Living in San Francisco even then was on the expensive side.

Then we had the challenge of the building. Now, the site where the academy and the de Young Museum are built was, until, what, the 1906 earthquake, was an area of sand dunes. As they moved out there to build, one of the earliest buildings at the academy was what was Bird Hall. Literally they scraped off the top of the sand dunes, smoothed them out, and then put down the foundation on top of the sand. Talk about seismically awful. Then the academy building had been increased in size by an addition here, an addition there, a connector there. So there wasn't really a thought about an overall functional pattern. Then there was a fire in the gift shop, a small fire, not much damage to the stock and so on. But it was large enough to require clearing the walls. As they did that they saw all the old wiring and plumbing that needed to be upgraded. So we were faced with making a decision about

going to a major expense to try and refurbish the existing buildings or move out so that the building could be remodeled. We tore down everything except a little corner of the foundation over in African Hall. So it's a remodel, not a new building.

07-01:10:06
Burnett: Okay, yes. For zoning and coding purposes.

07-01:10:08
Clemens: Coding, yes. Then the decision had to be made to just shut down the academy for two-and-a-half years and put everything in storage or try to keep some programs going in a temporary site. Basically they were hard decisions to make and involved all sorts of funding. But ultimately the decision was made to completely rebuild the buildings in Golden Gate Park, during that period move to a vacant building down on Howard Street and keep our scientific and educational staffs working there. We moved some exhibits and most of the collections down there. That was a challenge.

07-01:11:17
Burnett: I imagine.

07-01:11:19
Clemens: The invertebrate zoology collection and some of the vertebrate specimens are preserved in alcohol. The Fire Marshal of San Francisco had never been presented with this kind of challenge. How do you design storage facilities for these, that kind of collection? Basically a liquor warehouse. Yes.

07-01:11:50
Burnett: Yeah, a bunch of little bombs.

07-01:11:53
Clemens: So it was done, and that worked quite well.

07-01:12:03
Burnett: Well, can I ask how the California Academy of Sciences is funded? Does it have an endowment or is it the State of California that supports it? And then for the financing of this, was there a bond issue? Is it just way more complicated than that?

07-01:12:23
Clemens: No, those are good questions. First of all, there is the Steinhart Aquarium. When that was given to the City of San Francisco the city agreed to provide salaries for the technicians needed to keep the tanks going and maintain the fish. So yes, part of the budget of the academy comes from the city. The academy has, over the years, developed a major endowment, but a 5 percent draw on the endowment doesn't go that far. I don't know the current proportions but one of the major sources of income is the entry fee. It's sort of fascinating the way they structured it. For a single entry you pay a healthy amount. But you can also buy a family membership, which gives you an unlimited number of visits each year. Now, I thought if they do it this way

you're cutting revenue with these family memberships. But, no, it turns out people are buying them on speculation that they might come back. Of course, there are all sorts of other money raising activities around the academy. I'm rather tickled the way they use it in the evening. Thursday evening, band, bar, have a party in the basement. Other evenings they have sleep outs for kids. They're scrambling like any institution has to.

07-01:14:49

Burnett: And I think if you get a membership in one of, there's like a kind of association, like the Oakland Zoo and the aquarium. So if you get a membership in one you get a discount at another. So they're very savvy. And they also know their market, right, because families are the ones who go, I think. Right? That you bring your kids. As you said, you brought your kids and you went as a kid. It's a family educational event. There's a civic element to it. It's sort of pride in where you are and a window to the world of science. It's such a wonderful kind of public institution in that sense.

07-01:15:30

Clemens: Yes, it's great. I was really pleased to be able to help out.

07-01:15:39

Burnett: You weren't expecting that kind of work, though, when it came to the building—

07-01:15:42

Clemens: I wasn't expecting the problem with the building. That was a learning experience, and I sort of enjoyed it. I had another learning experience going at the same time.

07-01:15:59

Burnett: Well, you were also simultaneously, or not quite coterminous, but from 1991 you got back from Bonn and you became the president of the Society of Vertebrate Paleontology. So this is the, pretty much the—I don't want to say the—one of the most important international institutions.

07-01:16:23

Clemens: In vertebrate paleontology, if you measure importance in terms of size of membership, support of publication, support of educational programs, yes, it's the big one. On the other hand, a number of our foreign colleagues have lobbied successfully so that the SVP has met in Bristol and it's met in Berlin. It truly is an international society now. Where were we in the 1990s, oh, we had foreign members, but not that international scope. I'm just thinking that one of my former students, Marisol Montellano from Mexico, I had her nominated and she was elected a member of the executive committee for, what was it, three years. And we had Canadian, Betsy Nicholls who was another member during my term. I can't remember someone outside of North America being on the executive committee during that period but those days are behind me, and what's going on now, I wouldn't be surprised.

07-01:18:19
Burnett: Yeah, all the sciences and all the social sciences, humanities, there's been this big push for the—because often the meetings of the major association either originated in the United States or they became the dominant because of just the critical mass in the United States. And people just got sick of coming to the United States every time. So they've done a lot to move the meetings elsewhere around the world to make it more truly international.

07-01:18:52
Clemens: Today I got a survey request from Geological Society of America, "Would you be interested in attending a Geological Society of America meeting in Ethiopia?" [laughter] Fine. If I were still working in Ethiopia I'd be delighted to. It just shows you how the networking of societies and scholars is just growing.

07-01:19:30
Burnett: Absolutely. Absolutely. And so I think in the earlier interview you were talking about the size of the paleontology community, the international paleontology community in the 1950s. I mean, you would go to a meeting, I don't know how many people would be at that meeting.

07-01:19:53
Clemens: Thirty or forty.

07-01:19:55
Burnett: Thirty or forty.

07-01:19:56
Clemens: The first meeting I went to was at the University of Michigan and we were in a classroom. I would guess thirty to forty people were there. Then about a decade later, when I got to University of Kansas, my colleague Ted Eaton and I ran an annual meeting of the SVP. It was the first one when the attendance went over a hundred. Now, I do want to stress "we ran". There was no staff of the society. We did the mailings and that kind of stuff. The museum at KU provided some funding to help us with the meeting but it was, by modern standards, an amateur society. So when I got on to the executive committee more rapidly than I had expected, things had to change. The procedure in the bylaws was that you're elected as a vice president, and you serve two years. Then you become president for two years, and then continue on for the last two as a past president. Well, in spring I was elected vice president. The colleague who was going to be president resigned. So by the fall, the meeting in Albuquerque, I found myself president, which was a shock. Fortunately the past president, Rufus Churcher from Toronto, was just so very helpful.

At the time I became president we had an office in Nebraska, at the University of Nebraska. One woman was hired to be secretary, bookkeeper, that kind of stuff. Not to demean her, but she wasn't a lawyer. She couldn't advise us on insurance. She wasn't a meeting manager. She couldn't help us with finding appropriate venues for meetings where the attendance was getting up to

around a thousand. So it wasn't dissatisfaction with our employee, it was sort of realization that we'd grown, we needed professional management. That was the major transition that I got involved with in the SVP. Fortunately I had the help of John Bolt at the Field Museum. John was our treasurer and he was tight. He kept us on the straight and narrow. Also, from his own contacts and from the management committee, he set us up with the beginnings of what has become an important endowment. Again, it's sort of like the Cal Academy. You need your funding from membership dues, what you can garner in terms of sale of publications and so on. The annual meetings need to make a profit. We don't talk about that much. You certainly don't go in the red with the annual meeting. So when I think of the finances of the society, I think we got them on a good start. Oh, I can't say they're great now, but any society needs more money. Yes. But it isn't a matter of facing over-expenditure as far as I can see.

07-01:25:03
Burnett: And membership since that time, it's more, right? It's grown even more?

07-01:25:09
Clemens: It's over 2,000 with a lot of foreign members. I don't know whether that figure includes the program where a member of the SVP can make a donation to provide membership for someone in a Third World country. We are providing people from disadvantaged countries with memberships, facilitating international communication, and providing access to the journal. I'm really pleased to see the way the scope of coverage of the SVP has expanded.

07-01:26:20
Burnett: Well, you made your contribution there. So late eighties you were overseeing the planning stage of the transition to integrative biology at Berkeley and then you were president of the Cal Academy of Sciences and also president of the Society of Vertebrate Paleontology, and you were a professor with students and teaching responsibilities.

07-01:26:53
Clemens: Oh, busy decade. Gosh, yes.

07-01:26:56
Burnett: It was a busy decade. What we can do I think now with our remaining time is maybe set up for next time how you're research interests were evolving, maybe at and coming out of the time at Bonn in 1991, the year you had there and how that impacted you, what you were learning, who you were coming into contact with, and how that fit into your work with your students and your own research interests. How things changed in that time.

07-01:27:32
Clemens: Yes. That's a good plan for the next session—do you want to do that today or next time?

07-01:27:44
Burnett: Let's just talk a little bit about Bonn again because we did talk about it in our last session.

07-01:27:52
Clemens: Okay.

07-01:27:52
Burnett: But I think just to talk a little bit about some of the research that you were doing and your contact with Wighart von Koenigswald. I don't know if that's correct.

07-01:28:16
Clemens: Yes, Wighart.

07-01:28:16
Burnett: Wighart, okay. And he was director of the Paleontological Institute at the University of Bonn. And so can you talk about how that year helped you think about your work?

07-01:28:35
Clemens: Okay. Through the years I took maximum advantage of sabbatical leaves, and felt if I were going to take a sabbatical, I needed to get out of Berkeley. Early on in the seventies I'd had a Miller professorship here at Berkeley, stayed in Berkeley, and didn't get as much done as I really wanted to. Dorothy and I did have the limitation in terms of our children's schooling. So yes, Dorothy and I took off. I had earned a sabbatical for the '90-91 year. Earlier in my research on Mesozoic mammals I'd got interested in the microstructure of tooth enamel, particularly work being done by Giselle Fosse in Norway, Sandy Carson, who's now at UC Davis, and Dave Krause, who's at Stony Brook. At that time Dave and Sandy were students at Michigan and had investigated microstructure of enamel. Their work was interesting. I'd known Wighart von Koenigswald since he was a graduate student. We had corresponded and met at meetings. We just sort of planned it out that, okay, I'd go to Bonn. Dot and I would go to Bonn. How would we fund it? Well, I could get half a year on sabbatical salary. I had been appointed an Alexander von Humboldt scholar or senior scientist years before but hadn't used up all my allotted time. So I had a couple of months' worth of support. Wighart was able to convince the Humboldt folk they ought to finish off my grant. And then, of all things, I got an NSF mid-career grant to fill it out. They had great expectations for my longevity when I—[laughter]

07-01:31:50
Burnett: Right. Well, they turned out to be right.

07-01:31:54
Clemens: They turned out to be right. So there in Bonn working with Wighart I really got into microstructure, the study of enamel microstructure. Also, he gave me the opportunity to work on a skeleton of an Eocene mammal from the oil

shales at the Messel Pit near Darmstadt, which is interesting. To work with material preserved in oil shales is a challenge, there's plastic flow in the bones.

07-01:32:41
Burnett: What does that mean when it's preserved in oil shale? What are the consequences of that?

07-01:32:47
Clemens: Something gets into the bone. The bone gets a little plastic flow, so that if you look at the articulations on, say, the right ulna and the left ulna, they'll be slightly different because they've been—

07-01:33:08
Burnett: Deformed, I guess.

07-01:33:09
Clemens: —deformed a bit. And how do you make interpretations, what characters can you rely on as being the original characters? It really gets interesting. So that was a year when I could just explore. It was fun, and a relief from some of the things that were going on in Berkeley. One consequence of my stay in Bonn was a postdoctoral fellowship for Clara Stefan. Clara a student who completed her degree with Wighart, came over on a German fellowship to do a year here in Berkeley. So I had a student focusing on enamel microstructure working here. It quickly became apparent that we really didn't have the facilities to get deeply into the study of enamel microstructure. Clara did a nice job with the facilities we had and produced a significant research paper. But it just taught me this isn't the way I wanted to go for the next decade.

07-01:34:48
Burnett: And was that because of what was available at Berkeley or was it because the field or the confluence of fields had not yet gelled in that area of working on microstructure of dentition? Because that does become important later, right? It becomes very important.

07-01:35:06
Clemens: It becomes very important. Two points. One was the lack of a dedicated scanning electron microscope and someone to maintain it. Now, there was and still is the Ogg Lab over in Giannini [Hall]. They have nice electron microscopes, state of the art equipment and you can book time on their equipment. In my experience using their microscopes, the technicians had the scope I used up to snuff but it could have been fiddled with, tuned to get better images for me.

07-01:36:00
Burnett: Right. They weren't used to dealing with the kind of work that you needed done. Yeah.

07-01:36:09
Clemens: We needed a clean lab to polish and etch the specimens. Yes, we've got an acid lab down here. It tends to be a little on the disreputable side. [laughter]

But now, particularly with Kevin Padian and his students, who are looking at microstructure of bone, they have been able to convert one of the rooms down here into a clean lab. But that wasn't available when Clara was here. The other aspect of this, and this goes back to the year I spent in England sort of bouncing between Royal Holloway College, University College and the Natural History Museum. Percy Butler was the professor at Royal Holloway College and a remarkable man in terms of the width and breadth of his studies of dentitions. Apparently this showed up when he was a student, undergraduate student at Cambridge. And at his memorial, and he died at an age of over a hundred—

07-01:38:00
Burnett: Oh, my goodness.

07-01:38:02
Clemens: I was told that as an undergraduate he was known as Premolar Percy. He had a long-term interest in dentitions.

07-01:38:15
Burnett: That's commitment and focus. [laughter]

07-01:38:18
Clemens: Percy pioneered, in thinking about the genetic control of tooth morphology, and basically he was not looking at particular genes. He was looking at the control patterns. This was fascinating. What controls the development of these complex occlusal patterns of upper and lower teeth in mammals? Our upper and lower teeth form in isolation in the upper and lower jaw. They are not touching. What Percy was able to show was that, in a bat, which has a very complex dentition, at any stage of development you can take the dentitions out and they'll occlude perfectly. What's the correlation in development? Or what's causing this correlation in development that keeps the lower teeth in step with the upper? That was sort of the level we were working at in the nineties, early nineties. Now, with [A.W.] Fuzz Crompton and his student [Andrew] Lumsden getting into Hox genes and genetic control, it's been a quantum shift in terms of trying to address the same questions. I need to mention Jukka Jernvall and his lab, they've done so much along this line. And it's important to me. Thanks to them, I have genetic explanations so that for some characters of the morphology of a tooth, I can put more weight on them in developing evolutionary hypotheses. Other characters can be shown to be subject to individual variation. It's a different world.

07-01:41:04
Burnett: So some are more highly conserved by evolution? Whatever genes code for that, are very, very, very old and you can go back and look at fossil evolution and see that those—

07-01:41:18
Clemens: We hope so. That's the way we're going. Yes. Jukka and Alistair Evans, in Australia, others have gotten into this area. Greg Wilson went over. I wish he had spent a full year there but never mind. But it—

07-01:41:48
Burnett: It had a huge impact on him. Yeah.

07-01:41:53
Clemens: Yes. Another colleague of Jukka's is David Polly. Going a different way, David did some interesting work on the evolution of shrews in Europe. Where did they come from after the retreat of the glaciers? How did they get into England, or by what routes and from where? Now, the routes of dispersal are not recorded directly in the teeth but the teeth do have signatures of their heritage. It is an interesting study that he pulled together.

07-01:42:46
Burnett: And is it at that time where paleobotany is starting to come in? Because the nice chance element is that teeth tend to be preserved fairly well. So you have this abundance of teeth but teeth also tell you about what mammals ate or can tell you what animals might have eaten and something about their ecological niche perhaps.

07-01:43:16
Clemens: Perhaps. All those are valid questions. All those are lines of research that are being developed. There are questions coming out about just what are they telling, these scratches on the teeth and different morphologies. These areas of research are in development. They give promise but it's not like turning off and on a switch.

07-01:44:03
Burnett: No, no, certainly not. What seems to be clear is that there's this mutual stimulation of research questions from the different sciences converging. There's an interest in obviously evolutional developmental biology that's in play here, but there's also an interest, in order to understand the lineage of these organisms beyond morphology, it's a concern with climate change. It's a concern with how do organisms adapt to a changing environment. And you can see how that can be funded perhaps more easily. Or no? Do you think there's this move—

07-01:44:49
Clemens: Well, looking at my colleagues, Tony Barnosky and Liz Hadly at Stanford, yes, climate change is really in the news and fundable, I think, from what I see them doing. They're supporting several students here who are making their mark in the area. So yes, we have to follow the trends. Look where the gold is.

07-01:45:26
Burnett: Yeah. But I mean the story is always that there are public concerns about X-issue and scientific research can be oriented towards that. But scientists will do their own research that they need to do according to the questions that are,

in some degree, internal to their discipline, right? But they can understand which way the wind is blowing funding-wise and adapt, keeping in mind that they're going to do what they do.

07-01:46:01
Clemens: And add to that this interest in public education. There's something stimulating about having your thoughts directed in an appropriate venue for K-12 students. Every so often I've led tours of young kids. It's fun to talk to them about what I'm doing and answer their questions. So that this is a wonderful aspect of the museum, our public outreach program. Just go down the list of things they're doing, Understanding Evolution, Understanding Science, and tied in with the Paleontological Society, GSA, and US Geological Survey's so-called Paleo Portal. All these go out on the Web. Lisa White, who's now the assistant director for public outreach, she's generating more. So it's great.

07-01:47:25
Burnett: Well, that's a whole story, too, that we've talked about with some of the students, about the web presence of UCMP. It was one of the first websites, period, on the World Wide Web. It was like one of the first hundred websites and David Polly was involved in—

07-01:47:49
Clemens: David Polly and Rob Guralnick.

07-01:47:51
Burnett: Rob Guralnick and others, too. But one of the anecdotes that David Polly talked about is that he wrote to Tim Berners-Lee, basically one of the inventors of the internet, to ask him about coding and protocols. So he could write to him and got an answer from him.

07-01:48:14
Clemens: Great for Dave.

07-01:48:15
Burnett: So, this sense that this was a small world at that time that then just metastasized into this global thing we know today. But UCMP was at the forefront of that. And talk about public outreach. This is one of the first things you could do as a teacher going online, is find stuff about the stuff that the UCMP was doing and had. So it's an absolutely crucial aspect of scientific research to do this kind of public outreach. Well, perhaps we should leave it for then and we'll take up next session.

07-01:48:57
Clemens: Sounds very good. We'll start the new century, which was a very definite change of pace for me.

07-01:49:05
Burnett: Yes, yes. But still lots to discuss. Absolutely.

07-01:49:08
Clemens: Oh, yes.

[End of Interview]

Interview #8 March 10, 2016
Begin Audio File 8

08-00:00:07
Burnett: This is Paul Burnett interviewing Dr. Bill Clemens for the Bill Clemens UCMP Oral History Project. And it is March 10, 2016 and this is our eighth and I think final session. And we are getting into the latter part of your career and into the 1990s. There are some new sites for research that you become involved in. Can you talk a little bit about the Blue Nile Gorge Expedition and how that was undertaken?

08-00:00:54
Clemens: Okay. Like so many things in paleontology they have a long history. When I came back to the faculty at Berkeley my colleague and former major professor Don Savage was teaching a seminar every year or two to anthropologists and archeologists, teaching them how to identify mammal bones and bones of other vertebrates. Over the years this developed into a course where Don and I would talk about anatomy, how to identify bones. Then Clark Howell, Tim White, Bob Roddin would get into how you interpret butchery marks. What's the Schlep Effect in terms of a collection of bones? So there was a long-term cooperation. When we moved into the Valley Life Sciences Building it turned out that I was assigned an office across the hall from Clark and Tim.

I don't know just what sparked it. Mark Goodwin and I were talking to Craig Wood, or C.B. Wood, who was a student with me, a pre-doctoral student for a year. He got his degree at Harvard. C.B. and Chuck Schaff from Harvard had gone into the Blue Nile area looking for fossils and were successful. Now, Tim and the physical anthropologists, they go out into the Afar chasing their fossil folk. Given C.B.'s and Chuck's success we instead went north into the Blue Nile Gorge looking for Mesozoic fossils, dinosaurs, crocs, turtles, and hopefully mammals. We did this for two years. It resulted in one minute, somewhat fragmentary mammal tooth. But it turned out to produce records of a variety of turtles and crocodiles and so on. And then Mark went north into Tigray and ran into a Triassic deposit that had all sorts of primitive amphibians in it. So that started the ball rolling.

08-00:04:12
Burnett: And this was when? Just to be sure.

08-00:04:15
Clemens: I'd have to check on the date.

08-00:04:16
Burnett: Yeah. Early nineties? Does that ring a bell?

08-00:04:23
Clemens: I think it was after I retired.

08-00:04:24
Burnett: Oh, okay. Okay. I wanted to ask because I thought—

08-00:04:29
Clemens: Maybe not. Let's ask Mark.

08-00:04:31
Burnett: Yeah. Because I think there was a Blue Nile Gorge expedition with Mark Goodwin in 1993.

08-00:04:39
Clemens: Okay, then you're correct. [The first UCMP expedition was in 1993, with resampling expeditions in 1995 and 1996].

08-00:04:48
Clemens: But I think it ought to be stressed that under Mark's leadership this project keeps going on. He's involved Sterling Nesbitt, one of Kevin Padian's former graduate students, and Greg Wilson is involved in the project. They bring with them students from their institutions. So it's really quite a productive research project and teaching project.

08-00:05:31
Burnett: These are a lot of your students or colleagues. Is that symptomatic of the tight-knit nature of the vertebrate paleo-community or is it evidence of a Bill Clemens effect? You don't need to claim that if you don't want to.

08-00:05:50
Clemens: I won't claim that. No, cooperative projects like this aren't uncommon. With our field, to get ahead is getting so interdisciplinary. You've got to involve a variety of people in whatever project you're working on.

08-00:06:21
Burnett: And expeditions are expensive and you want to get the maximum bang when you're applying for that grant. You want to get the maximum bang for your buck. We're going to look at this and this and have this kind of expertise and that kind of expertise. It will generate excitement amongst the funders.

08-00:06:40
Clemens: And also pointing out that, yes, the senior investigators are going but also they're bringing students. We're teaching, which is something that one has to consider these days.

08-00:06:56
Burnett: We've talked about this before. The way that you understand the field as a teaching laboratory. It's a research laboratory but it's so crucial for formation of students. And so I think a lot of what happens is that there's resampling of localities, some of which are discovered in the seventies. I know that Marisol Montellano, speaking of this tight-knit community, she teams up with Greg Wilson to go to Baja, California to revisit a site that you were at with Harley

Garbani, I think, earlier, decades earlier, and with a new set of questions and a new set of techniques and some old ones, too. [laughter]

08-00:07:47
Clemens: Sure. [laughter]

08-00:07:50
Burnett: There's a discovery of new localities but also revisiting localities with different new tools, new research questions. That's something that happens.

08-00:08:04
Clemens: We are taking advantage of erosion.

08-00:08:09
Burnett: I hadn't even thought of that.

08-00:08:11
Clemens: Right now I'm helping an undergraduate who is describing and identifying a beautiful foot of a carnivorous dinosaur. And years ago, I can't remember the exact year, but I went up into this gully with Harley Garbani and he found a claw from a foot. We looked around, and we couldn't see anything else. Coming back a number of years later, after erosion had occurred on the slopes of the valley, there were the ends of three bones sticking out of the bank. Digging in we found the rest of the foot. So yes, revisiting localities to take advantage of erosion is a common procedure in the field.

08-00:09:21
Burnett: I never even thought about that. When you're thinking of geological erosion you're thinking of geologic time scale but there can be flash floods, there can be all kinds of—

08-00:09:30
Clemens: Ever sat under a thunderstorm in Montana? Yes, there's a lot of water coming down. [laughter]

08-00:09:38
Burnett: Tell me about that. Tell me about these gigantic thunderstorms.

08-00:09:42
Clemens: I can't codify it but, still—

08-00:09:46
Burnett: They're impressive.

08-00:09:47
Clemens: The water just comes down. The swelling clay gets washed off the surface. It really doesn't protect the rock during one of these downpours. So you can get a quarter of an inch of surface cleaned off. Who knows what's under it.

08-00:10:12
Burnett: Right. And after twenty years of successive storms like that, you get some significant changes to the landscape.

08-00:10:20
Clemens: Oh, yes.

08-00:10:23
Burnett: Wow. That's fascinating. Well, I guess your last student was Greg Wilson. He hooks up with you because you're involved in Helsinki. I'm not sure. Yeah. And we talked. When we sat down together we talked about the advanced nature of the research tools now, the three-dimensional imaging of the surface and quantifying the points on the surface to give you a sense of evolution. It's another tool. It doesn't replace the kind of painstaking examination under microscopes that you and others have done before but it's the computerization, the mathematization or the quantification or the research in paleontology and its marriage with research and, as you said, in these other disciplines in the life sciences. So that's accelerating right at this moment. The World Wide Web has opened up. UCMP is right out of the gate. One of the first hundred websites on the World Wide Web is the UCMP website.

08-00:11:51
Clemens: And thanks to two graduate students. Right.

08-00:11:53
Burnett: Right. Exactly. Yeah.

08-00:11:54
Clemens: Dave Polly and Rob Guralnick. Yes.

08-00:11:57
Burnett: Right, right. And we talked about that, as well. And so at this point you're beginning to wind down your career. What was your reflection when you were seeing at the end of the nineties the World Wide Web is exploding, there's this tremendous explosion of public outreach possibilities that the museum is taking advantage of and the tremendous research opportunities that seem to be popping up like mushrooms?

08-00:12:33
Clemens: Okay. Okay. We're talking about the end of the nineties. I retired in, what was it, 2002. The field was evolving rapidly. There were more participants, so more rapid change. One of the themes that I think I see in looking back was the emergence of large databases influencing or supporting new kinds of research questions. Well, first of all, there are the databases dealing with material, and here at the museum there is the project to provide a computerized catalogue of the specimens in our collection and their locality data. That computerization started in the 1960s. Remember Hollerith cards and all the old equipment? I guess it was in the 1980s we started putting the specimen catalogue online. The locality catalogue is not available that way,

primarily to protect the landowners. We'll share the data if you come here and ask us.

08-00:14:56
Burnett: Right, yeah. And let us know who you are, by the way.

08-00:15:00
Clemens: Right. Yes. Okay. That catalogue has a strength in that it shows what's here. If you as a researcher want to come here and look at *Dinohippus* or *Purgatorius* you can search the catalogue and see what's available. The limitation is that the catalogue is a work in progress. So that, okay, I'm starting work on a study of a group of fossils. Initially I think they represent the genus *Prodiacodon*. Now, to get catalogue numbers for these fossils I have to make that first guess. Then I'm able to get a number for each fossil so I can tie measurements and other observations to the particular fossil. But you come in and, "Well, where's all your *Prodiacodon*?" "You know, I made a mistake. Now I know it's really a new genus." You see there's that immediacy about the catalogue.

Now, we have today a number of online sites. One is the Paleobiology Database, which got started a number of years ago. Charles Marshall, our director, was one of the instigators in getting the project going. Basically there, colleagues enter information drawn from the literature. So you've got that filter. These are identifications that have gone through peer review. So there's a positive for the project. Now, although they've been successful in getting a lot of grant support, still the project is basically relying on volunteer effort, individual scientists contributing data. I looked at their website and what was it, four hundred and some different scholars have made contributions to this database, but the database is uneven. You get a scholar working on a particular animal, and you get a lot of data placed in the Paleobiology Database. A group that isn't the focus of current research is getting short shrift. So it's got its pluses, very strong pluses, and you have to be careful when you use it.

08-00:18:46
Burnett: What kind of data is in the Paleobiology Database?

08-00:18:51
Clemens: Basically it's taxonomic. Also there is information on the age of occurrence or the temporal range. There are lists of bibliographic citations, I mean, the papers from whence this information came. They're developing a whole series of different ways of analyzing the database. It's a symptom of the time and a positive one.

08-00:19:34
Burnett: Right, right. Well, timewise when these bibliographies were centralized there'd be central institutions, like UCMP would compile a bibliographic—

08-00:19:51
Clemens: *The Bibliography of Fossil Vertebrates*. That's a—

08-00:19:53
Burnett: For example, yeah.

08-00:19:55
Clemens: —fascinating project. It started in 1928 with Charles Camp, who was a member of our faculty. In the beginning of that century, O.P. Hay had compiled a bibliography of papers published in America on American fossil vertebrates. He covered up through ’28 or ’27 and then Camp took over in ’28 doing or developing the same kind of bibliographic work. You had taxonomic indexes and author indexes. There were some subject area indexes. Starting in the late thirties the project received support from the Geological Society of America, later NSF contributed, and toward the end of the project the Society of Vertebrate Paleontology was making contributions. The last volume of that series covered through 1993. Okay.

Why did the project come to an end I think is a valid question. I think the limitation of the project was that we were focused on publishing annual or multiyear volumes. So if I may get up—

08-00:22:07
Burnett: Oh, yeah.

08-00:22:08
Clemens: There’s the last one.

08-00:22:10
Burnett: Oh, perfect. Oh, great. Yes. In telephone-book type, too, font. There you go. It’s nicely bound. You can see it’s very, very small print for these—

08-00:22:33
Clemens: Okay. Well, with the computer age, references like that, they’re out of date in format. The last five or six volumes of the series, were composed on a computer so that the data could be shared with the American Geological Institute, and they incorporated them in their program, GeoRef, which is an online reference service. They were doing it much more efficiently. The executive committee of the SVP decided to shift the monies that had supported this project over to expanding the publication of our journal. Fine. In terms of the museum, we had hosted this project since the 1930s and it was wonderful in that the project employed two or three translators. So as we went into the literature, the foreign literature—in our field, in the biological sciences, you may publish something in Chinese but generic and specific names, they have to be Latinized.

08-00:24:33
Burnett: Latin, yeah.

08-00:24:34
Clemens: So you could pick up a journal, sort of thumb through, “Oh, here’s one about a fossil I’m interested in. I’ll take it over to the BFV translators.” And, yes, they’d have to read it to get the information they needed. But also you could

sit down with them and say, "Now, what's in this paper?" So it was a tremendous resource for the museum. Also, a number of our graduate students had employment in the project. So while it ran it was, I think, beneficial to the field of vertebrate paleontology, beneficial to UCMP, and provided support for our teaching program.

08-00:25:30
Burnett: Right, right. Well, that shift to online databases. There was this technological euphoria in the 1990s, as I'm sure you remember. It's interesting to think about what's maybe lost when this shift happens. There is some cost to the local intellectual resource, as you mentioned. And, of course, the real cost savings of moving it over to the online database is it absorbs all of that sunk effort since 1927, right? All of that research has been compiled and sorted and arranged so that people can use it. Once those databases gather steam online, though, it does, it seems, undeniably promote access, make it easier for these—every major research university that had anything like a paleontology program would have had the *Bibliography of Fossil Vertebrates* in their library, right? So that's a given. And I guess there are issues of licensing of GeoRef. It's perhaps the same thing. But one might imagine that it's *more* accessible if a library gets a bundle of these databases. It conceivably reaches more people. These are proprietary, right? So you have to have a subscription? The university has to have a subscription to GeoRef?

08-00:27:18
Clemens: Do we? I don't know.

08-00:27:20
Burnett: I don't know. Maybe it's open access. I don't know. We can verify that, too.[3]

08-00:27:28
Clemens: I'd have to check to see if it's open access or not. When I go to it I go through our library not directly.

08-00:27:39
Burnett: Right, right.

08-00:27:45
Clemens: From what I see, more and more of the library budget is going to licensing fees.

08-00:27:56
Burnett: I think Merced's library has relatively few books in its library and it has research space, meeting space, study space, and then a whole bunch of online access [licenses]. And that's kind of how they run it there. I could be wrong but I seem to remember reading something about that. So the writing is on the wall. We're thinking about how we organize information. The museum has to

[3] GeoRef does require a database subscription or license for access, and is owned by EBSCO publishing.

consider that. And what do you do with this expensive real estate, expensive in terms of maintaining these physical collections? So that's an administrative question. And I think I asked you this at the beginning of our sessions. But is there something about the physicality of specimens, that no matter how much three-dimensional high-resolution scanning you do of a dentition, that there's something there in the physical specimen that you just can't fully grasp unless you physically are in contact with it?

08-00:29:28
Clemens: Well, first of all, with all these new techniques of illustration, graphic—

08-00:29:46
Burnett: Yeah, representation.

08-00:29:48
Clemens: —graphic representations, they don't carry the geological data. This is one of our complaints about commercial collecting of fossils. Most frequently the commercial collectors will not tell you where they found the fossil. So you lose all that geological context that's so valuable in interpreting not just the specimen but putting it into a temporal framework. The other aspect of keeping the physical specimen is that ten years from now what new techniques of graphics will have been developed? Who will want to come back and say, "Well, that was fine for 2016 but here in 2020 we do it this way." So, yes, maintaining the collections is really an important part of the field. UCMP has been a major repository within the State of California, serving not only Berkeley but other campuses in terms of taking on collections that are no longer used or loaning material to support new programs. Outside the university, because of environmental protection laws, industries like CalTrans, for example, have to do a paleontological research or resource study and monitor their work in case they run into fossils. They usually hire commercial people to do the monitoring. But then there's a requirement that this material has to be curated into a museum and be made available for later study. So here's where UCMP has been playing a role and a role that is supported by, in this case, CalTrans. Mark Goodwin just announced at a meeting the other day that the East Bay Municipal Parks System wants a survey of the fossil localities within the parks. We, over the years, have collected a lot of material out there. So basically this summer the park system will be employing one of the graduate students to go through the paper records and then go out and try and relocate some of the localities within the park. So it's again a dynamically growing thing that recognizes the value of the original material.

08-00:33:47
Burnett: And is there sometimes training? So that UCMP is the repository for these required conservancy measures when there's digging anywhere basically. Does UCMP then send someone out, saying you're going to have private monitors monitoring the dig? This is how we'd like you to keep track of—because you mentioned that problem of locality and the geologic recording.

So is there any possibility of intervening in the protocols for excavation and packing and storing and all that?

08-00:34:30
Clemens: I think it's fair to say that of the people in these firms, many are trained archeologists. There are some vertebrate paleontologists who are working in the firms. They know the protocols, and they know they've got to meet them before we'll accept the material. So there isn't a conflict there. It flows nicely. Yes.

08-00:35:10
Burnett: Right, right. I was just thinking when you were talking about who knows what new techniques will emerge. Mark Goodwin was talking about recent research that has, by accident—there was a lab accident with a fossil, not in his lab, but that actually revealed blood vessels in the fossil material. And I found that so eye-opening because we're so accustomed to hearing "Fossils are rock; they're not [biological] material." They're rock that has injected itself into the cavity where a mineral has injected itself into the cavity where bone once was. And his claim is that it's never just rock. It's rock mixed with this biological matter. And through those discoveries, with their imaging techniques, with the particular kind of accidental technique that's now elaborated into a protocol for finding this stuff, they're discovering blood vessels and now nerves in fossils, which I just find so marvelous. I think that's the story of learning and piecing together evolutionary and developmental tracks. We're just getting more and more fine-grained information about this material. It's extraordinary.

08-00:36:46
Clemens: It's amazing the way these things have developed. To get back to the interdisciplinary theme and how it's affected the museum. Basically we started out with x-rays, film based cameras, that kind of thing. As the technology of representation and study of vertebrate fossils developed, well, for the small fossils like foraminifera or for studying the pattern of wear on mammal teeth, you needed an electron microscope. So for a number of years we had an electron microscope in UCMP. Then there was the development of a sort of genomics adding to the breadth of genetic studies, and we had a DNA lab here. In both cases the technology, the equipment improved. You needed a technician to support all this. And we've given up on both areas; given up in terms of doing it here. There's a university electron microscope set up over in Giannini. So if you want to do that kind of study based on electron microscopy you use that lab. With the bringing together of the museums here in VLSB, we have given up our own DNA lab. There is a much more modern efficient facility set up in MVZ, which if you want to do that kind of research you go upstairs. Now, Mark probably showed you that wonderful beak of *Triceratops*. Well, the beak was CT-scanned and they made a plastic model. The bone is represented by transparent plastic. Within it you can see the various channels for blood vessels and nerves and so on. That was all done down at the University of Texas. We don't have a CT scanner. Now, there are some interesting side effects to all this.

08-00:40:14
Burnett: Yeah, yeah. I imagine.

08-00:40:20
Clemens: You as historians, here's a challenge.

08-00:40:23
Burnett: All right.

08-00:40:24
Clemens: Okay. Has anyone ever taken a survey of peer-reviewed journals in a scientific field over a period of, say, the last forty years and determined, one, the number of coauthored papers per year, and, secondly, the average number of coauthors during that year? Now, I bring this up because you see papers today with eight, ten, or more coauthors.

08-00:41:15
Burnett: Oh, more than that. Yeah.

08-00:41:17
Clemens: Oh, you get into the molecular area and it's a cast of thousands. On one hand I think it reflects the increasing interdisciplinary nature of our field. And, secondly, it creates a problem. Monkey see, monkey do. Graduate students see these papers with multiple authors. They're used to reading papers not really knowing who wrote what. I was talking to Pat Holroyd, my colleague here in the museum. She had been talking to one of her friends back on the East Coast and this friend was part of a search committee. They were looking for a junior appointment in anatomy. They had a short list of four or five candidates. Her friend said, "You know, every one of them has several publications. Every one of those publications is coauthored. Can these particular candidates think for themselves? What did they contribute?"

08-00:42:57
Burnett: Well, what is scientific authorship? Right? That's maybe a prior question, right? We're used to thinking of priority in terms of a single inventor or a single scientific discovery with a single person attached to it. And one of the things that historians of science have done is gone back to these cases of this great discovery by this one person to show, in fact, it was a group of people and it was a network and it was technicians. It was a cast of thousands from the very beginning. And so scientific credit is changing and the question is, is it changing because it's reflecting that kind of participation a bit better or is there something self-defeating, I think that's what you're getting at, about assigning authorship so broadly. Usually there's that first author, second author thing, where you can basically say the first two were basically the primary. But you don't know exactly unless it's specified in detail in the abstract or in the first couple of pages. But I think the short answer to your question is, yes, that sociologists of science are writing and publishing about this very phenomenon.

08-00:44:16
Clemens: Oh, are they? Okay.

08-00:44:17
Burnett: And also scientists are challenging the hierarchies of journals and the way that publishing is undertaken and what publishing means. Randy Schekman, the Nobel Prize winner in cell biology recently, he has started his own online journal with a number of other collaborators to actually promote scientific publication with a different ethos. It's organized differently. And you can read his oral history that we've done. But, basically, I think this is in play and people are asking questions like you are. Is this the best outcome? And what costs are there from this growing system of scholarly credit? Do we devalue the currency by printing too much?

08-00:45:26
Clemens: Are we putting the current generation of students into a situation where they can't show what they as an individual, as individuals, can do? Well, things change. You have to evolve with them, but to me this problem of authorship is one that needs to be addressed. Also the impact of museums, universities like ours, depending upon other universities for up-to-date laboratory equipment and facilities. I don't know if Mark Goodwin talked to you about it, but he spent some time up at Lawrence Berkeley Lab working on his research. No longer is it the view that you're dealing with a self-sufficient organization.

08-00:46:31
Burnett: Yeah, yeah. I think that's a happy circumstance in that Lawrence Berkeley Laboratory, in the seventies, was kind of in search of a mission. And big physics was kind of on the wane and the life sciences were exploding at that time. And they opened the door to all these other sciences. And so there's geology work being done up there and paleontological work with, I guess, the Advanced Light Source. That's a tremendous boon, I think. And it does keep it in the family, as it were. But we were talking about graduate student training last time and the importance of place and space to knowledge production. And I wonder, is there an analogous problem with the dispersal of physical plant equipment and expertise across the United States, across the world. Is it this wonderful opportunity for collaborations, this globalization of science? Or is there a risk of losing that sense of place?

08-00:47:51
Clemens: I think the risk of losing a sense of place is real, but it's minimized. What's the difference between going to Montana and collecting fossils and geological data and going to CERN to collect data on the microstructure of the jaw of some prehistoric animal? It's your fieldwork. And if you're bringing data back there's the place to identify with, place where you're trying to put it together.

08-00:48:39
Burnett: So that's another instance of the lab-field border, that foreign laboratories are kind of fieldwork. It's a laboratory but you're going into the field with new collaborators, as another interviewee mentioned, different culture, different

academic culture when you go to work in Germany, for example, or you work in France. There's a different way of doing things. So I guess the question is about culture and formation. You always want cross-pollination, you always want to go outside. You're going outside to get the data and so on. But in terms of the community, it depends on that reintroduction of new blood through global associations, national associations of the science. But does it also crucially depend on this tightly packed, tightly-knit group of people where everything is done under one roof? Or maybe that's not necessary at all anymore. That it's just a different kind of work.

08-00:49:54
Clemens: Well, on one hand I'd say there are all sorts of different kinds of fieldwork with these databases. Still have to chuckle about Jack Sepkoski, a colleague who was at the University of Chicago and one of the early compilers of a major database. And more than once Jack would joke that, "You know, my field research area is the library." Okay. I think with our students and colleagues going out to different places to gather data, but then bringing it back and doing the analysis and the synthesis, that really instills a sense of place.

08-00:50:53
Burnett: Yeah, okay. That's great. So let's talk then about your retirement/non-retirement. You retire officially in December of 2002 the first time.

08-00:51:15
Clemens: The first time.

08-00:51:17
Burnett: So what do you do next?

08-00:51:19
Clemens: Okay. Dorothy and I packed up and went off to London for six months. Professor Kenneth Kermack, the man with whom I did my postdoc, had a student work on one of these faunas taken from a fissure filling in Wales and it turned out to have some rather interesting new animals represented in it. Unfortunately David, completed his degree, but even with offers of help he didn't get around to publishing. Kenneth asked me to pick up and try to finish the study and write a publication based on David's work. This meant going back and upgrading things, statements in terms of subsequent research. It was a nice project, and I enjoyed it. Then I came back here to accept appointment as interim director of UCMP.

08-00:52:37
Burnett: Why did that happen? You weren't expecting to do that, were you?

08-00:52:41
Clemens: When I left? No.

08-00:52:43
Burnett: Yeah. Okay. You were hoping to enjoy the theater district and take some time.

08-00:52:50
Clemens: Yes, and Dot and I did. No, the director, Dave Lindberg, became chair of the department and he wanted to give up the directorship. So yes. I'd experienced this before, and I thought it was only going to be for a year. To make sure for the spring of what would be the second year I made definite plans to get back to London. [laughter]

08-00:53.35
Burnett: Yeah, great.

08-00:53:37
Clemens: So it turned out to be a year-and-a-half term. There are a lot of parallels in terms of what's going on today. There were budgetary problems. When you're an interim you don't want to institute new programs for the future. You want to focus on things that are going to be completed during your term. It turned out that over the years a number of the directors of the museum had received funds through grant support, gifts to the museum, and they'd spent most of the money but there were these little residual pockets. Now, with the great help of the museum's financial analysts, we went through looking at each one of these little pots, looking at the restrictions on its use, and then seeing if we couldn't spend it on current expenses. So we were sort of cleaning up the budget that way. I think we were quite successful.

The other aspect of museum administration that really came to the fore was the changes. I had been director back in the end of the eighties. Now coming in at the beginning of this century, programs had expanded. There were more responsibilities to be dealt with. Judy Scotchmoor was developing this wonderful program of public education and outreach. One phase of it was focusing on supporting K-12 science teachers. I liked the design of that program because she had a board of consultants made up of classroom teachers. They'd come in and vet what was coming out from the folks working here. Her work and the work of her colleagues was garnering a significant amount of grant support. On the other side of the museum with the demands of collection usage, development of research techniques and so on, it just became obvious to me that the thing to do was appoint Judy as an assistant director of public education and outreach, Mark Goodwin as assistant director in charge of the collections and research and delegate. Micromanaging, in my book, isn't the way to go. Yes.

08-00:57:31
Burnett: That sounds like not an interim thing to do. That does sound like a structural change for the better, that you're thinking about this is going to make things better for the organization going forward. You've noted these are the trends. Education, public outreach has got its own funding coming in and it's building. On the public outreach, was that K through twelve outreach incorporated into the online presence? Were teachers bringing their students to the museum proper?

08-00:58:12
Clemens: The K-12 program was entirely online. Teachers do bring students, their students to the museum. The graduate students are organized to give tours. It's a significant aspect of the program. It's not a large one. Particularly, it maintains contact with people in Berkeley and the adjacent cities, which as a public institution, we have to do and have to be concerned about. But the online presence, really, that characterizes most of the work, and it's very successful.

08-00:59:10
Burnett: And that's something that's continued right up to the present day. There's a lot—

08-00:59:14
Clemens: Yes. Judy retired. Lisa White has taken over. I'm not sure of exactly what they're doing right now. One of the negatives of retiring—it's wonderful to avoid faculty meetings. On the other hand you lose contact with what's going on. Yes.

08-00:59:48
Burnett: Right, right. Yeah. You're still very much engaged here. People speak with admiration. Some standing faculty have trouble making their office hours but as a retired emeritus professor you are here almost every day.

08-01:00:12
Clemens: Yes.

08-01:00:14
Burnett: Almost the whole day, right?

08-01:00:15
Clemens: It's what I do.

08-01:00:16
Burnett: It's what you do. Yeah. I think before you retired was that Berkeley really made a conscious effort to keep that resource in the family. Make Berkeley a welcoming place for retired emeritus professors. Is that the case for you? Or are you just unable to stay away?

08-01:00:47
Clemens: Yes to both. The Emeritus Association is very active. I go to some of their meetings and have gone to their office to get help with some of the retirement issues. It's one thing to call up the Office of the University President and try and find your way around to ask your question, and it's another thing to have someone who's been there and done that giving you advice.

08-01:01:31
Burnett: Yes, yes. You need someone on the inside. Yeah. [laughter]

08-01:01:35
Clemens: Yes. They're very good.

08-01:01:38
Burnett: Upon your retirement there was some recognition of your accomplishments over the last several decades, many decades. Can you talk about some of the celebrations and awards that you garnered? They come in quick succession after you retire. Even before you retire, I think.

08-01:02:08
Clemens: Well, let's see. From the SVP, the first award was the Joseph T. Gregory Award and also I was elected an honorary member. Now, the Gregory Award focuses on service to the society. And I had served as president, but I think it also recognized the time I had put in with the BFV. Joe Gregory remained editor up to the last volume. But Joe had retired several years before, so I sort of stepped in as basically financial officer but also encourager and supervisor of the translators. So that was a very welcome honor. Now, let's see. You've got to keep track of the calen—

08-01:03:27
Burnett: Well, yeah. There's German recognition in 2004. Are you going to make me pronounce this?

08-01:03:38
Clemens: Ah, the Korrespondierendes Mitglied of the Paläontologische Gesellschaft. From my first study period in Germany I'd been supported by the Alexander von Humboldt-Foundation. It was a year's grant. I only used nine months and I got invited back and put together a package. I spent six months in Munich as a guest of the university. And then we did some more finagling with the Wighart von Koenigswald and that resulted in being able to spend a year in Bonn. I was very honored to receive this recognition. In some part it reflected the fact that they had been so welcoming to me, and we had welcomed so many of their students here at Berkeley. So yes.

08-01:05:08
Burnett: It's not a cold impersonal world, this world of paleontology. Even though it's grown into fairly large numbers, it's very much these personal relationships are so important and you can see how that is integral to the science and the practice of the science and the future of the science itself, right? To have these students meet each other and work with each other and the faculty to reach out to other countries and learn from others.

08-01:05:41
Clemens: Then the Society of Vertebrate Paleontology, I don't know whether they showed good judgment or not, but I was honored with their Romer-Simpson Medal. As stated, it's for sustained scholarly excellence in the field. So I guess I did something right.

08-01:06:12
Burnett: So it's the lifetime achievement award in the field of paleontology.

08-01:06:17
Clemens: Yes.

08-01:06:20
Burnett: And then later, I guess in 2009, the California Academy of Sciences recognizes you, as well.

08-01:06:31
Clemens: I received the Fellows Medal. It was to recognize my research, teaching, and also my help on the board during that troubled time when we had to tear down the old building, move, and then rebuild. Yes.

08-01:07:00
Burnett: That's not an insignificant amount of work. I remember we were talking about that. You were also a professor full-time and you had all of these—

08-01:07:08
Clemens: And I was involved in the SVP. The nineties were an administrative decade. Yes.

08-01:07:15
Burnett: Right. We've talked about this a little bit already, I think, but looking forward now, as you see the field evolving, where do you think the field needs to grow and develop? What are the areas that you see most important as needing support?

08-01:07:51
Clemens: I think we can't ignore the fact that our knowledge of the fossil record is so imperfect. A colleague once described it as a very poor grade of Swiss cheese, little substance, lots of air. Okay. So field work, and not just collecting more bones or more shells, but field work directed in terms of particular set of research questions. Also including a careful study of the geology. I don't see that being replaced by big databases. On the other hand, I can't see them replacing big databases. There are so many questions you can address with the data organized in a retrievable and organizable fashion. I see them growing hand-in-hand. The areas of technology and techniques of study, that continue to evolve. You see it in equipment, like CT scanners. You see it in techniques addressing new questions. One of the areas that I'm interested in is the development of dentitions. It's a whole different pattern of research to determine what is controlling the development of cusps, their positions, and their heights. Jukka Jernvall and his group are really pioneering in that area. Then I think we have to pay attention to the education of our students and be realistic about the job market. Now, realism also involves inventiveness. Maybe in talking to my students you've realized that in a way we're going back to the nineteenth century when many paleontologists were medical doctors. Now we have vertebrate paleontologists teaching anatomy in med schools. Well, as long as there are medical schools training doctors we hope they're trained in human anatomy. So there's a market there. But we need to have an overall concern about proper education of students, undergraduate and graduate with a realistic view of what comes after their degree. Yes.

08-01:12:05
Burnett: Right. And I think that's across the board. Especially at Berkeley I think Joe Cerny really paid attention to that in trying to get people to think about what happens after career and following students after they graduate and seeing where they end up. But it seems like the very interdisciplinarity of the training now or the possibilities for training in paleontology, because it involves so much of the life sciences and genomics and that kind of stuff, at least in terms of opportunities, that in itself is a kind of insulation. It's a hedge for their future. They can colonize new spaces in order to continue their work. And you've mentioned cases, a number of examples, and a number of the students that I've talked to have landed in positions that wouldn't have been available to them forty years ago. And I think that is a positive outcome for the field, I think. So I was thinking about one of the things that Marisol Montellano was talking about. She has this training in biology. And she was saying it's so hard to get biology students to think in terms of geologic time. Which I found striking because biology students, their objective research are these evolutionary organisms. But the nature of the research is on microevolution or it's on just genetics from one generation to—

08-01:13:57
Clemens: It tends to be, yes.

08-01:13:57
Burnett: And so it's just this kind of narrow timeframe. And at the same time I was also reflecting on Charles Darwin, who's trained as a geologist and as a naturalist. And he also trained initially for the clergy and the beginning of *On the Origin of Species*, his writing is almost religious when it comes to talking about this mysterious—not mysterious, these wondrous processes of life. This is perhaps not a fair question. I'm curious about almost the spiritual side of paleontology or the metaphysics of it. Here's a scientific field where you are daily confronted with geologic time. Is there something, not religious, but something powerful for you, that you think other people should think about or should reflect on? Is there something special about a paleontological state of mind? [laughter]

08-01:15:25
Clemens: Oh, my. Yes. That's interesting to think about. Yes, as you talk to friends who have no background in the geological sciences and blithely talk about a million years or a billion years, it's something new to them. And in terms of scientific work going on today, think about the interplay between colleagues who are working on climate change, the effects of agriculture on our modern biota, going back to Africa I don't know how many hundred thousand years, and what's the first impact of agriculture on the ecology. And those of us in paleontology, particularly—okay, I am working at the Cretaceous/Tertiary boundary, and there I feel lucky that the group up at Berkeley Geochron, the director Paul Renne and one of his students, Courtney Sprain, have been working with me out in Montana. And there was a certain self-congratulation. Courtney got age determinations with error bars measured in tens of

thousands of years. Now, looking at what we're seeing in terms of faunal and floral change sixty-six million years ago and trying to derive information from that as to what's happening here, say, in the last two or three thousand years, that's an exceptional challenge. I think that's going to be one of the areas that really is going to engender a lot of thought and new research. Currently I don't think I'll see the day when we can get age determinations from the sixty million years ago with error bars of a century. But we're sampling a process, and how do we translate our samples in a meaningful way to be able to contribute to current research on environmental change?

08-01:19:25

Burnett: It's a humbling experience and also cause for some pride, I imagine, too, at the same time. Humility before the complexity of the natural world and the objects that you are studying, but perhaps pride in the achievements that you've witnessed in your lifetime of human beings understanding where they have come from over the course of—

08-01:19:56

Clemens: Oh, yes.

08-01:19:57

Burnett: From millions of years. And I think that's a real testament to the work that you did. Zhe-Xi Luo wrote a paper and I think he described, in terms of the number of generations—when I spoke to him about this he talked about your generation as achieving an incredible expansion in the basic data for mammals and accounting for at least a tripling of the fossil record in that domain. And then in certain domains far more than tripling, just creating a massive, massive set of data. And then since 1980 more fossil specimens have been discovered than all of the fossils before 1980. Right. And this was in the nineties, I think, so this is only in less than a twenty-year span. So that's just one measure of what's going on. It's not just a quantitative revolution. But it's also this tremendous flowering of new techniques, new approaches, new ways of thinking about the problems, and real ground being covered, as you say, or [error] bars going down into tens of thousands of years from what used to be that you weren't sure. The error bars were much, much larger before. So there's this real sense of achievement.

08-01:21:40

Clemens: Yes, and don't leave out the observation that the increased rate of achievement also reflects our success in training, educating new generations of very talented students who have gone out and are extremely active. Maybe you sense through all of these interviews, one of my greatest accomplishments in my academic career is the group of students I've helped train.

08-01:22:34

Burnett: Absolutely. That is often the big contribution that someone makes, is that they show a path and they usher people into the path that they create for themselves. And then what's so wonderful is to see the collaborations among students, that

they're not just working with you and their colleagues, but they're working with each other. And sometimes they're out of a cohort, so they weren't even together at the same time, but through you and through UCMP's connections they've met each other and they've decided to work together and they've produced these fruitful collaborations. It's extraordinary.

08-01:23:25
Clemens: Yes. And I think mentioning the museum is important because there is this continued identification with the place and the people who are here and who have been here.

08-01:23:45
Burnett: Dr. Clemens, I want to thank you for taking all this time to speak with us.

08-01:23:50
Clemens: Well, thank you. I enjoyed, appreciated your commentary and it's been a pleasure to work with you. Thank you.

08-01:23:59
Burnett: Wonderful.

[End of Interview]