

# A Bone for All Seasons: The Human Pelvis

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There are some cool things about getting older (I'm lying; most everything stinks. I can't hear as well, see as well, taste food as well, and I forget things. At a recent faculty meeting someone even gave me a seat; and a former student, now a Vice President, fixed my tie. Not good signs.) One plus, however, is that as you march towards being a picture on a wall somewhere you realize that you have experienced directly the history of your world. While all the "Gen X'ers" and "Millenials" and "Gen Z'ers" can read about 20th century science, those of us who don't call a book "hard copy" or don't think its chic to wear the flag as underwear can go back to actually having been a part of what occurred. We experienced it, we lived it, we touched it; we saw how it shaped the way we understand and appreciate science today. So is the case with the story of the pelvis that I will tell here.

A little more personal backstory to set the stage. I like dissecting; no, I really adore dissecting. Goes back to childhood (doesn't everything?) In grade school, and even in high school, I was never permitted to take any "shop" classes. Those included "auto-shop," "electrical shop," and the one I wanted most, "wood-shop." Because I was on what the New York City School System called the "Academic Track," I was not allowed to learn anything practical, nothing in which I used my hands. That education was restricted to those not expected to go on to higher education. I, being one of the chosen ones (here referring to IQ), was given classes on subjects like "Medieval French Poetry," "Richard III and The War of the Roses," and "Gothic Architecture" instead (guess what three things I hate today?). Who does that to a twelve-year old? I remember having to describe the metrics in French fabliaux and compare them to similar ones from Chaucer's Canterbury Tales. I can barely change a light bulb because of the practical gaps in my education. My friends could fix a Pontiac GTO's carburetor or hot-wire a T-Bird and all I could do was recite a ballad or delve into poor Richard III's issues! How was this esoterica ever going to impress a cheerleader? Oy!

Enough moaning about 1960s educational theory (I could start on current, medical educational theory but let's not go there). All this rather arcane, if well-intentioned, "book-learning" did get me top grades later in college (I did have to join a jock frat, however, to find those cheerleaders) and eventually helped me garner fellowships for graduate study at Yale, where I was accepted to investigate lemur behavior in Madagascar and the meaning of evolutionary and linguistic theory. Once there, however, I rebelled. Anatomy was the cause. As soon as I encountered Gross lab, and smelled the smells, it was as if my senses collectively heard the call of the wild. Once I was given a scalpel I was finally liberated. All those years

of interacting with odd books, being around kids with glasses, talking about Kierkegaard, iambic pentameter, Fibonacci sequences and that damn Richard III (hate that guy!) were out the window; I finally could, would, be a person like all others and use my hands. I could now dissect.

Only problem was I stunk. "Don't worry, Peter said, 'I'll get the band aid.'" Great way to begin one's first day of Anatomy! Peter-Peter Dodson-now Professor of Veterinary Anatomy at the University of Pennsylvania and amongst the most distinguished of dinosaur experts in the world (see Dodson, 2009; Laitman, 2009) was a senior graduate student when I was beginning my journey at Yale back in 1973. He took me under his wing and always protected me. "You'll get the hang of it" he added, positive as always. "You cut yourself already?" came a booming voice over my shoulder. That was not Peter; it was Edmund S. Crelin, our Anatomy Professor, and the master I was hoping to one-day study under. "Who cuts himself in the first hour of anatomy lab?" questioned Crelin. "Do you mind blood?" he asked me. "No, sir" I stammered. "Good. Looks like you're going to see plenty of it! And stop hunching over so much; you'll end up looking like Richard III!" What! He said what? Not a good start.

But, start I did, and I did get better, actually, much better. Dissecting gave me a sense of peace and fulfillment as it has for many. I made up for all those years of not being able to touch things by literally living in the lab (or a small room next to it) that served as my office. My years of digital deprivation led me to overcompensate by dissecting every inch of every beast that I could work into my schedule, be it at the medical school or across campus at my second home, the Peabody Museum of Natural History. All regions fascinated me as well: the limbs had an organization and regularity that was serenely predictable and comforting, and fun to see differences between different species; the thoraco-abdominal organs were plentiful and each with their own story and definable embryology and regularity (I like order and was learning that I liked predictability); the brain was disappointing on a gross level, but histologically fascinating; and the area of my eventual love and life's work, the majestic larynx, with its outer shell of cartilages opening onto an inner world of

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folds and nerves was to me like uncovering the “Holy of Holies.” One region, however, always gave me problems: the pelvis. It was just, just, so much. And with so little order I never knew where to begin. Or which structures, which “system” to prioritize. The pelvis seems just as confusing and overwhelming to my medical and graduate students today as it did for me when I started in what now seems like the Cenozoic.

The difficulty with the “pelvis” is that it is not a single entity, even a single bone, with a discrete or focused function. I’ve always viewed it as the “Jerusalem” of the human body; the home of seminal, yet vastly differing anatomical units each “claiming” priority to territory, functionality, and evolution. Indeed, the majesty of this extraordinary “basin” (the Latin etymology for Pelvis) is that whether one is referring to its osteological framework, or its totality of structure, one is by definition, opening up a Pandora’s box of differing opinions as to what to emphasize, and what nature itself has emphasized, in the course of both an organism’s ontogeny and its evolution.

With these issues in mind, we come to this extraordinary Special Issue of *The Anatomical Record*, “The Human Pelvis,” Guest Edited by noted physical anthropologists and pelvic-ophiles Karen R. Rosenberg of the University of Delaware and Jeremy M. DeSilva of Dartmouth College. Due to the breadth and depth of topics to be covered in the remarkable Special Issue that they have put together, it will be presented in two parts. This first volume, presented here in the April issue (DeSilva and Rosenberg, 2017), will focus on “Anatomy Development and Function” while the second volume will appear in next month’s May issue and focus on “Evolution.” Together, they will offer a multi-dimensional view into state-of-the-art science exploring the world of the human pelvis and how it came to be.

Both Drs. Rosenberg and DeSilva bring an enormous and diverse background of the region as Guest Editors. A few words first on Jerry DeSilva, who can best be described as one of the young, turbocharged dynamos who study a range of primate and human evolutionary questions. His background encompasses preparation exploring Miocene apes and variation in living primates and now melds fieldwork with the latest in laboratory and technological advances to gain insight into his passion, the story of human locomotion. And his intensity can be contagious. Indeed, when a sharp first year medical student I was teaching had me rapidly enmeshed (read: costing me money) in a project imaging the variation and bony parameters of the cadaveric peroneus longus muscle and its role in pedal evolution (which first year student even cares about this stuff?) I started to enquire as to his background only to learn that this student was working with Dr. DeSilva (I’m now sending the imaging bills to him).

At the outset of this Commentary I noted that getting a bit longer in the tooth affords one an opportunity to be present as a participant and direct observer as the history of their science unfolds. Indeed, one of the reasons this duo, particularly Dr. Rosenberg, was tapped to oversee this issue was the vantage point of perspective. A little look back on the path of pelvic study, and Dr. Rosenberg’s role in it, will elaborate.

The 1970s and the 1980s were a particularly heady time in the discovery of fossil human ancestors and for

those of us that interpret them. In particular, the extraordinary discovery of early Plio-Pleistocene material such as the famous Lucy australopith (AL 288-1) dated at roughly 3.2 million years ago (mya) from the Hadar region of Ethiopia caused quite a stir (see Johanson et al., 1978; Johanson and Edey, 1981; Johanson et al., 1982). Lucy was indeed a lady and graciously revealed to Don Johanson, Yves Coppens, Maurice Taieb and their team a largely complete sacrum, left ilium, ischium, and pubis in addition to sizable portions of the left femur and right leg and even foot bones. When coupled with the equally dramatic discovery by Mary Leakey in 1976 of preserved footprints from the Laetoli region in northern Tanzania (Hay and Leakey, 1982; Leakey and Harris, 1986) dated at some 3.7 mya, physical anthropologists had material upon which to opine energetically on aspects of a central theme of our being: the origins of bipedality.

The annual meeting of the American Association of Physical Anthropologists—the prime watering hole (often, literally) for the subspecies of researchers that persevere over issues of function and evolution of human form – was a hot spot for presentations and discussions about the evolution of human locomotor patterns during the 1980s. Indeed, some of the brightest minds in the field—Tim White, Bill Kimbel, Bruce Latimer, Owen Lovejoy, Philip Tobias, Jack Stern, Bill Jungers, Randy Sussman, Charles Oxnard—among many others, studied and advanced insightful ideas regarding pelvic form and its interface with the lower limbs and bipedality. Every iliac flare, every pubic crest, every ischial spine was analyzed this way and that to extract insights into how shape may have influenced function. So many thoughts, ideas, theories. So many reporters!

Interestingly, while the alpha males of paleoanthropology were trying to crack the bipedal code or any secrets that lie within the subtleties of an ancient iliac crest or pubic ramus, a few souls were starting to raise questions regarding the role that the pelvis might play in aspects *other* than locomotion. Of course, such discussions had long been held in the more serene halls of the medical establishment, but not so much now on the anthropological side of the fence. Previously, the great Adolph Schultz, within his incomparable studies of birth, growth and development had studied pelvic inlet proportions among many living species of primates (see Schultz, 1969). Quietly, even now among the bipedal fervor, however, a few anthropologists with a sharp eye towards reproductive biology like Walter Leutenegger (e.g., 1972) and, later, Robert Tague, were meticulously putting forward data that began to view aspects of the pelvis from a different vantage point, from that of obstetric pressures, rather than solely posture or gait (see, e.g., Tague and Lovejoy, 1986). One of the voices that made the greatest impression upon me during those years was that of Karen Rosenberg, the Guest Editor of this Issue.

First off, Karen is a woman. This is an important part of the story, and one that I have thought long and hard about before putting pen to paper as it can be seen as controversial and that is not my intent. Nevertheless, it is part of history as I see it. Like most fields in the long ago, men dominated much of physical anthropology. This included the then vague, but rapidly growing, subfield of “paleoanthropology,” a melding of individuals with skill-

sets and approaches from human paleontology, anatomy, archeology, genetics, among others, with a focus to understand human origins. This is not to say that there were no fine women scientists in these areas, there certainly were, as there were in the traditional discipline of anatomy itself. Just that in a discipline whose highlighted poster children were dashing field-workers shown with their wind-swept hair out in the blistering Rift Valley for months on end, and then back in the field tent making phenomenal discoveries, and quickly on to a PBS special, the face was usually that of a handsome, tanned, thin (ok, a little jealously here) male. When it came to national meetings, these alpha-dudes would be up at the podium in the primo Paleo sessions going on about bipedal-this and bipedal-that and how the chimp pelvis could do this and an early human that. Tensions and voices would often rise. An unceasing, testosterone shower.

Enter our friend Karen. I met her in the early 1980s when she was a graduate student of C. Loring Brace and Milford Wolpoff in Anthropology at the University of Michigan, long one of the great centers of physical anthropology in the United States. Then, as now, she was quiet, thoughtful, unfailingly kind; I never remember a harsh or cruel word coming out of her mouth. We both shared a fascination with the enigmatic group of our family known as Neanderthals, so had an instant bond, Karen studying their pubic bones and me their skulls. Through the '80s Karen and I, the graduate student and the young junior professor, would sit and absorb the cacophony of arguments abounding in our field. I often retreated back to the anatomy lab to dissect; Karen, to museums in Europe to study Neanderthal pelvises and the like. As our mutual research progressed we would share our findings when we would be together searching through collections at the University of Pennsylvania Museum with our mutual friends Alan Mann and Janet Monge, or crawling along caves in Croatia or Israel (she was a lot nimbler than I was) that often accompanied international Conferences that were not as peaceful as the caves.

During these years Karen steadfastly advanced the ideas that our remarkable pelvis did not come to be *solely* for bipedal gait. Yes, the advent of such was, and is, a major feature of our kind she would stress; obstetric considerations were, however, equally important in determining loads and forces and, in the end, shape. Karen eventually teamed with Wenda Trevathan, a human biologist who studies birth through an evolutionary lens and who had even trained as a midwife for part of her doctoral dissertation! Through scores of Symposia and platform presentations at international forums and the national meetings, bolstered by the support of colleagues like Trevathan and Tague, Karen made her case. As she gained stature and publications grew and eventually became mainstream (e.g., Rosenberg and Trevathan, 1992, 1995; Trevathan and Rosenberg, 2002) her voice became heard more often. She became so mainstream that her articles even reached the rarified air of medical journals (e.g., Rosenberg and Trevathan, 2002.) As she told me once when we sat in the heat of a Zagreb summer sun during an international meeting in 1988, "If you can't be born you can't walk." (I wrote it in my diary; yes, I keep one.)

Mind you, getting her place in the anthropology sun was not easy. It is really only in retrospect, and in the course of planning for this Special Issue, that I started to realize the effect she had on influencing the direction of thought in her science. In a male dominated world in which the pelvis was seen as evolving essentially to effectuate bipedalism, it was in large part due to the persistence of this kind, quiet, yet determined, woman that a view to how our evolution was perceived changed. She was clearly not alone; yet her persistence and perseverance in the face of both written and personal confrontation was a transformative element. As an aging and probably too-loud (remember the diminishing hearing part) now older male, I can only imagine how hard it must have been for a young woman to stand in front of scores of often aggressive men and tell them essentially what she told me: "If you can't be born, you can't walk!" I sat in the audience then and can remember some colleagues snickering as she spoke about babies, birth canal size, viability issues and how much this all means in the course of our evolution. Some, like me, found it fascinating and new thoughts entered into our set ideas. Others, not so much. Indeed, I remember that some of those I sat next to 30 plus years ago quickly closed their ears, in large part due to Karen being a woman, and having the temerity to contest the science advanced by many of her male colleagues.

We now skip to 2017 and the birth of an extraordinary Special Issue showcasing the multi-dimensional nature of the pelvis and the myriad of forces that have shaped it. And the openness of thoughts, directions and research investigating the region. Jerry DeSilva is a product of this new multidisciplinary approach; Karen Rosenberg has helped usher in this new field.

In 2012, Karen was elected President of the American Association of Physical Anthropologists, the first woman paleoanthropologist to hold the office.

And I was there to see it all happen. Maybe there is something special about getting older after all.

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