

Carving Nature at Its Joints: Mammalian Anatomy, Behavior, Development, and Evolution

by Theodore Grand

Book review by Wolfgang Dittus (Amazon, five stars).

A resplendent portrayal of the function of form in mammalian evolution

If you are dazzled by the diversity of life, curious about mammals, and ponder about the philosophical basis of science - then this book is for you. The author integrates anatomy, behavior, and ecology from his personal studies of more than 150 species of mammal as diverse as opossums, kangaroos, monkeys, apes, humans, bats, rodents, antelopes, pandas, racoons, rhinoceros, and aardvarks among others. The focus is muscular function (around the joints), the anatomy and movement of body parts as adaptations to the environment, their evolutionary history and ontogeny. Many exquisite drawings promote appreciation. The book aims to make sense of this fantastic mammalian radiation for the professional biologist, student, and layman.

In the first of three book sections (Decoding the Body) we are introduced to the author's conceptual and empirical approach to anatomical study. He cautions students about the potential confusion of common understanding introduced by the baggage of culture and logic of language where biological disciplines and specialties differ in their dialects – "same words, different meanings." Comparisons in body composition among different species are related to their lifestyles and is illustrated in three chapters with examples from South American opossums and rodents, and the African great apes. The point is driven home that differences in body composition rather than similarities in mass, per se, are key to understanding adaptation. The principle is extrapolated to variation in the musculature of humans practicing different sports. The diversity of anatomical adaptation to niche is detailed further in other chapters that explore the ancestral (to primates) nocturnal loris, vertically leaping galagos and tarsiers of Africa and Asia, respectively, and low metabolism sloths that avoid predators and conserve

energy by hanging below branches. The influence of Miocence grasslands on the evolution of grazer anatomy, social organization, antipredator strategies (altricial vs precocial young) come to light in the interplay between skeleton-muscular anatomy, behavior, and sexual dimorphism as exemplified by the ancient African dik-diks and their modern bovid cousins the wildebeest, gazelles, and other antelopes. Special attention is given to the perplexing differences and similarities between Australian marsupials and their New and Old World placental ecological counterparts. The author concludes the section with "Evolutionary reconstruction is the best window through which to see cause and effect"... in anatomical structure. Irreverently perhaps, the author also details the flaws in the evolution of bipedalism that characterize humans as an "anatomical catastrophe."

Consideration in the second part changes the perspective from the body composition, per se, to the body in its various movement configurations in nature, the behavior of organisms as they rest, forage, court, escape predators, seek refuge, and play. In short, we are offered insights into the evolution of the synergy between anatomy and behavior as gleaned by observing animals in nature. For closer analyses animals were filmed as they traverse unstable arboreal and other substrates. Convenient categorial labels such as terrestrial, arboreal, and semi-arboreal tend to be defied by the observed behavioral variation. What are the roles of experience, development, comfort zones, and cognitive maps in determining behaviors and the implementing of anatomical tools that were of selective advantage? The ecologies of diet selection leave their mark not only on form but also on individual and social behaviors. Relevant environmental grains and point of reference change with substrate and speed of movement a phenomenon of relevance to humans walking, cycling, travelling by car or encapsulated in a subway tunnel.

The section is capped by yet another perspective on anatomical function and form – that of ontogeny from the embryo to the adult. Developmental trajectories across species are examined in terms of the ratio of brain to muscle mass and related to their life-histories and phylogenetic radiations in changing environments of the Old and New Worlds. Darwin's ontogeny recapitulates phylogeny is given a refreshing relevance in the context of mammalian species diversification.

The third section, entitled "The Language and Logic of Biological Systems" rounds off the first two; the lessons introduced in earlier chapters bear fruit in a critical evaluation of how the history of scientific thought, ancestral vocabulary, dialects between siloed disciplines, and alternative narratives have created dissonance in what should have been resolved by the clarity of the "facts of anatomy." At the heart of this discourse is the decades long controversy (careers hung in balance) in the taxonomy of the red and giant pandas; both species overlap in their Asian habitat, specialize in eating unpalatable bamboo, and both were referred to informally by English-language zoologists as the panda. The devil lay in the vernacular, "The effects were cognitively overpowering" for taxonomists who lumped them together as relatives of the same family - bamboo folivores, whereas in empirical reality (amply documented in two chapters) the red panda is related to the New World racoons and their cousins (Family Procyonidae) and the giant panda is a bear (Family Ursidae). Words trap concepts, which the Germans avoided by referring to the giant panda as "the bamboo bear."

Although the disciplines of Physical Anthropology and anatomical dissection deflected the author's career away from his passion for history and the classics, philosophical references illuminate real-world lessons from his play with comparative anatomy. This reflective weave is evident throughout the book and culminates in the last two chapters where he weighs the influence of history, ancient wisdoms, and myths on the development of modern scientific thought.

The style is conversational, laced with humor from personal experiences - the pranks and levity required to lubricate serious investigation. Throughout, scintillating factual tidbits season the smorgasbord of mammalian diversity. For example, the marmosets *Leontopithecus* with brains too large and eyes too close to judge distance with binocular vision head-cock to assess distance. We meet small (40-90 g) blind underground star-nosed moles that dig tunnels with disproportionality large shoveling forefeet and use tentacled noses (like the rays of anemones) to locate their prey of earthworms, insects, and small fish with electrosensory perception. The kangaroos' pongo-stick bounding gait uses elastic energy stored on impact and released at take-off as a replacement for muscular effort; the human foot has similar, through less spectacular mechanism of energy conservation.

In conclusion, the strength of the book lies in its richly illustrated exposé, in pictures and words, of the evolution of mammalian form and its adaptive qualities in divergent and convergent parallel radiations on the different continents. It also stimulates us to consider how we interpret natural phenomena when observations are filtered through historical linguistic and philosophical constructs.