Vertebrate Paleobiology and Paleoanthropology Series

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Patricia A. Holroyd
James D. Gardner *Editors*

Morphology and Evolution of Turtles

Springer

Morphology and Evolution of Turtles

Vertebrate Paleobiology and Paleoanthropology Series

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Morphology and Evolution of Turtles

Proceedings of the Gaffney Turtle Symposium (2009) in Honor of Eugene S. Gaffney

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Cover Illustration: "The Ghosts of Turtles Past" by Don Brinkman

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Preface

With over 100 publications, many of monographic length, Gene Gaffney has brought research on fossil turtles to the forefront of paleontological study. His work set the stage for the current explosion of research on fossil turtles, which is showing exceptional potential for contributing to higher level concepts, such as the nature of evolutionary processes, paleobiogeography, and paleoecology. Upon Gene's retirement in 2007, the consensus among turtle researchers was that his valuable contribution to turtle research should be recognized. An informal survey of researchers at the 2007 Society of Vertebrate Paleontology meetings indicated that a dedicated meeting on fossil turtles and turtle relationships, together with a Festschrift publication, was the most appropriate way to honor Gene.

The idea of a stand-alone meeting dedicated to fossil turtles follows a tradition established by France Lapparent, who organized the first international meeting on fossil turtles in Paris, France, in 1983. Subsequent fossil turtle symposia were held at: the American Museum of Natural History, New York, USA, in 1987; the University of Alberta in Edmonton, Alberta, Canada (in conjunction with the 75th annual meeting of the American Society of Ichthyologists and Herpetologists), in 1995; and at the Zoological Institute of the Russian Academy of Sciences in St. Petersburg, Russia, in 2003. At the time of writing, plans are well underway for hosting the next symposium at the University of Tübingen, Germany, in 2012.

To emphasize that the meeting was being held in Gene's honor, it was formally named the "Gaffney Turtle Symposium", and quickly became known simply as "Gaffneyfest". The success of the meeting was proof of the high esteem in which Gene is valued by his peers. Held at the Royal Tyrrell Museum of Palaeontology in October 2009, the meeting lasted 2 full days, featured 37 talks and 16 posters, and was attended by approximately 100 people. In keeping with the desire to mark Gene's latest career milestone, the meeting was a gathering of several generations of researchers. One end of the spectrum was represented by 6 of the 13 attendees at the original 1984 Paris meeting and by 2 of Gene's classmates from university, all of whom made presentations. The other end of the generational spectrum was represented by an equal number of presentations from researchers who were either within the final stages of their graduate training or had graduated within the past year. And somewhere in the middle were presenters who had never known a time when some of Gene's classic papers, such as "The systematics of the North American Family Baenidae (Reptilia, Cryptodira)" (1972) and "Comparative cranial morphology of Recent and fossil turtles" (1979) were not available as standard references.

Many of the previous turtle meetings resulted in benchmark publications that have played a key role in the development of fossil turtle research, and in some cases, continue to be standard references. The meeting in Paris in 1984 resulted in the first volume of

Vertebrata Paleochelonica, a series that included, among other topics, reviews of fossil turtles from central Asia and Mongolia that provided western researchers with the first easily accessible overview of turtle research being undertaken in the Soviet Union. During the second meeting at the American Museum of Natural History in 1987, attendees received a compilation of translated papers on fossil turtles that fostered further development of an international perspective by turtle researchers. Thus, it was clear in the organizers' minds that to have a long-lasting impact, the Gaffney Turtle Symposium must be followed by a Festschrift volume. It was recognized early on by the editorial team that to be a fitting tribute, the Festschrift ideally should contain a mix of focused papers that would appeal to specialists along with papers having a broader scope that would appeal to a more general audience. For the latter, we solicited several review-style papers on subjects of current interest, such as the origins of turtles and development of the turtle shell. Although there are some obvious gaps in this volume (e.g., no comprehensive analyses of turtle relationships or paleobiogeography), this Festschrift contains a broad range of research and review papers, and we hope it will be a useful resource for years to come.

Don Brinkman got the ball rolling on this Festschrift project. Soon thereafter, Jim Gardner and Pat Holroyd stepped up to help the volume come to fruition, bringing with them extensive experience as editors for the *Journal of Vertebrate Paleontology*. Due to the enthusiastic response to our invitation to contribute to Gene's Festschrift, the editors realized the volume would have to take the form of a book, rather than a special issue of the Bulletin of the American Museum of Natural History as originally planned. At the suggestion of Walter Joyce, the editors approached Eric Delson and Eric Sargis with the idea of including this in Springer's *Vertebrate Paleobiology and Paleoanthropology* series. Pat Holroyd did the key work in drafting the proposal, which was positively received by Springer. Don Brinkman and Jim Gardner shared the workload in getting the manuscripts and other parts of the text ready for publication. Several years later, this volume is the final result of the editors' and authors' collective efforts.

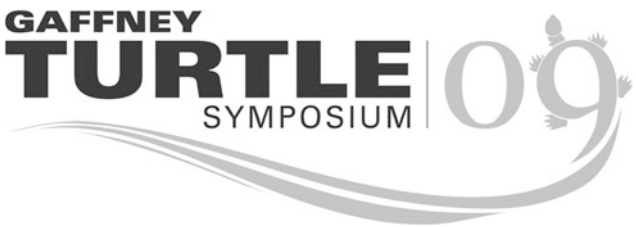

Fig. 1 Logo for the Gaffney Turtle Symposium

Fig. 2 Traditional Chinese painting presented to Eugene Gaffney during the Gaffney Turtle Symposium in October 2009

Acknowledgments

Many of the papers included in this volume were presented at the Gaffney Turtle Symposium, held in October 2009 at the Royal Tyrrell Museum Palaeontology in honor of Gene Gaffney. This symposium was made possible through the financial support of The Cooperating Society of the Royal Tyrrell Museum, the American Museum of Natural History, and a Community Spirit Grant from the Department of Culture and Community Spirit of the Province of Alberta. The support of those organizations is greatly appreciated, especially because it helped defray travel expenses for several international participants who otherwise would not have been able to attend the symposium. The symposium also would not have been possible without the assistance of the organizing committee and staff of the Royal Tyrrell Museum. As well, the editors thank the participants of the symposium, whose enthusiastic discussions led to the development and refinement of many of the ideas presented in this volume.

The role of reviewers in the peer-review process is critical for a volume of this kind. As well as generously donating their time and energy, the reviewers for this volume maintained a high degree of professionalism, provided constructive and supportive comments, and returned their reviews promptly; all of this made the work of the editors much easier. For their efforts in reviewing manuscripts, the editors thank the following individuals:

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Igor Danilov,
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Haiyan Tong,
Matthew Vickaryous,
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Chang-Fu Zhou,
and several anonymous reviewers.

Three of the above-listed reviewers (Igor Danilov, Walter Joyce, and Jim Parham) deserve particular recognition, because they were called upon repeatedly and often at short notice to review manuscripts for this volume.

We are grateful to Eric Delson and Eric Sargis (a.k.a. "the Erics"), co-editors for Springer's Vertebrate Paleobiology and Paleoanthropology Book Series, for their help and guidance in shepherding this project from proposal to publication. Judith Terpos, Tamara Welschot, and other staff at Springer also provided invaluable help in producing this volume. The Cooperating Society of the Royal Tyrrell Museum provided funds to cover additional costs for printing some of the color figures in this volume.

Finally, we thank Gene Gaffney for his leadership and willingness to share information and ideas about fossil turtles, paleontology, and science throughout his more than thirty year career as a student of fossil turtles. His passionate interest in turtle evolution and the information they provide for studying the processes and patterns that have shaped the history of life, his openness in sharing unpublished information and ideas, and his willingness to provide access to undescribed specimens have led to the development of a uniquely collegiate atmosphere among fossil turtle researchers. We hope this book, and the symposium that preceded it, demonstrate the esteem and respect with which Gene and his work are held.

Drumheller, Alberta, Canada, 13 January 2012 — Donald B. Brinkman and James D. Gardner

Berkeley, California, USA, 13 January 2012 — Patricia A. Holroyd

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Part I
Perspectives on the Life and Accomplishments of Eugene S. Gaffney

Chapter 1
Eugene S. Gaffney: A Professional Biography and Bibliography

Robert L. Carroll

Introduction

Eugene (Gene) Gaffney, long time Curator of Vertebrate Paleontology at the American Museum of Natural History, has made the most significant contributions to understanding the fossil record, evolution, and interrelationships of the Chelonia of any paleontologist. He has studied all the significant fossil and living turtles assembled in the major museums of the world, as well as collected specimens from localities throughout North America and as far distant as Lord Howe Island, off the coast of Australia. Gene was also instrumental in the conception, detailed planning and implementation of the current vertebrate paleontology gallery at the American Museum of Natural History. Its six fossil halls constitute the largest vertebrate fossil exhibition in the world. A significant aspect of this exhibition was the explicit integration of cladograms in association with the phylogenetic distribution of the specimens.

Gaffney's Accomplishments

Gene's first interest was in dinosaurs and primitive mammals, but through a visit to Princeton University he met Don Baird who became his advisor on a senior thesis based on a specimen of the side-necked turtle *Taphrosphys*. Don also introduced Gene to the then dean of fossil turtles, Rainer Zangerl, who became his co-author on the related genus *Bothremys*, whose type specimen had just been re-located by Gene in the Rutgers teaching collection (Gaffney and Zangerl 1968).

From Rutgers, Gene went on to Columbia University for his PhD and took advantage of its links with the American Museum of Natural History, which has been Gene's professional home ever since. Bobb Schaeffer instilled in Gene the importance of the highest standards in anatomical description and scientific objectivity. What is most important is Gene's thorough and highly detailed preparation, illustration and analysis of both fossil and living turtles at the broadest scale possible. Already in his PhD thesis he was investigating the highest taxonomic level of chelonian systematics, the cryptodire-pleurodire dichotomy (Gaffney 1969). Between 1972 and 1977, he published 10 major papers on the anatomy and systematics of turtles at the generic and family level including: "The Systematics of the North American Family Baenidae (Reptilia, Cryptodira)" and "An Illustrated Glossary of Turtle Skull Nomenclature" (both in 1972) and "A Revision of the Side-necked Turtle *Taphrosphys sulcatus* (Leidy) from the Cretaceous of New Jersey", "A Taxonomic Revision of the Jurassic Turtles *Portlandemys* and *Plesiochelys*", "*Solnhofia parsonsi*, a New Cryptodiran Turtle from the Late Jurassic of Europe", "A Phylogeny and Classification of the Higher Categories of Turtles", and "Phylogeny of the Chelydrid Turtles: a Study of Shared Derived Characters in the Skull" (all in 1975). "Cranial Morphology of the European Jurassic Turtles *Portlandemys* and *Plesiochelys*" was published in 1976 followed in 1977 by "The Side-necked Turtle Family Chelidae: a Theory of Relationships Using Shared Derived Characters" and "An Endocranial Cast of the Side-necked Turtle, *Bothremys*, with a New Reconstruction of the Palate". His later papers were closely linked with the development of phylogenetic systematics, as seen through the eyes of Karl Popper and discussed in a trio of papers by Platnick and Gaffney in 1977 and 1978.

Major integrative contributions in 1979 included "The Jurassic Turtles of North American" and "Comparative Cranial Morphology of Recent and Fossil Turtles." In the same year, he published his only paper (with McKenna) discussing a specific genus as a possible sister-taxon of

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turtles, followed in 1980 by a more general investigation, "Phylogenetic Relationships of the Major Groups of Amniotes." His paper "The Cranial Morphology of the Extinct Horned Turtle, *Meiolania platyceps*, from the Pleistocene of Lord Howe Island, Australia" (1983) and other later papers summarized results from his extensive field work off the coast of Australia (e.g., Gaffney 1996a, b). Other field work included collecting trips to the Grizzly Buttes localities in the Bridger Basin, the Lance Formation of Wyoming, the Cretaceous-Paleocene of Montana, the San Juan Basin in New Mexico, and the Lower Jurassic Kayenta beds of Arizona.

An exhaustive phylogeny of all turtles was undertaken with Peter Meylan in 1988 and in 1990 Gene published a 263 page monograph on the oldest turtle then known: "The Comparative Osteology of the Triassic Turtle, *Proganochelys*". Through the 1990s and early years of this century, Gene published a wide range of descriptive papers based on turtles from Australia, Africa, China, Europe, the Middle East, South America, and India.

So far, Gene's largest publication has been the 698 page monograph "Evolution of the Side-Necked Turtles: The families Bothremydidae, Euraxemydidae, and Araripemydidae", co-authored with Haiyan Tong and Peter Meylan (2006), with a core data base of 41 taxa.

One of his most recent publications (2010) was entitled "*Kayentachelys*, an Early Jurassic Cryptodire, and the Early History of Turtles", with Farish Jenkins as co-author. This paper discussed the problems of establishing the phylogenetic position of this genus, whether as a sister-taxon of all more advanced cryptodires or as being outside the common ancestry of cryptodires plus pleurodires. Gaffney and Jenkins (2010) demonstrated that very different phylogenetic positions can be hypothesized, even when dealing with the same specimen and using comparable means of phylogenetic analysis.They compared the results of an earlier paper on this genus by Gaffney et al. (1987) and ones by Joyce (2007) and Sterli and Joyce (2007). Gaffney and Jenkins (2010) pointed out that a general problem, the absence of adequate knowledge of well preserved skeletal remains of pre-Late Cretaceous pleurodires, is a major difficulty in establishing their phylogenetic position.This applies specifically to the skull. Joyce (2007) and Sterli and Joyce (2007) had depended heavily on shell characters, which are known to be much more homoplastic than those of the skull and primarily involve loss of primitive features. In contrast, cranial features support close affinities between *Kayentachelys* and other cryptodires.

Gaffney and Jenkins (2010, p. 365) wrote: "The frequent proliferation of contrary results of analysis of the same taxa shows that at least a moderate degree of subjectivity is involved, despite the use of PAUP… An unfortunate by-product of the computer algorithm is the trend to assemble large data sets, often containing a high percentage of unanalyzed and miscoded characters leading to results that are more phenetic than cladistic.Using large number of taxa also increased the likelihood of making a mistake in the homology assessment and distribution.As taxa are included which are farther and farther removed from each other, the morphology becomes harder to compare as differences increase, and the coding of characters becomes even more arbitrary." As the pioneer cladist Colin Patterson and David Johnson (1997, p. 361) said "This change of emphasis replaces our pernicious old black box, evolutionary systematics, with a new one, the [data] matrix."

All but two or three of Gaffney's papers (now totaling more than 100) have been focused on members of the Chelonia. This has been possible, and remains highly significant for understanding evolutionary processes, because all turtles, fossil and living, can be unquestionably united in a single taxonomic assemblage based on a long list of unique synapomorphies (autapomorphies) known only in this assemblage.The structure and modes of development of the carapace and plastron are the most striking examples, but many other aspects of the skeleton and its functions also support a unique evolutionary history.

Ironically, neither Gene's studies of all groups of living turtles and their known fossil record nor his application of phylogenetic analysis have enabled him to determine their specific relationships among other lineages of primitive amniotes. Gene has subsequently avoided active participation in the current arguments regarding the specific sister-taxa of chelonians. In the summary of his recent magnum opus on the evolution of side-necked turtles (2006, p. 570) it was stated: "We consider turtles to be the sister group of diapsids, not within diapsids or within pareiasaurs/procolophonids." Furthermore, "We do not consider the hypothesis that turtles are within diapsids (e.g., deBraga and Rieppel 1997) to have merit, but even accepting this would not alter relationships within turtles as analyzed here."

Nevertheless, Gene's research provides the basis for understanding not only the anatomy and phylogeny of all known turtle taxa, but also demonstrates the clear distinction of even the oldest recognized Late Triassic fossils from any of the known clades of earlier amniotes that have been proposed as the sister-group of chelonians over the past 120 years.

Quoting from Gene's autobiography (Gaffney 2012): "Although I was an active participant and minor contributor to the Clade Wars of the 1970s, I've never been much of a systematics theoretician, at least by AMNH standards.My real love in paleontology has always been the intricacies of morphology—systematics was simply the obvious thing to do with it."

References Not Included in " Bibliography of Eugene S. Gaffney"

deBraga, M., & Rieppel, O. (1997). Reptile phylogeny and the interrelationships of turtles. *Zoological Journal of the Linnean Society, 120*, 281–354.

Joyce, W. G. (2007). Phylogenetic relationships of Mesozoic turtles. *Bulletin of the Peabody Museum of Natural History, 48*, 3–102.

Patterson, C., & Johnson, G. (1997). The data, the matrix, and the message: comments on Begle's "Relationships of the Osmeroid fishes". *Systematic Biology, 46*, 358–365.

Sterli, J., & Joyce, W. G. (2007). The cranial anatomy of the Early Jurassic turtle *Kayentachelys aprix*. *Acta Palaeontologica Polonica, 52*, 675–694.

Bibliography of Eugene S. Gaffney

Burke, A. C., Anderson, M., Weld, A., & Gaffney, E. S. (1983). The reconstruction and casting of a large extinct turtle, *Meiolania*. *Curator, 26*, 5–26.

Burke, A. C., Gaffney, E. S., & Rich, T. H. (1983). Miocene turtles from Lake Tarkarooloo, South Australia. *Alcheringa, 7*, 151–154.

Colbert, E. H., & Gaffney, E. S. (1984). Bobb Schaeffer, a biographical sketch. *Journal of Vertebrate Paleontology, 4*, 285–291.

Dingus, L., Tedford, R., Gaffney, E. S., McKenna, M., Novacek, M., & Delson, E. (1994). *Mammals and their extinct relatives: A guide to the Lila Acheson Wallace Wing*. New York: American Museum of Natural History.

Dingus, L., Gaffney, E. S., Norell, M. A., & Sampson, S. D. (1995). *The halls of dinosaurs. A guide to saurischians and ornithischians*. New York: American Museum of Natural History.

Gaffney, E. S. (1967). Early evolution of pleurodires. *American Society of Ichthyologists and Herpetologists, Forty-seventh Annual Meeting, Abstracts,* 7

Gaffney, E. S. (1969). The North American Baenoidea and the cryptodire-pleurodire dichotomy (Ph.D. Dissertation, Columbia University)

Gaffney, E. S. (1971a). Chelonia. In McGraw-Hill (Ed.), *Yearbook of Science and Technology* (pp. 140–142). New York: McGraw-Hill Inc.

Gaffney, E. S. (1971b). Inadequacy of lower tetrapod fossils for determination of past continental relationships. *Geological Society of America, 3*(7), 576. (Abstracts.)

Gaffney, E. S. (1972a). The systematics of the North American family Baenidae (Reptilia, Cryptodira). *Bulletin of the American Museum of Natural History, 147*, 241–320.

Gaffney, E. S. (1972b). Field trip to the American Museum of Natural History. New York *Paleontological Society, Notes*, *3*, 4–11.

Gaffney, E. S. (1972c). An illustrated glossary of turtle skull nomenclature. *American Museum Novitates, 2486*, 1–33.

Gaffney, E. S. (1974). (Review of) Vertebrate history: Problems in evolution. Barbara J. Stahl. New York, McGraw-Hill, 594 pp. *Systematic Zoology*, *23*, 299

Gaffney, E. S. (1975a). A revision of the side-necked turtle *Taphrosphys sulcatus* (Leidy) from the Cretaceous of New Jersey. *American Museum Novitates, 2571*, 1–24.

Gaffney, E. S. (1975b). A taxonomic revision of the Jurassic turtles *Portlandemys* and *Plesiochelys*. *American Museum Novitates, 2574*, 1–19.

Gaffney, E. S. (1975c). *Solnhofia parsonsi*, a new cryptodiran turtle from the Late Jurassic of Europe. *American Museum Novitates, 2576*, 1–25.

Gaffney, E. S. (1975d). A phylogeny and classification of the higher categories of turtles. *Bulletin of the American Museum of Natural History, 155*, 389–436.

Gaffney, E. S. (1975e). Phylogeny of the chelydrid turtles: A study of shared derived characters in the skull. *Fieldiana: Geology, 33*, 157–178.

Gaffney, E. S. (1976a). Cranial morphology of the European Jurassic turtles *Portlandemys* and *Plesiochelys*. *Bulletin of the American Museum of Natural History, 157*, 489–543.

Gaffney, E. S. (1976b). The history of turtles in Australia. 25th *International Geological Congress, 25*(1), 325–326. (Abstracts.)

Gaffney, E. S. (1977a). The side-necked turtle family Chelidae: A theory of relationships using shared derived characters. *American Museum Novitates, 2620*, 1–28.

Gaffney, E. S. (1977b). An endocranial cast of the side-necked turtle, *Bothremys*, with a new reconstruction of the palate. *American Museum Novitates, 2639*, 1–12.

Gaffney, E. S. (1977c). Phylogeny as science, North American Paleontological Convention II. *Journal of Paleontology*, *51*(suppl 2), 11

Gaffney, E. S. (1979a). The Jurassic turtles of North America. *Bulletin of the American Museum of Natural History, 162*, 91–136.

Gaffney, E. S. (1979b). Turtles from the age of dinosaurs. *Explorers Journal, 57*, 8–9.

Gaffney, E. S. (1979c). Tetrapod monophyly: A phylogenetic analysis. In J. H. Schwartz & H. B. Rollins (Eds.), *Models and methodologies in evolutionary theory* (pp. 92–105). *Bulletin of the Carnegie Museum of Natural History, 13*

Gaffney, E. S. (1979d). An introduction to the logic of phylogeny reconstruction. In J. Cracraft & N. Eldredge (Eds.), *Phylogenetic analysis and paleontology* (pp. 79–111). New York: Columbia University Press.

Gaffney, E. S. (1979e). Comparative cranial morphology of recent and fossil turtles. *Bulletin of the American Museum of Natural History, 164*, 65–375.

Gaffney, E. S. (1979f). Fossil chelid turtles of Australia. *American Museum Novitates, 2681*, 1–23.

Gaffney, E. S. (1979g). Description of a large trionychid turtle shell from the Eocene Bridger Formation of Wyoming. *Contributions to Geology, University of Wyoming, 17*, 53–57.

Gaffney, E. S. (1979h). Fossil trionychids of Australia. *Journal of Paleontology, 53*, 1354–1360.

Gaffney, E. S. (1980). Phylogenetic relationships of the major groups of amniotes. In A. L. Panchen (Ed.), *The terrestrial environment and the origin of land vertebrates* (pp. 593–610). London: Academic Press.

Gaffney, E. S. (1981a). A review of fossil turtles of Australia. *American Museum Novitates, 2720*, 1–38.

Gaffney, E. S. (1981b). Phylogeny and biogeography of meiolaniid turtles. In H. F. Recher & W. F. Ponder (Eds.), *Lord Howe Island* (pp. 26–29). *Occasional Reports, Australian Museum, 1*

Gaffney, E. S. (1982a). Cranial morphology of the baenid turtles. *American Museum Novitates, 2737*, 1–22.

Gaffney, E. S. (1982b). The lower jaws of baenid turtles. *American Museum Novitates, 2749*, 1–10.

Gaffney, E. S. (1982c). On the horns of a dilemma (Letters from the field). *Rotunda, 56*(4), 4–5.

Gaffney, E. S. (1982d). (Review of) Kemp, T. S.: Mammal-like reptiles and the origin of mammals. London: Academic Press. *Systematic Zoology, 31*, 526–527.

Gaffney, E. S. (1983a). The basicranial articulation of the Triassic turtle, *Proganochelys*. In A. G. J. Rhodin & K. Mayata (Eds.), *Advances in herpetology and evolutionary biology; Essays in honor of Ernest E. Williams* (pp. 190–194). Cambridge: Museum of Comparative Zoology, Special Publications.

Gaffney, E. S. (1983b). The cranial morphology of the extinct horned turtle, *Meiolania platyceps*, from the Pleistocene of Lord Howe Island, Australia. *Bulletin of the American Museum of Natural History, 175*, 326–479.

Gaffney, E. S. (1984a). Historical analysis of theories of chelonian relationship. *Systematic Zoology, 33*, 283–301.

Gaffney, E. S. (1984b). Progress towards a natural hierarchy of turtles. *Studia Geologica Salamanticensia, Vol. especial, 1,* 125–131.

Gaffney, E. S. (1985a). The cervical and caudal vertebrae of the cryptodiran turtle, *Meiolania platyceps*, from the Pleistocene of Lord Howe Island, Australia. *American Museum Novitates, 2805*, 1–22.

Gaffney, E. S. (1985b). The shell morphology of the Triassic turtle, *Proganochelys*. *Neues Jahrbuch für Geologie und Paläontologie Abhandlungen, 170*, 1–26.

Gaffney, E. S. (1985c). *Meiolania platyceps*. The Lord Howe Island horned turtles. In P.V. Rich & G.F. Van Tets (Eds.), *Kadimakara: Extinct vertebrates of Australia* (pp. 132–136). Lilydale: Pioneer Design Studio.

Gaffney, E. S. (1986). Triassic and Early Jurassic turtles. In K. Padian (Ed.), *The beginnings of the age of dinosaurs* (pp. 183–187). New York: Cambridge University Press.

Gaffney, E. S. (1988). A cladogram of the pleurodiran turtles. *Acta Zoologica Cracoviensia, 31*, 487–492.

Gaffney, E. S. (1990a). The comparative osteology of the Triassic turtle *Proganochelys*. *Bulletin of the American Museum of Natural History, 194*, 1–263.

Gaffney, E. S. (1990b). *Dinosaurs a golden guide*. Racine: Western Publishing Company, Inc.

Gaffney, E. S. (1991a). The fossil turtles of Australia. In P. Vickers-Rich, J. M. Monaghan, R. F. Baird & T. H. Rich (Eds.), *Vertebrate Palaeontology of Australasia* (pp. 704–720). Lilydale: Pioneer Design Studio.

Gaffney, E. S. (1991b). (Review of) D. B. Weishampel, P. Dodson, & H. Osmólska (Eds.), *The Dinosauria*, 1990, Berkeley: University of California Press, pp. 733). *Systematic Zoology, 40,* 378–379.

Gaffney, E. S. (1991c). Phylogeny and biogeography of the horned turtles. *Journal of Vertebrate Paleontology, 11*(suppl 3), 30A.

Gaffney, E. S. (1992). *Ninjemys*, a new name for "*Meiolania*" *oweni* (Woodward), a horned turtle from the Pleistocene of Queensland. *American Museum Novitates, 3049*, 1–10.

Gaffney, E. S. (1996a). The postcranial morphology of *Meiolania platyceps* and a review of the Meiolaniidae. *Bulletin of the American Museum Natural History, 229*, 1–165.

Gaffney, E. S. (1996b). Unique among vertebrates. *Natural History, 96*(6), 38–39.

Gaffney, E. S. (2000). Turtles of the Santana Formation. *International Geological Congress*, Rio de Janeiro, Brazil: CD-ROM

Gaffney, E. S. (2001). Phylogeny of turtles as seen in patterns of skull diversity. ICVM-6. *Journal of Morphology, 248*, 232–233.

Gaffney, E. S. (2003) Lord Howe Island Australia. *Natural History*, *112*(4A), 44.

Gaffney, E. S. (2012). Autobiography (through May 2009). In D. B. Brinkman, P. A. Holroyd, & J. D. Gardner (Eds.), *Morphology and evolution of turtles*. Dordrecht: Springer.

Gaffney, E. S., Archer, M., & White, A. (1989). Chelid turtles from the Miocene freshwater limestones of Riversleigh Station, Northwestern Queensland, Australia. *American Museum Novitates, 2959*, 1–10.

Gaffney, E. S., Archer, M., & White, A. (1992). *Warkalania*, a new meiolaniid turtle from the Tertiary Reversleigh deposits of Queensland, Australia. *The Beagle, Records of the Northern Territory Museum of Arts and Sciences, 9*, 35–48.

Gaffney, E. S., Balouet, J. C., & De Broin, F. (1984). New occurrences of extinct meiolaniid turtles in New Caledonia. *American Museum Novitates, 2800*, 1–6.

Gaffney, E. S., Brinkman, D. B., Hutchison, H., & Meylan, P. A. (1995). Early history of the Eucryptodira. *Seventy-fifth Annual Meeting of the American Society of Ichthyologists and Herpetologists*, (University of Alberta, Edmonton, Alberta, Canada), Abstracts, 106.

Gaffney, E. S., Campbell, K. E., & Wood, R. C. (1998). Pelomedusoid side-necked turtles from late Miocene sediments in southwestern Amazonia. *American Museum Notivates, 3245*, 1–11.

Gaffney, E. S., Chatterjee, S., & Rudra, D. K. (2001). *Kurmademys*, a new side-necked turtle (Pelomedusoides: Bothremydidae) from the Late Cretaceous of India. *American Museum Novitates, 3321*, 1–16.

Gaffney, E. S., de Campos, D. A., & Hirayama, R. (2001). *Cearachelys*, a new side-necked turtle (Pelomedusoides: Bothremydidae) from the Early Cretaceous of Brazil. *American Museum Novitates, 3319*, 1–20.

Gaffney, E. S., DeBlieux, D. D., Simons, E. L., Sánchez-Villagra, M. R., & Meylan, P. A. (2002). Redescription of the skull of *Dacquemys* Williams, 1954, a podocnemidid side-necked turtle from the late Eocene of Egypt. *American Museum Novitates, 3372*, 1–16.

Gaffney, E. S., Dingus, L., & Smith, M. K. (1995). Why cladistics? *Natural History, 6*(95), 33–35.

Gaffney, E. S., & Forster, C. A. (2003). Side-necked turtle lower jaws (Podocnemididae, Bothremydidae) from the Late Cretaceous Maevarano Formation of Madagascar. *American Museum Novitates, 3397*, 1–13.

Gaffney, E. S., & Hiatt, R. (1971). A new baenid turtle from the Upper Cretaceous of Montana. *American Museum Novitates, 2443*, 1–9.

Gaffney, E. S., Hooks, G. E. III., & Schneider, V. P. (2009a). New material of North American side-necked turtles (Pleurodira: Bothremydidae). *American Museum Novitates, 3655*, 1–26.

Gaffney, E. S., Hutchison, J. H., Jenkins, F. A., Jr., & Meeker, L. J. (1987). Modern turtle origins: The oldest known cryptodire. *Science, 237*, 289–291.

Gaffney, E. S., & Jenkins, F. A., Jr. (2009). The cranial morphology of *Kayentachelys*, an Early Jurassic cryptodire, and the early history of turtles. *Gaffney Turtle Symposium* (*October 17–18, 2009, Royal Tyrrell Museum, Drumheller, Canada*), *Abstract Volume*, 59–63

Gaffney, E. S., & Jenkins, F. A., Jr. (2010). The cranial morphology of *Kayentachelys*, an Early Jurassic cryptodire, and the early history of turtles. *Acta Zoologica (Stockholm), 91*, 335–368.

Gaffney, E. S., & Kitching, J. W. (1994). The most ancient African turtle. *Nature, 369*, 55–58.

Gaffney, E. S., & Kitching, J. (1995). The morphology and relationships of *Australochelys*, an Early Jurassic turtle from South Africa. *American Museum Novitates, 3130*, 1–29.

Gaffney, E. S., Kool, L., Brinkman, D. B., Rich, T. H., & Vickers-Rich, P. (1998). *Otwayemys*, a new cryptodiran turtle from the Early Cretaceous of Australia. *American Museum Novitates, 3233*, 1–28.

Gaffney, E. S., Kool, L., Rich, T., Vickers-Rich, P., Pledge, N., Archer, M., et al. (1992). Early history of the cryptodiran turtles in Australia. *The Beagle, Records of the Northern Territory Museum of Arts and Sciences, 9*(1), 261.

Gaffney, E. S., & Krause, D. W. (2011). *Sokatra,* a new side-necked turtle (Late Cretaceous, Madagascar) and the diversification of the main groups of Pelomedusoides. *American Museum Novitates 3728*, 1–28.

Gaffney, E. S., Krause, D. W., & Zalmout, I. S. (2009b). *Kinkonychelys*, a new side-necked turtle (Pelomedusoides, Bothremydidae) from the late Cretaceous of Madagascar. *American Museum Novitates, 3662*, 1–25.

Gaffney, E. S., & McKenna, M. C. (1979). A Late Permian captorhinid from Rhodesia. *American Museum Novitates, 2688*, 1–15.

Gaffney, E. S., & McNamara, G. (1990). A meiolaniid turtle from the Pleistocene of Northern Queensland. *Proceedings of the De Vis Symposium, memoirs of the Queensland Museum, 28*, 107–113.

Gaffney, E. S., & Meeker, L. J. (1983). Skull morphology of the oldest turtles: A preliminary description of *Proganochelys quenstedti*. *Journal of Vertebrate Paleontology, 3*, 25–28.

Gaffney, E. S., & Meylan, P. A. (1988a). A phylogeny of turtles. In M. J. Benton (Ed.), *The Phylogeny and Classification of Tetrapods* (pp. 157–219). Oxford: Clarendon Press.

Gaffney, E. S., & Meylan, P. A. (1988). A new phylogeny of cryptodiran turtles. *Journal of Vertebrate Paleontology, 8*(suppl 3)*,* 15A.

Gaffney, E. S., & Meylan, P. A. (1989). The early history of the side necked turtles. *Journal of Vertebrate Paleontology, 9*(suppl 3)*,* 21A–22A.

Gaffney, E. S., & Meylan, P. A. (1990). A history of the cranial circulation in turtles. *Journal of Vertebrate Paleontology, 10*(suppl 3), 6A.

Gaffney, E. S., & Meylan, P. A. (1991). Primitive pelomedusid turtle. In J. G. Maisey (Ed.), *Santana fossils: An illustrated atlas* (pp. 335–339). Neptune: Tropical Fish Hobbyist Publications.

Gaffney, E. S., & Meylan, P. A. (1992a). The Transylvanian turtle, *Kallokibotion*, a primitive cryptodire of Cretaceous age. *American Museum Novitates, 3040*, 1–37.

Gaffney, E. S., & Meylan, P. A. (1992b). *Sinaspideretes* is not the oldest trionychid turtle. *Journal of Vertebrate Paleontology, 12*, 257–259.

Gaffney, E. S., & Meylan P. A. (1993). Relationships of primitive Eucryptodira. *Journal of Vertebrate Paleontology 13*(suppl 3)*,* 36A.

Gaffney, E. S., Meylan, P. A., & Wood, R. C. (1997). Changing interpretations of the history of the side-necked turtles. *Journal of Vertebrate Paleontology, 17*(suppl 3), 47A–48A.

Gaffney, E. S., Meylan, P. A., Wood, R. C., Simons, E., & Campos, D. A. (2011). Evolution of the side-necked turtles: The family Podocnemididae. *Bulletin of the American Museum of Natural History, 350*, 1–236.

Gaffney, E. S., Meylan, P. A., & Wyss, A. (1991). A computer assisted analysis of the relationships of the higher categories of turtles. *Cladistics, 7*, 313–335.

Gaffney, E. S., Moody, R. T. J., & Walker, C. A. (2001). *Azabbaremys*, a new side-necked turtle (Pelomedusoides: Bothremydidae) from the Paleocene of Mali. *American Museum Novitates, 3320*, 1–16.

Gaffney, E. S., Rich, T. H., Vickers-Rich, P., Constantine, A., Vacca, R., & Kool, L. (2007). *Chubutemys*, a new eucryptodiran turtle from the Early Cretaceous of Argentina, and the relationships of the Meiolaniidae. *American Museum Novitates, 3599*, 1–35.

Gaffney, E. S., Roberts, E., Sissoko, F., Bouaré, M. L., Tapanila, L., & O'Leary, M. A. (2007). *Acleistochelys*, a new side-necked turtle (Pelomedusoides: Bothremydidae) from the Paleocene of Mali. *American Museum Novitates, 3549*, 1–24.

Gaffney, E. S., Sahni, A., Schleich, H. H., Singh, S. D., & Srivastava, R. (2003). *Sankuchemys*, a new side-necked turtle (Pelomedusoides: Bothremydidae) from the Late Cretaceous of India. *American Museum Novitates, 3405*, 1–10.

Gaffney, E. S., Scheyer, T. M., Johnson, K. G., Bocquentin, J., & Aguilera, O. A. (2008). Two new species of the side necked turtle genus, *Bairdemys* (Pleurodira: Podocnemididae) from the Miocene of Venezuela. *Paläontologische Zeitschrift, 82*, 209–229.

Gaffney, E. S., & Tong, H. (2003). *Phosphatochelys*, a new side-necked turtle (Pelomedusoides: Bothremydidae) from the Paleocene of Morocco. In L.G. Flynn (Ed.), *Vertebrate Fossils and Their Context: Contributions in Honor of Richard H. Tedford* (pp. 644–659). *Bulletin of the American Museum of Natural History, 279*.

Gaffney, E. S., & Tong, H. (2008). Redescription of the skull of *Ummulisani rutgersensis* Gaffney, Tong, and Meylan, 2006, a bothremydid side-necked turtle from the Eocene of Morocco. *American Museum Novitates, 3615*, 1–20.

Gaffney, E. S., Tong, H., & Buffetaut, E. (1998). *Foxemys*, a new side-necked turtle (Bothremydidae: Pelomedusoides) from the Late Cretaceous of France. *American Museum Novitates, 3251*, 1–19.

Gaffney, E. S., Tong, H., Chatterjee, S., Moody, R. T. J., & Hirayama, R. (1998). Evolution of the bothremydid turtles. *Journal of Vertebrate Paleontology, 18*(suppl 3), 44A.

Gaffney, E. S., Tong, H., & Meylan, P. A. (2002). *Galianemys*, a new side-necked turtle (Pelomedusoides: Bothremydidae) from the Late Cretaceous of Morocco. *American Museum Novitates, 3379*, 1–20.

Gaffney, E. S., Tong, H., & Meylan, P. A. (2006). Evolution of the side-necked turtles: The families Bothremydidae, Euraxemydidae, and Araripemydidae. *Bulletin of the American Museum of Natural History, 300*, 1–698.

Gaffney, E. S., & Wood, R. C. (2002). *Bairdemys*, a new side-necked turtle (Pelomedusoides: Podocnemididae) from the Miocene of the Caribbean. *American Museum Novitates, 3359*, 1–28.

Gaffney, E. S., Wood, R., & Sanchez-Villagra, M. (1996). Relationships of the *Shweboemys*-group of side necked turtles. *Journal of Vertebrate Paleontology, 16*(suppl 3)*,* 36A.

Gaffney, E. S., & Ye, X. (1992). *Dracochelys*, a new cryptodiran turtle from the Early Cretaceous of China. *American Museum Novitates, 3048*, 1–13.

Gaffney, E. S., & Ye, X. (1993). A new cryptodiran turtle from the Early Cretaceous of China. Zigong Dinosaur Museum Newsletter, 1, 5–11. (In Chinese)

Gaffney, E. S., & Zangerl, R. (1968). A revision of the chelonian genus *Bothremys* (Pleurodira: Pelomedusidae). *Fieldiana: Geology, 16*, 193–239.

Lewy, Z., & Gaffney, E. S. (2005). First record of a possible chelonioid sea turtle from the Upper Campanian of southern Israel. *Israel Journal of Earth Sciences, 54*, 55–58.

MacPhee, R. D. E., Iturralde-Vinent, M. A., & Gaffney, E. S. (2003). Domo de Zaza, an early Miocene vertebrate locality in South-central Cuba, with notes on the tectonic evolution of Puerto Rico and the Mona Passage. *American Museum Novitates, 3394*, 1–42.

Maisey, J. G., Gaffney, E. S., Norell, M. A., Posen, M., & Dingus, L. (1996). *The Hall of Vertebrate Origins. A guide to fishes, amphibans, turtles, lizards, crocodiles, and pterosaurs*. New York: American Museum of Natural History.

Meylan, P. A., & Gaffney, E. S. (1989). The skeletal morphology of the Cretaceous cryptodiran turtle, *Adocus*, and the relationships of the Trionychoidea. *American Museum Novitates, 2941*, 1–60.

Meylan, P. A., & Gaffney, E. S. (1991). *Araripemys* Price, 1973. In J. G. Maisey (Ed.), *Santata fossils: An illustrated atlas* (pp. 326–334). Neptune: Tropical Fish Hobbyist Publications.

Meylan, P. A., Gaffney, E. S., & De Campos, D. A. (2009). *Caninemys*, a new side-necked turtle (Pelomedusoides: Podocnemididae) from the Miocene of Brazil. *American Museum Novitates, 3639*, 1–26.

Meylan, P. A., Gaffney, E. S., & Wood, R. C. (1995). The case for recognition of the Podocnemidae. *Seventy-Fifth Annual Meeting of the American Society of Ichthyologists and Herpetologists* (University of Alberta, Edmonton, Alberta, Canada), Abstracts, 143.

Norell, M. A., Gaffney, E. S., & Dingus, L. (1991). *Barosaurus* on Central Park West. *Natural History, 12*, 36–40.

Norell, M. A., Gaffney, E. S., & Dingus, L. (1995). *Discovering dinosaurs in the American Museum of Natural History*. New York: Alfred A. Knopf.

Olsson, R. K., & Gaffney, E. S. (1970). The Cretaceous-Tertiary datum in New Jersey. *Geological Society of America, 2*(1), 30. Abstracts.

Platnick, N. I., & Gaffney, E. S. (1977). (Review of) Systematics: A Popperian perspective. The logic of scientific discovery by Karl R. Popper. Conjectures and refutations: The growth of scientific knowledge by Karl R. Popper. *Systematic Zoology, 26,* 360–365.

Platnick, N. I., & Gaffney, E. S. (1978a). [Review of] Evolutionary biology: a Popperian perspective. The poverty of historicism by Karl R. Popper objective knowledge: an evolutionary approach by Karl R. Popper. Unended quest: An intellectual autobiography by Karl R. Popper. *Systematic Zoology, 27*, 137–141.

Platnick, N. I., & Gaffney, E. S. (1978b). (Review of) Systematics and the Popperian paradigm. The philosophy of Karl R. Popper, Paul A. Schillp (Eds.), Criticism and the growth of knowledge; Imre Lakatos, Alan Musgrave (Eds.), the philosophy of Karl R. Popper

by Robert J. Ackermann. Karl Popper by Bryan Magee. *Systematic Zoology*, *27,* 381–388.

Rueda, E. A. C., & Gaffney, E. S. (2005). *Notoemys zapatocaensis*, a new side-necked turtle (Pleurodira: Platychelyidae) from the Early Cretaceous of Columbia. *American Museum Novitates, 3470*, 1–19.

Sánchez-Villagra, M. R., Burnham, R. R. J., Campbell, D. C., Feldmann, R. M., Gaffney, E. S., Kay, R. F., et al. (2000). A new near-shore marine fauna and flora from the early Neogene of northwestern Venezuela. *Journal of Paleontology, 74*, 957–968.

Schleich, H. H., & Gaffney, E. S. (1994). New reptile material from the German Tertiary. 16. On *Chelydropsis murchisoni* (Bell, 1892) from the Middle Miocene locality of Unterwohlbach/South Germany. *Courier Forschungsinstitut Senckenberg, 173*, 197–213.

Siddall, M. E., & Gaffney, E. S. (2004). Observations on the leech *Placobdella ornata* feeding from bony tissues of turtles. *Journal of Parasitology, 90*, 1186–1188.

Singh, S. D., Sahni, A., Gaffney, E. S., & Schleich, H. H. (1998). Reptilia from the Intertrappean Beds of Bombay (India). *Veröffentlichungen aus dem Fuhlrott-Museum, 4*, 307–320.

Tong, H., & Gaffney, E. S. (2000). Description of the skull of *Polysternon provinciale* (Matheron, 1869), a side-necked turtle (Pelomedusoides: Bothremydidae) from the Late Cretaceous of Villeveyrac, France. *Oryctos, 3*, 9–18.

Tong, H., & Gaffney, E. S. (2001). Turtle fauna from the Cenomanian (Late Cretaceous) of Southern Morocco. *Bulletin de la Société d'etude des Sciences Naturelles d'Elbeuf, 2001*, 89–90.

Weldon, P. J., & Gaffney, E. S. (1998). An ancient integumentary gland in turtles. *Naturwissenschaften, 85*, 556–557.

Wood, R. C., Johnson-Gove, J., Gaffney, E. S., & Maley, K. F. (1996). Evolution and phylogeny of the leatherback turtles (Dermochelyidae), with descriptions of new fossil taxa. *Chelonian Conservation and Biology, 2*, 266–286.

Woodburne, M. O., Hunt, R. M., Jr., Gould, G. C., Gaffney, E. S., & Flynn, L .J. (2003). Richard H. Tedford: Field man, systematist, professor, and mentor. In L.G. Flynn (Ed.), *Vertebrate Fossils and Their Context: Contributions in Honor of Richard H. Tedford* (pp. 1–17). Bulletin of the American Museum of Natural History, 279.

Chapter 2
Autobiography (Through May 2009)

Eugene S. Gaffney

My research interests are the morphology and systematics of turtles, primarily as seen in the fossil record. Turtles are a good group for phylogenetic problems: they have a long history with a diverse fossil record and a good sampling of living taxa that allow for accurate identification of structures. I became an early proponent of phylogenetic systematics due to the influence of Gary Nelson and Bobb Schaeffer in the late 1960s, and I was very fortunate to be present during the development of cladistics at one of its primary centers, the American Museum of Natural History (AMNH). Although most of my publications consist of the documentation and analysis of morphology, I think that my main scientific achievement has been the increase of phylogenetic knowledge of turtles using cladistic methodology. I never had an overall plan, but in retrospect my research reveals an accidentally sensible pattern. After doing a general treatise on turtle skull morphology (Gaffney 1979), I concentrated on the earliest turtles (Triassic and Jurassic) and the largest group of turtles, the cryptodires. I have devoted the past decade to the other main clade, the pleurodires.

I was born in Jersey City, New Jersey, on August 12, 1942. We lived only a few miles from the AMNH, where my parents did take me when I was 5 or 6 years old, but I don't remember seeing the dinosaurs. After my father died in 1949, my mother remarried and we moved to Texas, where I spent most of my childhood. My stepfather was in the Air Force and we did a fair amount of traveling. It was in Texas that I discovered paleontology and collected my first fossils, invertebrates not vertebrates. When my Dad left the Air Force we returned to New Jersey and I entered high school in East Orange. For various reasons, my parents went from a good life in the military to poverty in a New Jersey slum. After high school, I attended Rutgers, the State University of New Jersey, where I received full scholarships. I first majored in biology, as this was the facet of paleontology I was most interested in. However, the very large biology department at Rutgers was very oriented to pre-med and getting as many graduates into medical school as possible. When I saw that the Department of Geology actually had a museum with a mastodon skeleton, a mosasaur skull, and a hind limb of a sauropod, I left the brand-new Biology building for the hundred-year old Geological Museum and never regretted it for a second.

Although Rutgers was and is a large school, the Geology Department was small at that time, and, with a faculty/student ratio (for majors) of close to 1:1, the faculty had a very personal relationship with the students. We did a lot of field work, possible even in New Jersey (Fig. 2.1), and I learned a lot. My interests in paleontology at this time were dinosaurs and primitive mammals. But as a senior, Steven K. Fox and Richard K. Olsson of the Rutgers Geology faculty took me to Princeton University where I met Don Baird. Don, who became my advisor on my senior honors thesis, persuaded me to do a description of the side-necked turtle, *Taphrosphys*, based on new material from New Jersey that he provided. Don was a great inspiration for me, and my first real contact with a vertebrate paleontologist. In 1965 he took me to Nova Scotia as his field assistant. We met and worked with Bob Carroll there, another life-long friendship I acquired.

While I was working on my senior thesis at Rutgers, Don told Rainer Zangerl (Chairman of the Dept of Vertebrate Paleontology and Curator of Fossil Reptiles at the Field Museum in Chicago) about this kid working on pleurodires. At this time Rainer was the world turtle expert (although rapidly changing to fishes), and he offered me a travel grant to Chicago to do a paper with him on the related pleurodire, *Bothremys*. I had just re-located the type skull of *Bothremys cooki* Leidy in the Rutgers teaching collection, along with about a dozen other fossil reptile types dating back to Leidy from the 1860s, including *Taphrosphys sulcatus*. So suddenly

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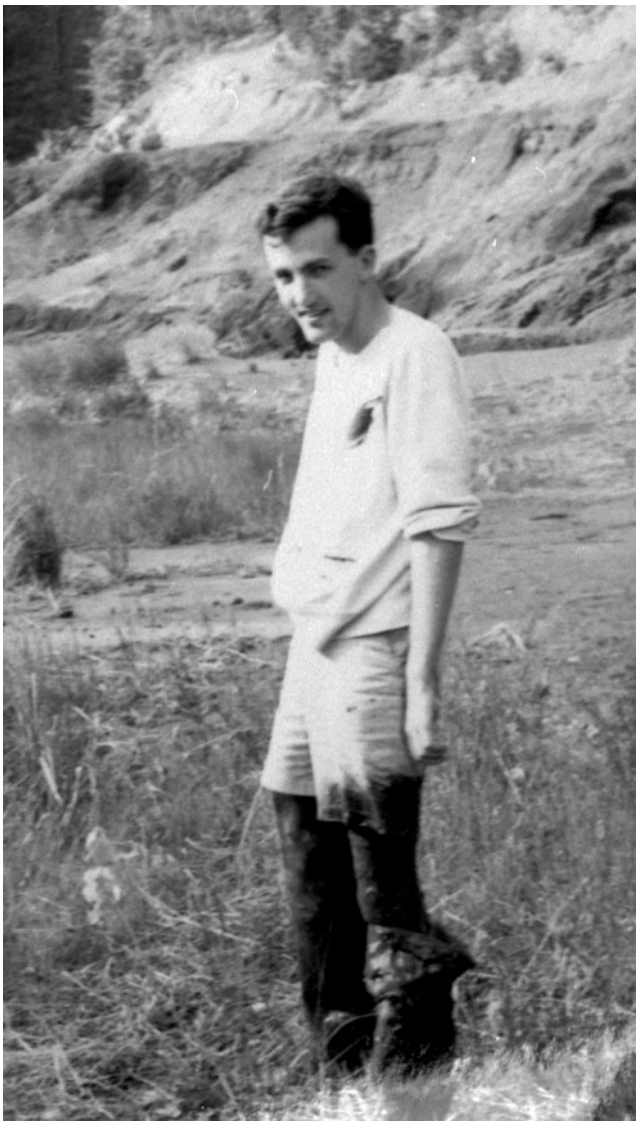

Fig. 2.1 Gene in 1964 collecting (mostly mud) in the Cretaceous-Paleocene Greensands of Sewell, New Jersey, while an undergraduate at Rutgers University. Photo by J. Cunliffe

from a lowly undergrad I became a turtle expert going on my first museum trip to study collections for a genuine paper with a real honcho. I don't think I could have gotten this far if I tried sticking to mammal teeth or dinosaurs. This was heady stuff and I was on my way. My association with Rainer lasted a long time; I always valued his friendship.

After graduating from Rutgers in 1965, I was accepted to the Columbia University Department of Geology cognate field program in vertebrate paleontology with Edwin H. Colbert, Curator of Fossil Reptiles at the AMNH, as my advisor. In that year I moved into office space at the AMNH and have had an office there ever since. Although my original intention was to work on dinosaurs, Colbert turned out to be less than supportive, and I turned to a subject I knew something about, turtles. I wrote my paper with Rainer (Gaffney and Zangerl 1968). I also met Sam McDowell, a Research Associate in Herpetology at the AMNH. Sam is a gifted anatomist and became a good friend, filling me with his sometimes disorganized, but seemingly infinite, knowledge of turtle basicrania. Sam also inspired me to do dissections of recent turtles, using the nearly limitless corpses from the Bronx Zoo. But my real mentor (and close friend in later years) in grad school was Bobb Schaeffer, Curator of Fossil Fishes and Chair of the Department of Vertebrate Paleontology at the AMNH. Bobb gave the best course I've ever taken, on fossil fishes, but it was really a basic vertebrate anatomy course, turning us on to Edwin Stephen Goodrich and Sir Gavin de Beer. I was not the only one who Bobb inspired to accept only the highest standards in anatomical description and scientific objectivity. But Bobb was the one who helped me through the thesis, read it with care, and inspired me to do things I didn't think I could.

Although I had no particular interest in turtles, they kept appearing as excellent targets of opportunity. I don't know anymore where I first heard the story, but I used it when people would ask why I was only working on turtles. I wrote it up in a departmental review we had sometime in the 1980s and was very enamored of it, even if it's kind of silly. A famous geologist gave a public talk on continental drift and the history of the earth. After the talk an old lady came up to him and complained that he had it all wrong. She said the earth was supported on the backs of four giant turtles. The great man replied that that was impossible, what were the turtles standing on? The old lady said they were standing on four even larger turtles. So the professor thought a second and said, "Aha, but what are those turtles standing on?" And the old lady looked at him, shook her head a bit in disappointment and replied, "It's no use, Professor, it's turtles all the way down."

The AMNH has an excellent collection of turtles, including many turtle skulls, including baenids, supposed "Amphichelydia" or ancestral group turtles. Even before cladistics, it was apparent to me that using the basicranial criteria developed from Sam McDowell and my own work, baenids were cryptodires. My thesis included both a revision of the baenids as well as a redefinition of cryptodires and pleurodires, and was called: "The North American Baenoidea and the Cryptodire-Pleurodire Dichotomy." Colbert never actually read it, but both Bobb Schaeffer and Malcolm McKenna made major improvements to it. Colbert, however, gave me the best possible legacy, his job. Actually, it was Schaeffer who did that, although I subsequently learned that he asked the opinion of a number of people. There were no search committees in those days. Malcolm was very supportive, as were other curators in the

Fig. 2.2 After his PhD thesis defense in 1969, Gene celebrated with his close friends in the joint Columbia University-AMNH graduate program. From *left* to *right* (corresponding AMNH advisor indicated in parentheses): Gene Gaffney (E. H. Colbert, fossil reptiles), Niles Eldredge (N. Newell, fossil invertebrates), John Boylan (B. Schaeffer, fossil fishes), and Bob Hunt (M. McKenna and R. H. Tedford, both fossil mammals). Photo by H. Osborn

museum. Schaeffer told me to finish up quickly as Colbert was retiring soon, and I completed my grad career in 4 years (1965–1969; Fig. 2.2).

Although my thesis as submitted (not the published version) showed no influence from cladistics, the topic was a burning controversy during my last years as a grad student. Gareth Nelson, the new curator of recent fishes, brought cladistics to the vertebrate departments (entomology had an independent origin), around 1967. I saw a real opportunity with the turtles. Here was a group with many living representatives to provide excellent anatomical information, a relatively good fossil record, systematics largely uninfluenced by skull morphology, and a good collection of "primitive" taxa with lots of skulls in my own basement. My first cladistic paper was the baenids in 1972 when I renovated that part of the thesis. The cryptodire-pleurodire part I rewrote and published in 1975.

After I got the AMNH job in 1970, I went after anything called "Amphichelydia" to see if they were cryptodires or pleurodires. I first toured European museums in 1971 and started on Jurassic turtles primarily. While I was still a graduate student I was approached by Carl Gans to do a chapter on the turtle skull for his "Biology of the Reptilia" series. But it got out of hand, became too long for the series, and I ended up publishing it as an AMNH bulletin on turtle cranial morphology in 1979, illustrating and discussing all the living and extinct genera then known. My life-long interest in morphology always depended on high quality illustrations and illustrators. Over the years, first Lorraine Meeker, then Frank Ippolito supported me with superb talent and dedication.

Although I was an active participant and minor contributor to the Clade Wars of the 1970s, I've never been much of a systematics theoretician, at least by AMNH standards. My real love in paleontology has always been the intricacies of morphology—systematics was simply the obvious thing to do with it. In any case, the 1970s was mostly spent working up the material I could get easily, largely from the Jurassic of North America and Europe. I did much of my own acid preparation of European specimens where necessary.

One of the classic "Amphichelydia" was the horned turtles, the meiolaniids. At the AMNH we had one partial specimen collected from South America and described by George Gaylord Simpson in the 1930s, but most of the

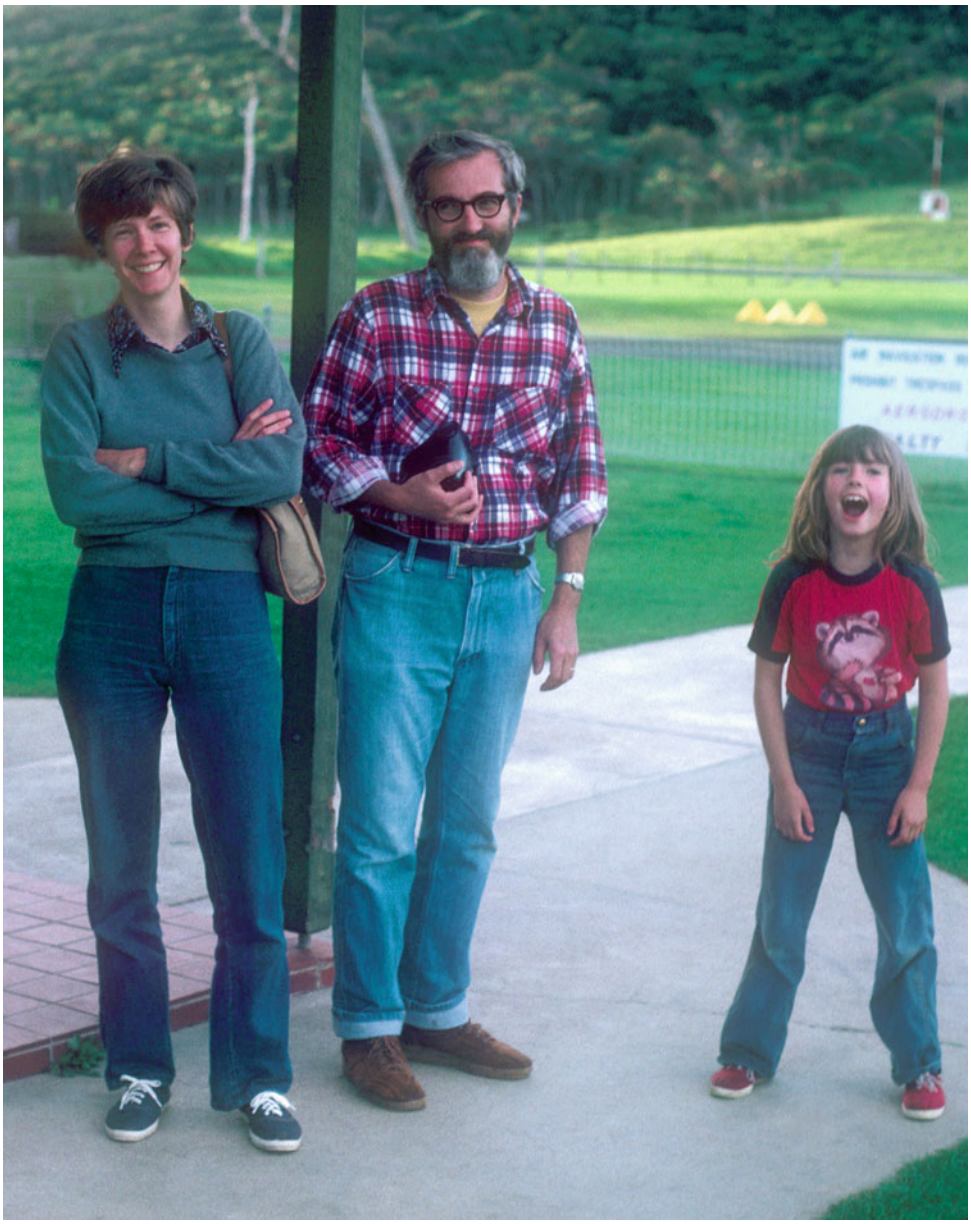

Fig. 2.3 Gene with his wife Barbara and daughter Karen in 1980, while collecting Pleistocene *Meiolania* on Lord Howe Island, Australia. As recounted by his then PhD student Paul Sereno, "a tropical paradise isn't the usual setting for paleontological exploration and can make for family fun. The expedition was supported by food, beer and other luxuries, airlifted by Hercules aircraft to the short airstrip on Lord Howe Island courtesy of the Australian army." Photo by P. Sereno

known specimens were Australian. I was never much of a field man, but Australia really appealed to me, so in 1976 I went to Australia. I had heard about the place of course, from Dick Tedford, a fellow AMNH Department of Vertebrate Paleontology curator, who was famous for great discoveries in the Australian deserts from years of work there. I was still interested in pleurodires, which were big in Australia, and hoped to find some fossil chelids, at least in Australian collections. I loved Australia. Even the 1976 trip was a great adventure for me. I visited a lot of museums, saw a lot of people, and went into the Dead Center. I even slept in a tent, for a couple of days anyway. The roughing-it life is not mine, I'm more the Hilton-type. I studied meiolaniid skulls in the collections in Sydney and decided I wanted to go to Lord Howe Island where they came from, collect some more, and resolve the conflicting statements about the source. Eventually, I managed two ambitious field seasons on Lord Howe with field parties of up to 12 people, and a number of supporting trips. I visited Australia eight times, many of those with my wife, Barbara, and our daughter, Karen (Fig. 2.3). We also collected in Oligocene deposits at Lake Palankarinna, another Tedford turtle locality.

I think most of my contemporaries thought I was crazy wasting time and effort on the horned turtles, which were an extreme of evolution no matter what their relationships were. But they had not visited Lord Howe Island. Lord Howe was my kind of field work. It is fantastically beautiful, and no camping allowed. Meiolaniids and other Australian turtles formed the subjects of a number of my monographs