

SPOTLIGHT**TREATISE ON INVERTEBRATE PALEONTOLOGY: A WORK IN PROGRESS**

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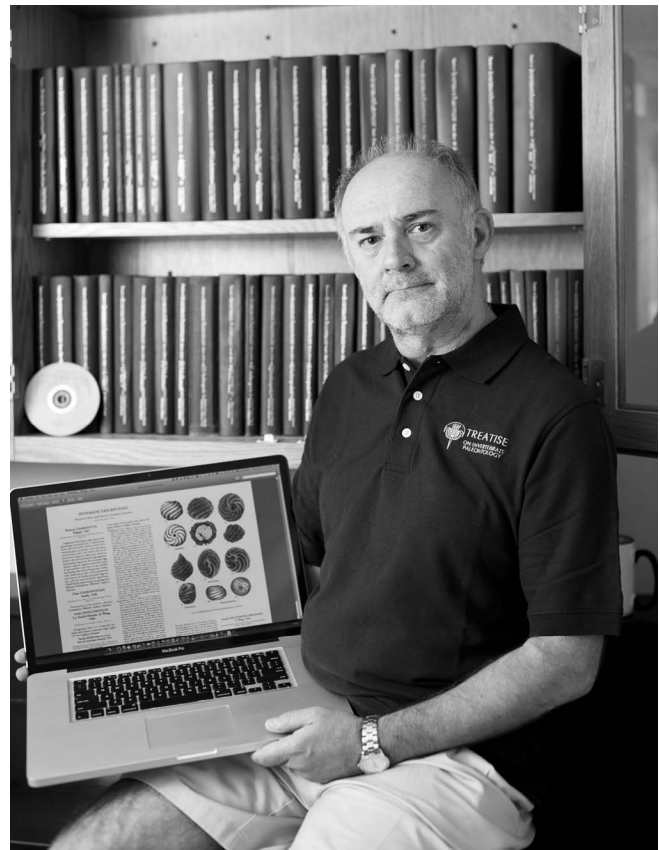
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No article on the *Treatise on Invertebrate Paleontology* would be complete without first discussing its founder and longest-serving Editor: Raymond Cecil Moore. R.C. Moore was a cofounder of the Society for Economic Paleontologists and Mineralogists (SEPM), which was formally established in 1927 (Moore, 1940), and he served as one of its first Presidents in 1928. In 1944, a committee of the Paleontological Society, chaired by Benjamin F. Howell of Princeton University, invited Moore to lead a project to develop a textbook on invertebrate paleontology that would update and replace volume 1 of the old Textbook of Palaeontology by Zittel and Eastman (1913) (Moore, 1952). Moore brought together SEPM, The Paleontological Society, and the Palaeontographical Society (founded in England in 1847) to further the project. Moore's vision for the *Treatise* was for a three-volume work of about 3000 pages, following the pattern of another, now-classic, textbook he was working on: *Invertebrate Paleontology* (Moore, Lalicker, and Fischer, 1952). The *Treatise* was to "... summarize compactly, but with reasonable completeness, the state of knowledge concerning invertebrate fossils as of about the middle of the present century" (Moore, 1952). Rather than approaching a publishing house, Moore arranged for the Geological Society of America to underwrite the cost of illustrations, in an attempt to keep costs down and thus make the *Treatise* affordable to paleontologists all around the world.

The *Treatise* is, thus, a compendium of all invertebrate fossil genera, together with their taxonomic synonymy, stratigraphic ranges, geographic occurrence, and illustrations of the type specimens. Introductory material to each volume provides the current state of knowledge of the paleobiology of the group, commonly including comprehensive essays on morphology (including that of modern relatives, if appropriate), paleoecology, ontogeny, geological history, classification, and molecular systematics, and genetics, if available. Written by the foremost experts in the field, to this day the *Treatise* provides the gold standard of paleontological knowledge. The first volume appeared in 1953 (Part G, Bryozoa), and since then 51 volumes have been published, authored by more than 300 contributors worldwide, covering most invertebrate groups, and including trace fossils and charophytes (Table 1; and see www.paleo.ku.edu for a complete list of volumes in progress). Moore's prediction of 3000 pages has been vastly exceeded: the current page count is 20,115 and rising. The *Treatise* truly is a work in progress.

R.C. Moore stepped down as Editor to make way for Curt Teichert in 1964; however, Moore continued to be the main guiding hand of the *Treatise* until his death in 1974. The volumes edited by Teichert alone are mostly remembered because their covers are colored other than blue! Richard Robison took over the editorship after Teichert retired in 1977 and continued until 1985. Roger Kaesler then took the lead in 1986, and his legacy is the start of the move to a *Treatise* in digital form. I took up the reins in 2007, with the aim of making the *Treatise* more widely available in digital format, as Roger had envisaged, while maintaining a steady output of hard-copy volumes (about one per year at present).

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The author displaying the charophyte volume (Part B) in digital form, and in the background, a DVD containing the entire *Treatise on Invertebrate Paleontology* is positioned in front of the set of hard-copy published volumes. Paul Selden earned his Bachelors degree in Geology and Zoology at the University of Manchester (UK); he then went on to study for his PhD at the University of Cambridge, advised by the late Harry Whittington. Paul worked on eurypterids at first, and then moved on to other fossil chelicerate arthropods. He has published on horseshoe crabs, various arachnid groups, and occasionally on other arthropods such as millipedes and crustaceans. Shortly after graduating from Cambridge, he was invited to collaborate with Bill Shear (Hampden-Sydney, Virginia) on studies of the earliest land animals, a partnership which still flourishes today. In more recent years, his work on fossil spiders is probably best known. Paul has been Director of the Paleontological Institute since 2007. This year, he will spend six months in Berlin, as part of an Alexander von Humboldt Research Award, working with his former graduate student Jason Dunlop on a revision of the Chelicerata *Treatise* (Part P, Arthropoda 2), which first appeared in 1956 (photo courtesy of Steve Puppe).

From 1953 until 2008, the *Treatise* was copublished by The University of Kansas Paleontological Institute and the Geological Society of America. Since 2008, when digital publication was becoming a reality, the *Treatise* has been published solely by the Paleontological Institute

TABLE 1—List of published volumes of *Treatise on Invertebrate Paleontology*.

Part A. INTRODUCTION: Fossilization (Taphonomy), Biogeography, and Biostratigraphy, xxiii + 569 p., 169 fig., 1979.
Part B. PROTOCTISTA 1 (Charophyta), xvi + 170 p., 79 fig., 9 tables, 2005.
Part C. PROTISTA 2 (Sarcodina, Chiefly “Thecamoebians” and Foraminiferida), Volumes 1 and 2, xxxi + 900 p., 653 fig., 1964.
Part D. PROTISTA 3 (Protozoa: Chiefly Radiolaria, Tintinnina), xii + 195 p., 92 fig., 1954.
Part E. ARCHAEOCYATHA and PORIFERA, xviii + 122 p., 89 fig., 1955.
Part E, Revised. ARCHAEOCYATHA, Volume 1, xxx + 158 p., 107 fig., 1972.
Part E, Revised. PORIFERA, Volume 2 (Introduction to the Porifera), xxvii + 349 p., 135 fig., 10 tables, 2003.
Part E, Revised. PORIFERA, Volume 3 (Demospongiae, Hexactinellida, Heteractinida, Calcarea), xxxi + 872 p., 506 fig., 1 table, 2004.
Part F. COELENTERATA, xx + 498 p., 358 fig., 1956.
Part F. COELENTERATA, Supplement 1 (Rugosa and Tabulata), Volumes 1 and 2, xl + 762 p., 462 fig., 1981.
Part G. BRYOZOA, xiii + 253 p., 175 fig., 1953.
Part G, Revised. BRYOZOA, Volume 1 (Introduction, Order Cystoporata, Order Cryptostomata), xxvi + 625 p., 295 fig., 1983.
Part H. BRACHIOPODA, Volumes 1 and 2, xxxii + 927 p., 746 fig., 1965.
Part H, Revised. BRACHIOPODA, Volume 1 (Introduction), xx + 539 p., 417 fig., 40 tables, 1997.
Part H, Revised. BRACHIOPODA, Volumes 2 and 3 (Linguliformea, Craniiformea, Rhynchonelliformea [part]), xxx + 919 p., 616 fig., 17 tables, 2000.
Part H, Revised. BRACHIOPODA, Volume 4 (Rhynchonelliformea [part]), xxxix + 768 p., 484 fig., 3 tables, 2002.
Part H, Revised. BRACHIOPODA, Volume 5 (Rhynchonelliformea [part]), xlvi + 631 p., 398 fig., 2006.
Part H, Revised. BRACHIOPODA, Volume 6 (Supplement), l + 906 p., 461 fig., 38 tables. CD of compiled references from volumes 1–6, 2007.
Part I. MOLLUSCA 1 (Mollusca General Features, Scaphopoda, Amphineura, Monoplacophora, Gastropoda General Features, Archaeogastropoda, Mainly Paleozoic Caenogastropoda and Opisthobranchia), xxiii + 351 p., 216 fig., 1960.
Part K. MOLLUSCA 3 (Cephalopoda General Features, Endoceratoidea, Actinoceratoidea, Nautiloidea, Bactritoidea), xxviii + 519 p., 361 fig., 1964.
Part L. MOLLUSCA 4 (Cephalopoda: Ammonoidea), xxii + 490 p., 558 fig., 1957.
Part L, Revised. MOLLUSCA 4, Volume 2 (Carboniferous and Permian Ammonoidea), xxix + 258 p., 139 fig., 1 table, 2009.
Part L, Revised. MOLLUSCA 4, Volume 4 (Cretaceous Ammonoidea), xx + 362 p., 216 fig., 1996.
Part N. MOLLUSCA 6 (Bivalvia), Volumes 1 and 2 (of 3), xxxvii + 952 p., 613 fig., 1969; Volume 3, iv + 272 p., 153 fig., 1971.
Part O. ARTHROPODA 1 (Arthropoda General Features, Protarthropoda, Euarthropoda General Features, Trilobitomorpha), xix + 560 p., 415 fig., 1959.
Part O, Revised. ARTHROPODA 1 (Trilobita: Introduction, Order Agnostida, Order Redlichiida), xxiv + 530 p., 309 fig., 1997.
Part P. ARTHROPODA 2 (Chelicerata, Pycnogonida, Palaeoisopus), xvii + 181 p., 123 fig., 1955 [1956].
Part Q. ARTHROPODA 3 (Crustacea, Ostracoda), xxiii + 442 p., 334 fig., 1961.
Part R. ARTHROPODA 4, Volumes 1 and 2 (Crustacea Exclusive of Ostracoda, Myriapoda, Hexapoda), xxxvi + 651 p., 397 fig., 1969.
Part R. ARTHROPODA 4, Volumes 3 and 4 (Hexapoda), xxii + 655 p., 265 fig., 1992.
Part S. ECHINODERMATA 1 (Echinodermata General Features, Homalozoa, Crinozoa, exclusive of Crinoidea), Volumes 1 and 2, xxx + 650 p., 400 fig., 1967 [1968].
Part T. ECHINODERMATA 2 (Crinoidea), Volumes 1–3, xxxviii + 1,027 p., 619 fig., 1978.
Part T, Revised. ECHINODERMATA 2 (Crinoidea), Volume 3, xxix + 261 p., 112 fig., 2011.
Part U. ECHINODERMATA 3 (Asterozoans, Echinozoans), xxx + 695 p., 534 fig., 1966.
Part V. GRAPTOLITHINA, xvii + 101 p., 72 fig., 1955.
Part V, Revised. GRAPTOLITHINA, xxxii + 163 p., 109 fig., 1970.
Part W. MISCELLANEA (Conodonts, Conoidal Shells of Uncertain Affinities, Worms, Trace Fossils, Problematica), xxv + 259 p., 153 fig., 1962.
Part W, Revised. MISCELLANEA, Supplement 1 (Trace Fossils and Problematica), xxi + 269 p., 110 fig., 1975.
Part W, Revised. MISCELLANEA, Supplement 2 (Conodonts), xxviii + 202 p., frontis., 122 fig., 1981.

and is now available in both hard-copy and digital form. There are several aspects to digital publication. First, making the legacy volumes available to read on a computer screen should be a simple matter. In practice, more recent volumes had been typeset digitally, and so Adobe portable digital format (pdf) files were already available. Older volumes needed to be scanned and, to be searchable, also required passing over with optical character recognition (OCR) software. All *Treatise* volumes ever published are now available as searchable pdf files on compact disks (CD); all volumes still in print are available additionally as individual chapters downloadable on the Internet; and, of course, all in-print hard-copy books can be purchased online. The golden CDs, each with a logo representing the organism pertinent to the volume, are the same price as the respective print volume, and the whole *Treatise* series (39 CDs) is available for \$1720, or on a single DVD for a mere \$1670 (for more information, go to paleo.ku.edu).

Second, one of the common complaints of the *Treatise* has been that, because numerous authors were involved in the writing of each volume, some would finish much sooner than others, resulting in some chapters becoming outdated by the time the volume finally went to press, which may be several years after its inception. Even worse, some authors have not lived to see the fruits of their labors published. To overcome these problems, now, as soon as a chapter is ready for publication—i.e., submitted by the authors, peer reviewed, typeset, and signed off by the Coordinating Author for the volume—it is made available online in our new journal *Treatise Online* (paleo.ku.edu/treatiseonline/). Chapters are still proofread and edited to the highest standards, which readers have come to expect of the *Treatise*.

This publication began in 2010 and today runs to 47 chapters (Table 2) from 4 different *Treatise* volumes—hypercalcified sponges, coleoids, bivalves, and crinoids, and decapod and ammonoid chapters are due out very soon—each of which can be purchased and downloaded from the Internet. When a complete volume is ready, there is a short period of revision, and then the hard-copy volume is published as usual. *Treatise Online* is an online, peer-reviewed journal with an ISSN number and complies with the requirements of ICBN and ICZN for publication of valid nomenclature; hard copies of each article are archived at libraries throughout the world. *Treatise Online* is amenable to online searches and inclusion in such databases as citation indexes. As soon as possible, *Treatise Online* will be submitted to join the Thompson Reuters science citation list. The online journal also allows for the possibility of working on several volumes at once, where before the staff of the Paleontological Institute staff was forced to focus on one volume at a time. Color illustrations are yet another benefit of online publication.

Searching for information in pdf files on a computer is extremely useful, but the data themselves cannot easily be mined and queried. To this end, the third aspect of digital publication is the most exciting. The *Treatise* format has remained remarkably consistent over the 60 years since it first appeared, particularly the systematic sections. The format, generically known as semistructured, can be searched for many types of data; for example, genus name (bold), immediately followed by author(s) (small capitals), date (numerical), and so on. Computer algorithms can be used to mark each data type using Extended Markup Language (XML) tags. In this way, much more powerful searches and queries can

TABLE 2—List of *Treatise Online* chapters (as of mid-May 2012), comprising manuscript from 4 different *Treatise* volumes. Members of SEPM, Paleontological Society, and Palaeontological Association are allowed free access to *Treatise Online* through their respective society member web pages.

- Vacelet, Jean, Philippe Willenz, & W. D. Hartman. 2010. Part E, Revised, Volume 4, Chapter 1: Living hypercalcified sponges. *Treatise Online* 1:1–16, fig. 1–5.
- Stearn, C. W., & C. W. Stock. 2010. Part E, Revised, Volume 4, Chapter 5: A list of Upper Paleozoic–Mesozoic stromatoporooid-like genera; and excluded taxa. *Treatise Online* 2:1–8.
- Stearn, C. W. 2010. Part E, Revised, Volume 4, Chapter 6: Systematic descriptions of the class and order Uncertain: Family Disjectoporidae. *Treatise Online* 3:1–11, fig. 1–7.
- Webby, B. D., compiler. 2010. Part E, Revised, Volume 4, Chapter 8: Glossary of terms applied to the hypercalcified Porifera. *Treatise Online* 4:1–21.
- Stearn, C. W. 2010. Part E, Revised, Volume 4, Chapter 9A: Paleozoic Stromatoporoidea: General introduction. *Treatise Online* 5:1–3.
- Stearn, C. W. 2010. Part E, Revised, Volume 4, Chapter 9D: Microstructure and Mineralogy of Paleozoic Stromatoporoidea. *Treatise Online* 6:1–25, fig. 1–15.
- Stearn, C. W. 2010. Part E, Revised, Volume 4, Chapter 9E: Morphologic Affinities of the Paleozoic Stromatoporoidea to other fossil and Recent groups. *Treatise Online* 7:1–9.
- Stearn, C. W. 2010. Part E, Revised, Volume 4, Chapter 9F: Functional morphology of the Paleozoic stromatoporooid skeleton. *Treatise Online* 8:1–26, fig. 1–9.
- Stearn, C. W. 2010. Part E, Revised, Volume 4, Chapter 11A: Diversity trends of the Paleozoic Stromatoporoidea. *Treatise Online* 9:1–5, fig. 1–2.
- Stearn, C. W. 2010. Part E, Revised, Volume 4, Chapter 11B: Extinction patterns of the Paleozoic Stromatoporoidea. *Treatise Online* 10:1–17, table 1–2.
- Stearn, C. W. 2010. Part E, Revised, Volume 4, Chapter 15A: Techniques of study: Collection, preparation, and analysis of the Paleozoic Stromatoporoidea. *Treatise Online* 11:1–10.
- Stearn, C. W. 2010. Part E, Revised, Volume 4, Chapter 15B: Classification of the Paleozoic Stromatoporoidea. *Treatise Online* 12:1–9.
- Nixon, Marion. 2010. Part M, Chapter 5: Reproduction and lifespan. *Treatise Online* 13:1–29, 14 fig.
- Nixon, Marion. 2010. Part M, Chapter 6: Biogeography of Recent forms. *Treatise Online* 14:1–40, 14 fig.
- Carlini, David. 2010. Part M, Chapter 15: Molecular systematics of the Coleoidea. *Treatise Online* 15:1–8, 1 fig.
- Hess, Hans. 2010. Part T, Revised, Volume 1, Chapter 19: Paleoecology of pelagic crinoids. *Treatise Online* 16:1–33, 23 fig. Nixon, Marion. 2011. Part M, Chapter 3: Anatomy of Recent forms. *Treatise Online* 17:1–49, 33 fig.
- Stearn, C. W. 2011. Part E, Revised, Volume 4, Chapter 9C: Internal morphology of the Paleozoic Stromatoporoidea. *Treatise Online* 18:1–37, fig. 1–17.
- Stearn, C. W. 2011. Part E, Revised, Volume 4, Chapter 16E: Stromatoporellida, Stromatoporida, Syringostromatida, Amphiporida, and genera with uncertain affinities. *Treatise Online* 19:1–61, fig. 1–52.
- West, R. R. 2011. Part E, Revised, Volume 4, Chapter 2A: Introduction to the fossil hypercalcified chaetetid-type Porifera (Demospongiae). *Treatise Online* 20:1–79, 52 fig.
- West, R. R. 2011. Part E, Revised, Volume 4, Chapter 2B: Functional morphology of the fossil hypercalcified chaetetid-type Porifera (Demospongiae). *Treatise Online* 21:1–38, 9 fig., 9 tables.
- West, R. R. 2011. Part E, Revised, Volume 4, Chapter 2C: Classification of the fossil and living hypercalcified chaetetid-type Porifera (Demospongiae). *Treatise Online* 22:1–24, 6 tables.
- Nixon, Marion. 2011. Part M, Chapter 7: Ecology and mode of life. *Treatise Online* 23:1–38, 6 fig., 11 tables.
- Wood, Rachel. 2011. Part E, Revised, Volume 4, Chapter 3: Introduction to Post-Devonian Hypercalcified Sponges (Stromatoporooid Type). *Treatise Online* 24:1–17, 4 fig.
- Webby, B. D., & S. Kershaw. 2011. Part E, Revised, Volume 4, Chapter 9B: External morphology of the Paleozoic Stromatoporoidea: Shapes and growth habits. *Treatise Online* 25:1–73, 44 fig.
- Nestor, Heldur. 2011. Part E, Revised, Volume 4, Chapter 16C: Clathrodictyida. *Treatise Online* 26:1–15, 8 fig.
- Wells, Martin J. 2011. Part M, Chapter 4: Physiology of Coleoids. *Treatise Online* 27:1–39, 24 fig.
- Senowbari-Daryan, B., & J. Keith Rigby. 2011. Part E, Revised, Volume 4, Chapter 7: Sphinctozoan and Inozoan hypercalcified sponges: An overview. *Treatise Online* 28:1–90, 58 fig.
- Harnik, Paul G., & Rowan Lockwood. 2011. Part N, Revised, Volume 1, Chapter 24: Extinction in the marine Bivalvia. *Treatise Online* 29:1–24, 4 fig., 1 table, 1 appendix.
- Webby, B. D. 2012. Part E, Revised, Volume 4, Chapter 17: Class Uncertain, Order Pulchrellaminida, new order. *Treatise Online* 30:1–9, 4 fig.
- Kershaw, Stephen. 2012. Part E, Revised, Volume 4, Chapter 13: Paleoecology of the Paleozoic Stromatoporoidea. *Treatise Online* 31:1–24, 14 fig.
- Webby, B. D., C. W. Stearn, & Heldur Nestor. 2012. Part E, Revised, Volume 4, Chapter 12: Biostratigraphy of the Paleozoic Stromatoporoidea. *Treatise Online* 32:1–22, 5 fig.
- Webby, B. D. 2012. Part E, Revised, Volume 4, Chapter 10: Origins and Early Evolution of the Paleozoic Stromatoporoidea. *Treatise Online* 33:1–22, 2 fig.
- Stock, Carl W., Heldur Nestor, & B. D. Webby. 2012. Part E, Revised, Volume 4, Chapter 14: Paleobiogeography of the Paleozoic Stromatoporoidea. *Treatise Online* 34:1–44, 6 fig., 10 tables.
- West, Ronald R. 2012. Part E, Revised, Volume 4, Chapter 2D: Evolution of the hypercalcified chaetetid-type Porifera (Demospongiae). *Treatise Online* 35:1–26, 6 tables.
- West, Ronald R. 2012. Part E, Revised, Volume 4, Chapter 2E: Paleoecology of the hypercalcified chaetetid-type Porifera (Demospongiae). *Treatise Online* 36:1–68, 46 fig., 3 tables.
- West, Ronald R. 2012. Part E, Revised, Volume 4, Chapter 2F: Paleogeography and biostratigraphy of the hypercalcified chaetetid-type Porifera (Demospongiae). *Treatise Online* 37:1–29, 7 fig., 2 tables.
- Debrenne, F., A. Yu. Zhuravlev, & P. D. Kruse. 2012. Part E, Revised, Volume 4, Chapter 18: General features of the Archaeocyatha. *Treatise Online* 38:1–102, 34 fig.
- Ros, Sonia, Miquel De Renzi, Susana E. Damborenea, & Ana Márquez-Aliaga. 2012. Part N, Revised, Volume 1, Chapter 25: Early Triassic–Early Jurassic bivalve diversity dynamics. *Treatise Online* 39:1–19, 17 fig., 2 tables.
- Stearn, C. W., B. D. Webby, Heldur Nestor, & Carl W. Stock. 2012. Part E, Revised, Volume 4, Chapter 16A: Paleozoic Stromatoporoidea. *Treatise Online* 40:1.
- Webby, B. D. 2012. Part E, Revised, Volume 4, Chapter 16B: Labechiida. *Treatise Online* 41:1–51, 29 fig.
- Stock, Carl W. 2012. Part E, Revised, Volume 4, Chapter 16D: Actinostromatida. *Treatise Online* 42:1–12, 10 fig.
- Fang Zong-jie, & Teresa M. Sánchez. 2012. Part N, Revised, Volume 1, Chapter 16: Origin and early evolution of the Bivalvia. *Treatise Online* 43:1–21, 5 fig.
- Harper, Elizabeth M., & Patricia H. Kelley. 2012. Part N, Revised, Volume 1, Chapter 22: Predation of bivalves. *Treatise Online* 44:1–21, 7 fig.
- Harper, Elizabeth M. 2012. Part N, Revised, Volume 1, Chapter 21: Cementing Bivalvia. *Treatise Online* 45:1–12, 5 fig.
- Schöne, Bernd R., & Donna M. Surge. 2012. Part N, Revised, Volume 1, Chapter 14: Bivalve sclerochronology and geochemistry. *Treatise Online* 46:1–24, 8 fig.
- Donovan, D. T. 2012. Part M, Chapter 18: Ammonites and Octopuses. *Treatise Online* 47:1–9, 3 fig.

be made; for example, to find the number of Ordovician brachiopod genera in Norway or the distribution of Pennsylvanian goniatites. More complex algorithms are needed to extract details from the descriptive part of the genus record. For this, an unsupervised algorithm for semantic annotation is used (Cui et al., 2010). In both cases, some human intervention is required before the dataset is ready for opening to online access and queries. The Paleontological Institute is involved with two National Science Foundation–funded research projects extracting data from the *Treatise*. One of these, based at the University of Kansas, also aims to integrate the illustrations with the text and will incorporate pattern-recognition algorithms in an attempt to provide digital fossil

identification, ultimately on mobile devices such as cell phones—an intriguing prospect which, I am sure, R.C. Moore would approve!

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