Specimens as Records: Scientific Practice and Recordkeeping in Natural History Research

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Abstract

For the past two decades, scholars in archival science have begun to question traditional assumptions about the nature of the record. Drawing on theories from fields such as sociology, organization theory, and science studies, and on their own ethnographic studies, they propose more inclusive definitions and widening the contexts of analysis of record making and recordkeeping. This paper continues this critical consideration of the concept of *record* by examining the nature of nonprototypical records in the scientific world. The paper focuses on the system of specimens and field notes established by biologist Joseph Grinnell at the Museum of Vertebrate Zoology (University of California, Berkeley) as a means of examining several aspects of the nature of the scientific record: materiality, representation, and the triad evidence/memory/accountability. Focusing on the creation and management of these scientific records, the paper argues that further analyses of scientific record making and recordkeeping are bound to benefit both scientific work, which depends more and more on databases and archives, as well as archival science, which is becoming more relevant beyond its traditional realm of the legal/business/administrative world.

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> The distinction between what can and cannot be "annexed" to a document is like all fine distinctions, difficult. Its particular difficulty may perhaps be illustrated best by a reduction ad absurdum. Supposing for example that a Viceroy sends home to the Secretary of State in England an elephant with a suitable covering-note or label;…the question may be imagined to arise:… Is the elephant attached to the label or the label to the elephant?[1]

For the past two decades, emerging trends and perspectives have had profound effects on archival theory. Challenges derived from the new prominence of electronic records drive some of these changes. An example is the rebirth and new rise to prominence of traditional approaches such as diplomatics. But other changes result from the introduction of non-traditional perspectives into the field of study, comprising what Terry Cook calls an "archival paradigm shift."[2] For Cook, the record is "no longer a passive object, a 'record' of evidence, but an active agent playing an on-going role in lives of individuals, organizations, and society"; the focus of archival science should no longer be the record, but the "functional and structural contexts of records."[3] As Ciaran Trace puts it, representatives of this new "post-Positivist paradigm," such as Brien Brothman, Joan Schwartz, Verne Harris, and Tom Nesmith, write about the record as a "socially constructed and maintained entity" and argue "for an archival theory placed in a broader socio-cultural and ideological background to transcend the profession's traditional administrative-juridical roots."[4]

In practice, attempts to go beyond the traditional approaches of archival science involve in many cases a fresh look at the contexts of record creation (and even appraisal) from the perspectives of sociology, anthropology, psychology, and the new literature of organizations.[5] Scholars in archival science have started to conduct ethnographic studies as an attempt "to include the sociocultural realm of record creation and management, thus defining the record in direct relationship to the communities of individuals who generate,

[1] Hilary Jenkinson, *A Manual of Archive Administration Including the Problems of War Archives and Archive Making* (Oxford: Clarendon Press, 1922), 7.

[2] Terry Cook, "Archival Science and Postmodernism: New Formulations for Old Concepts," *Archival Science* 1 (2001): 2.

[3] Cook, "Archival Science and Postmodernism," 22.

[4] Ciaran B. Trace, "What Is Recorded Is Never Simply 'What Happened': Record Keeping in Modern Organizational Culture," *Archival Science* 2 (2002): 140.

[5] Peter Botticelli, "Records Appraisal in Network Organizations," *Archivaria* 49 (1994): 161–91; Elizabeth Yakel, "The Way Things Work: Procedures, Processes, and Institutional Records," *American Archivist* 59 (1996): 454–64.

accumulate, and preserve documentary evidence."[6] These field studies have led them into the work areas of recordkeeping professionals as varied as nurses,[7] radiologists,[8] film preservationists,[9] and laboratory scientists.[10]

These new perspectives and methods lead both to questions regarding the traditional assumptions about the nature of the record and a profusion of new formulations to replace those traditional views. These new definitions work mainly in two ways. Some of them try to make the concept of *record* less restrictive, perhaps as a reaction against diplomatics. For instance, reflecting David Bloor's views of strong and weak research programs in the sociology of science, Brien Brothman distinguishes between "strong" and "weak" senses of *record*. The "strong" sense would more or less follow the traditional view of records as "public or business documents made during the course of, or as a means of, completing an action—or a business transaction," while the "weaker" sense reduces the record to "any unique inscription on any medium created in the past, any writing related to public affairs or private life, any and all private-sector institutional records and personal manuscripts."[11] Other definitions react against the notion of the record as a passive object, as in the statement above by Terry Cook. Following the ideas of sociologists such as Susan Leigh Star and Bruno Latour, for instance, Peter Botticelli sees records as "technological infrastructure" or "actors within an organization."[12] This view also echoes Hugh Taylor's conception of records as " 'instruments' for the conduct of affairs or relationships."[13]

If "problematizing the nature of the record" is the first step toward the development of "a true theory of the record," as Trace puts it,[14] the second step must be an attempt to bring some unity or consensus among these centrifugal forces that threaten to disintegrate the central concept of archival theory. One such attempt to reconcile this variety of new views on the nature of the record

[6] Karen F. Gracy, "Documenting Communities of Practice: Making the Case for Archival Ethnography," *Archival Science* 4 (2004): 335.

[7] P. M. Ngin, "Recordkeeping Practices of Nurses in Hospitals," *American Archivist* 57 (1994): 616–30.

[8] Elizabeth Yakel, "The Social Construction of Accountability: Radiologists and Their Recordkeeping Practices," *Information Society* 17 (2001): 233–45.

[9] Gracy, "Documenting Communities of Practice."

[10] Kalpana Shankar, "Recordkeeping in the Production of Scientific Knowledge: An Ethnographic Study," *Archival Science* 4 (2004): 367–82; Kalpana Shankar, "Order from Chaos: The Poetics and Pragmatics of Scientific Recordkeeping," *Journal of the American Society for Information Science and Technology* 58 (2007): 1457–66; Kalpana Shankar, "Ambiguity and Legitimate Peripheral Participation in the Creation of Scientific Documents," *Journal of Documentation* 65 (2009): 151–65.

[11] Brien Brothman, "Afterglow: Conceptions of Record and Evidence in Archival Discourse," *Archival Science* 2 (2002): 318, 321.

[12] Peter Botticelli, "Records Appraisal in Network Organizations," 174.

[13] Hugh Taylor, " 'Heritage' Revisited: Documents as Artifacts in the Context of Museums and Material Culture," *Archivaria* 40 (1985): 10.

[14] Trace, "What Is Recorded Is Never Simply 'What Happened'," 138.

is a recent article by Geoffrey Yeo, who argues that we need to distinguish the record from other "organizational and cultural resources" with which the new paradigm seems to conflate it. He draws on business and organizational literature to define records as *"persistent representations of activities, created by participants or observers of those activities or by their authorized proxies."*[15] With this definition he seeks to distance the record from its attachment to the bureaucratic-administrative environment that has been so criticized within the new paradigm, while maintaining what he sees as the three main characteristics of records:

1. *persistence*, or their capability "to endure beyond the immediate circumstance leading to its creation;"
2. their being representations of *activities*; and
3. their having been created by participants or observers with *firsthand knowledge* of the activities.

Yeo's definition is intended to capture the prototypes of records, such as single written documents created for business purposes and maintained in a formal recordkeeping system, as well as "borderline" or "non-prototypical" cases, such as personal diaries, paintings, drawings, and photographs of activities. He acknowledges that, "in the context of a records or archives service that recognizes the needs of extra-institutional and cultural users, non-prototypical records may acquire more importance [than prototypical records]."[16]

To ground this problematization of the concept of record, this paper examines the nature of nonprototypical records in the sciences, a domain that has come to the attention of archival scientists only recently. I will use as an example the recordkeeping practices followed at the Museum of Vertebrate Zoology (MVZ) in Berkeley, California. Zoologist Joseph Grinnell founded the MVZ to establish and advance a "uniform system" for the gathering of animal specimens and data on their geographical distribution. He standardized procedures not only for the collection of specimens, but also for accompanying materials such as field notes and annotated maps. The object of these interrelated records was to enable the correlation of environmental conditions with characteristics of the fauna, both at a given point in time as well as from a longitudinal perspective. During its first hundred years, the MVZ accumulated over 600,000 specimens, over 700 volumes of field notes, a photograph collection of over 14,000 images, and almost 500 maps, all of them documenting fieldwork conducted at the museum.[17]

The MVZ records are non-prototypical in more than one sense. Not only do they fall outside the traditional administrative and juridical context of

[15] Geoffrey Yeo, "Concepts of Record (1): Evidence, Information, and Persistent Representations," *American Archivist* 70 (Fall/Winter 2007): 337; emphasis in original.

[16] Geoffrey Yeo, "Concepts of Record (2): Prototypes and Boundary Objects," *American Archivist* 71 (Spring/Summer 2008): 141.

[17] See http://mvz.berkeley.edu/index.html, accessed 12 April 2010.

archival science because they are involved in the production of scientific knowledge, they are also (to a large extent) nontextual, possessing material characteristics that set them apart from the traditional or prototypical results of legal and business transactions.

This paper has three parts. First, it briefly examines how scholars in both science and archival studies conceive of the scientific record and its place within the scientific enterprise. Second, it analyzes record creation and recordkeeping at the Museum of Vertebrate Zoology. It concludes with a discussion about what this particular case tells us about three aspects of records that recent analyses of the concept in archival theory have touched upon: materiality, representation, and the triad evidence/memory/accountability.

Records and Science

Traditionally, science has not been considered a bureaucratic or administrative enterprise in which records and recordkeeping play an important role. On the contrary, the scientific enterprise is viewed predominantly in very different terms: as an activity characterized by its creativity and theoretical ideas, rather than its organizational processes. Not until the 1960s and 1970s did scholars start to focus on science as a social enterprise with career patterns, institutional constraints, social supports, and structures of authority in scientific communities. More recently, the issue of science as a practice has come to the fore, mostly in the form of ethnographic studies in scientific laboratories.[18] Thus, since the 1980s, literature in science studies has focused increasingly on the analysis of the process of scientific practice, as opposed to its end results,

With the emergence of these new approaches, a view of science as more akin to a record-making and recordkeeping bureaucratic enterprise has developed. Bruno Latour and Steve Woolgar, for instance, see scientists as "a strange tribe who spend the greatest part of their day coding, marking, altering, correcting, reading, and writing"; they equate the laboratory with "a system of literary inscription."[19] Latour has a document-centric view of science in which the creation of "inscriptions" or "immutable mobiles" (charts, tables, etc.) and the establishment of "centres of calculation" (laboratories, museums, etc.) for the creation, processing, and storage of those inscriptions are the main tools for the

[18] See, for example, Karin Knorr-Cetina, *The Manufacture of Knowledge: An Essay on the Constructivist and Contextual Nature of Science* (Oxford: Pergamon Press, 1981); Bruno Latour and Steven Woolgar, *Laboratory Life: The Construction of Scientific Facts,* 2nd ed. (Princeton, N.J.: Princeton University Press, 1986).

[19] Latour and Woolgar, *Laboratory Life,* 49, 52.

recruitment of allies and the establishment of networks, which are in his view what science is really all about.[20]

Latour's views have been influential, but one does not need to share his overall view of science to grasp the importance of placing documents and material culture at the center of scientific practice. Today's students of science look at scientific practice as both discursive and manipulative, based on the construction of arguments and apparatus, propositional theories and material instruments alike. Analysis of this practical world of knowledge creation from the point of view of archival theory has just begun in the form of three recent articles reporting on an ethnographic study by Kalpana Shankar.[21] Shankar examines the recordkeeping practices of biologists in a laboratory, with a particular focus on their laboratory notes. Following the work of sociologist Susan Leigh Star,[22] Shankar views scientific recordkeeping as "information infrastructure": the invisible background that makes other kinds of work possible.[23] She characterizes laboratory notes as flexible and autonomous, and sees them as the result of a double process: first, through selection, synthesis, and integration, the scientist turns data into a personally meaningful record; then, the scientist proceeds to standardize the record to make it more broadly reliable. This process, Shankar contends, "may have to be reinvented for each new project and environment."[24]

Shankar concludes her study with a plea for "more in-depth studies into the nature of the record, and the environments in which they are created," discussion of how context affects record creation, and consideration of such issues as memory, practice, and organizational accountability in relation to the use of the

[20] Bruno Latour, *Science in Action: How to Follow Scientists and Engineers through Society* (Cambridge, Mass.: Harvard University Press, 1987). Other scholars in science studies have focused on the textual dimension of scientific work from a variety of approaches. See, for instance, Charles Bazerman, *Shaping Written Knowledge: The Genre and Activity of the Experimental Article in Science* (Madison: University of Wisconsin Press, 1988); Alan Gross, *Starring the Text: The Place of Rhetoric in Science Studies* (Carbondale: Southern Illinois University Press, 2006); Timothy Lenoir, ed., *Inscribing Science: Scientific Texts and the Materiality of Communication* (Stanford, Calif.: Stanford University Press, 1998).

[21] Shankar, "Recordkeeping in the Production of Scientific Knowledge"; Shankar, "Order from Chaos"; Shankar, "Ambiguity and Legitimate Peripheral Participation." However, it is worth noting the pioneering work of the Joint Committee on Archives of Science and Technology, which, in the early 1980s, called for a shift from documenting results to focusing on the actual process of conducting science from an archival perspective. See Clark A. Elliott, ed., *Understanding Progress as Process: Documentation of the History of Post-War Science and Technology in the United States* (Chicago: Society of American Archivists, 1983). A similar program aimed at safeguarding scientific memory is the Australian Science Archives Project, originally established in 1985 at the University of Melbourne, see http://www.asap.unimelb.edu.au/, accessed 15 March 2010.

[22] Susan Leigh Star, "The Ethnography of Infrastructure," *American Behavioral Scientist* 43 (1999): 377–91; Susan Leigh Star and K. Ruhleder, "Steps toward an Ecology of Infrastructure: Design and Access for Large Information Spaces," *Information Systems Research* 7 (1996): 111–34.

[23] Shankar, "Order from Chaos," 1459.

[24] Shankar, "Order from Chaos," 1463.

record.[25] This article begins to accomplish this by looking at scientific records in a different context: the context of field work and collecting for a research natural history museum.

Scientific recordkeeping is as multifaceted as the scientific enterprise itself. Thus, any generalization based on the analysis of a single, specific scientific research group is bound to carry limited weight. As this paper shows, in contrast to Shankar's study, recordkeeping at the Museum of Vertebrate Zoology can be characterized as completely standardized so that variations across projects are negligible. This may seem paradoxical, given traditional assumptions regarding laboratory biology versus field/museum natural history. But it also shows how difficult it is to properly assess recordkeeping in a scientific organization without a careful analysis of the specific methods and ideas that shape its practice. By focusing on what scientists do to the exclusion of how they think, ethnographic studies of science seem to paint an incomplete picture of the scientific enterprise. We may have moved beyond conceiving it as a mere realm of ideas and acts of creativity, but we cannot forget that ideas and epistemology are still quite important for its practice. A similar obstacle may lie in the way of ethnographic studies of recordkeeping that don't engage these practices in all their dimensions. A full understanding of the context of record creation and recordkeeping, and of the role of records in the functionality of an organization, can hardly be achieved by merely following the recordkeepers around without thoroughly discussing what a specific organization is about.

Collecting at the Museum of Vertebrate Zoology

The Museum of Vertebrate Zoology, established in 1908 at the University of California in Berkeley, was the result of the collaboration between Anne Montague Alexander, a rich heiress with a passion for collecting, and Joseph Grinnell, a Darwinian naturalist whose research focused on the role of geography in the process of evolution.[26] Alexander provided the funds and was in charge of the finances and administration; Grinnell, as director until his death in 1939, set the research program for the museum. Although Alexander was interested in a dual function museum that would prepare public exhibits in addition to supporting scientific research, Grinnell's vision was that of a "center of authority" on the West Coast—a respected research institution that could not

[25] Shankar, "Recordkeeping in the Production of Scientific Knowledge," 381.

[26] James Griesemer and Elihu Gerson, "Collaboration in the Museum of Vertebrate Zoology," *Journal of the History of Biology* 26 (1993): 185–203; Barbara R. Stein, *On Her Own Terms: Annie Montague Alexander and the Rise of Science in the American West* (Berkeley: University of California Press, 2001).

divide its energies between conflicting or even complementary tasks.[27] To this day, a sign on the front door states that "NO PUBLIC EXHIBITS" are to be found in the museum.[28]

Grinnell relied on a variety of sources for the museum's collections: paid outside collectors and young assistants trained by him, as well as heterogeneous collecting parties headed by Alexander or himself. But, unlike other large museums in the United States, such as Boston's Museum of Comparative Zoology, that thrived on specimen donations arriving from every conceivable amateur collector or sympathizer, the MVZ established rigorous collecting procedures from the outset. To begin with, Grinnell restricted his museum's collections both geographically and taxonomically, focusing exclusively on California mammals and birds. More importantly, Grinnell created a precise set of standard procedures for the collecting, labeling, and preservation of specimens. He also developed guidelines for taking field notes following a uniform format that included not only how to enter information on each page (placement and nature of headings, information to be included), but even the kind of paper and ink to use. The field notes were to include three different elements: the itinerary followed by the collecting party, the catalog of specimens collected, and the account of species captured and observed. Field maps (where collections were plotted and itineraries marked) and, later, photographs of the specimens and habitats complemented specimens and field notes. All of these elements formed an integrated system, "a complex information storage and retrieval network" at the center of which was a labeling tag attached to each specimen, linking it to specific places in the other elements of the system.[29]

The meticulousness of the procedures established by Grinnell found its permanent written expression in the manual for the collection and preparation of vertebrate student specimens published by his foremost student, E. Raymond Hall. On how to write a catalog, for instance, he says:

> All specimens of vertebrate animals should be given consecutive numbers. Never repeat a number; for instance, do not begin a new series each year. One line of the notebook page should be devoted to the precise locality. Include distance in air-line miles from some well-established landmark. Include also elevation, county, and state. Devote one line to each specimen. If a specimen is not a conventional one, indicate the nature by entry directly above the field number, whether (if) skeleton, skull-only, skin-only, or alcoholic. Use the vernacular name of the species if you are not *sure* of the scientific name.[30]

[27] J. Grinnell to A. Alexander, 14 November 1907, quoted in Susan Leigh Star and James Griesemer, "Institutional Ecology, 'Translations' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907–39," *Social Studies of Science* 19 (1989): 398.

[28] Star and Griesemer, "Institutional Ecology," 391.

[29] James Griesemer, "Modeling in the Museum: On the Role of Remnant Models in the Work of Joseph Grinnell," *Biology and Philosophy* 5 (1990): 24.

[30] E. Raymond Hall, "Collecting and Preparing Study Specimens of Vertebrates," *Miscellaneous Publications of the University of Kansas Museum of Natural History* 30 (1962): 4.

A similar description is devoted to the writing of itineraries, while the guidelines for the species accounts occupy two full pages. (See Figures 1–3 for examples of a catalog, an itinerary, and a species account.)

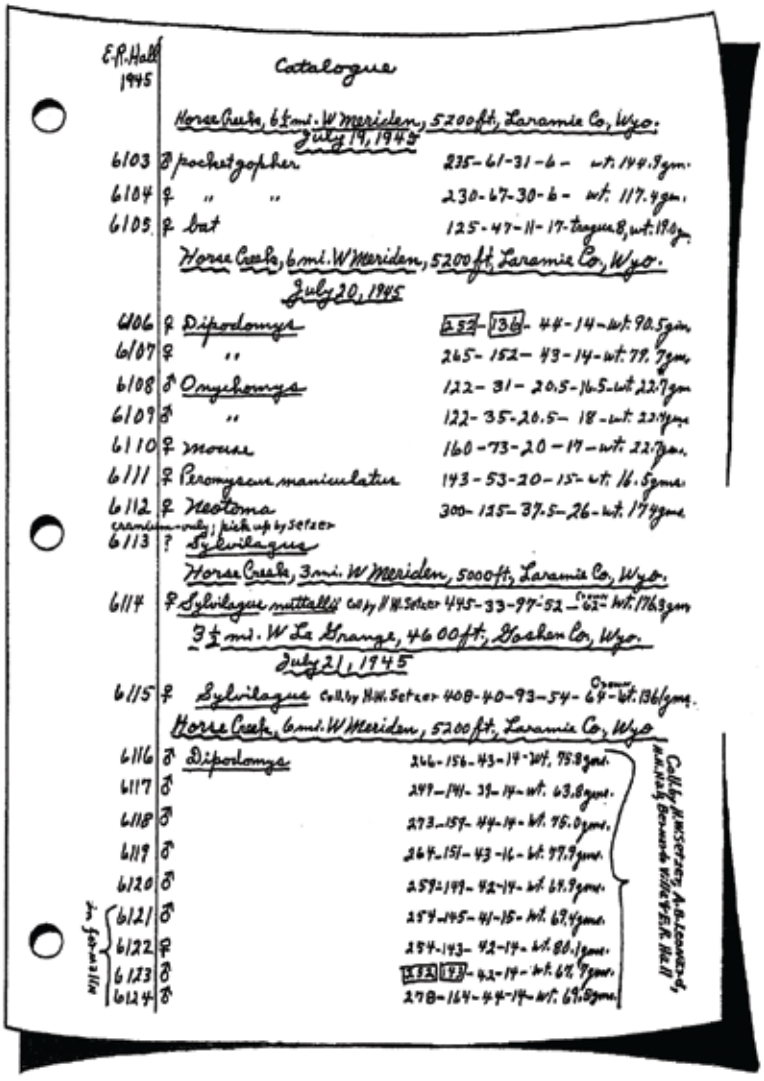
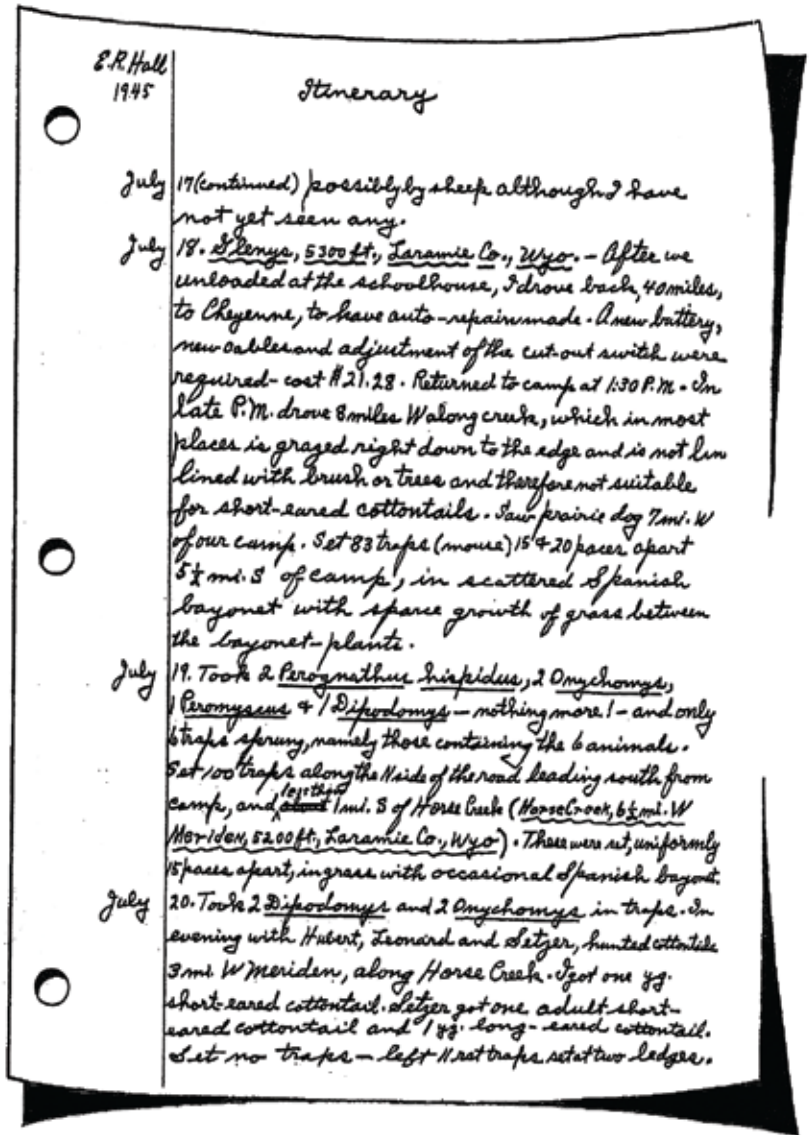


FIGURE 1. *Field catalog page listing specimens collected in Wyoming in July 1945.* **From E. Raymond Hall's field notes used as an example in his manual, "Collecting and Preparing Study Specimens of Vertebrates," 1962, p. 5. Each group of numbers is headed by a description of the location (including altitude, county, and exact place) and the date. Each specimen is listed with the collector's number (a unique number), its sex, species, measurements (generally measurements of the skin, such as total length, length of tail, length of hind foot, and height of ear for the small mammals listed in this page), and weight.**



E. R. Hall
1945

Itinerary

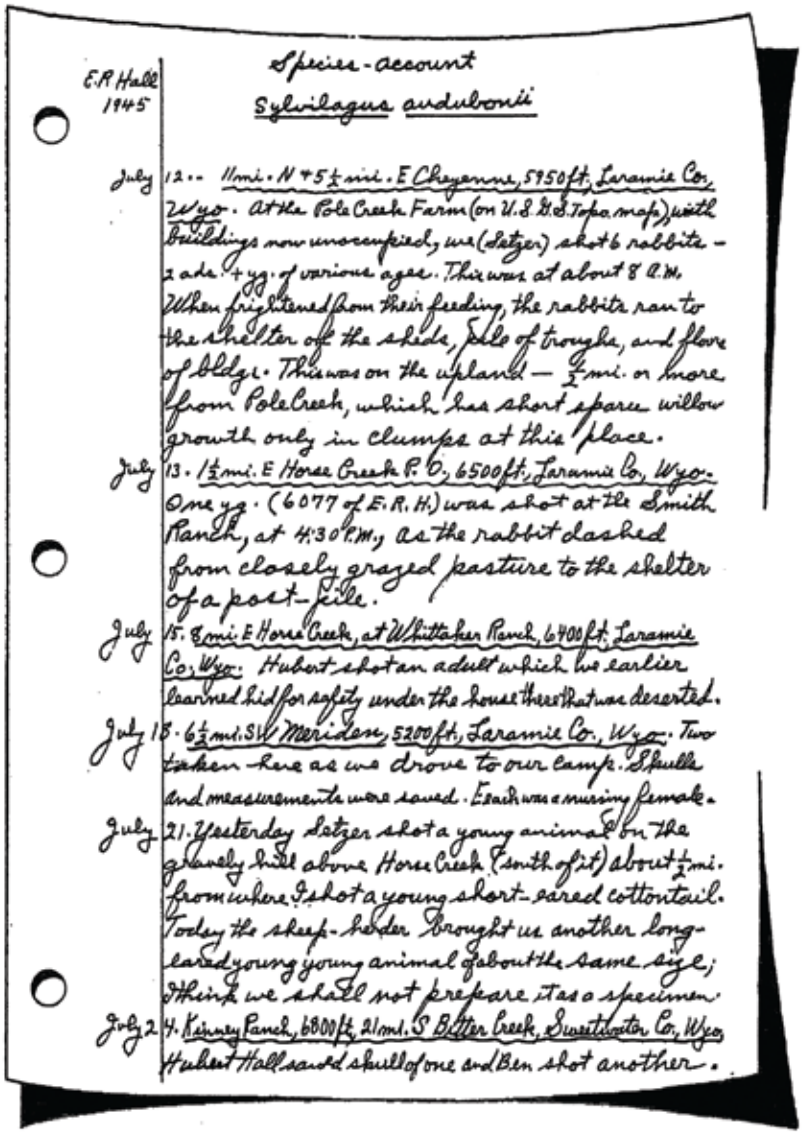
July 17 (continued) possibly by sheep although I have not yet seen any.

July 18. Lenya, 5300 ft., Laramie Co., Wyo. – After we unloaded at the schoolhouse, I drove back, 40 miles, to Cheyenne, to have auto-repairs made. A new battery, new cables and adjustment of the cut-out switch were required – cost $21.28. Returned to camp at 1:30 P.M. In late P.M. drove 8 miles W along creek, which in most places is grazed right down to the edge and is not lined with brush or trees and therefore not suitable for short-eared cottontails. Saw prairie dog 7 mi. W of our camp. Set 83 traps (mouse) 15 & 20 paces apart 5½ mi. S of camp, in scattered Spanish bayonet with sparse growth of grass between the bayonet-plants.

July 19. Took 2 Perognathus hispidus, 2 Onychomys, 1 Peromyscus & 1 Dipodomys – nothing more! – and only 6 traps sprung, namely those containing the 6 animals. Set 100 traps along the W side of the road leading south from camp, and 1 mi. S of Horse Creek (Horse Creek, 6½ mi. W Meriden, 5200 ft., Laramie Co., Wyo.). These were set uniformly 15 paces apart, in grass with occasional Spanish bayonet.

July 20. Took 2 Dipodomys and 2 Onychomys in traps. In evening with Hubert, Leonard and Setzer, hunted cottontails 3 mi. W Meriden, along Horse Creek. Got one yg. short-eared cottontail. Setzer got one adult short-eared cottontail and 1 yg. long-eared cottontail. Set no traps – left 11 rat traps set at two ledges.

FIGURE 2. *Itinerary page reporting itinerary followed by the collecting party in Wyoming in July 1945.* **From E. Raymond Hall's field notes used as an example in his manual, "Collecting and Preparing Study Specimens of Vertebrates," 1962, p. 6. Each entry begins with the date and locality, followed by an account of the route followed, habitats encountered, kinds and number of traps set, distance between the traps, number and kinds of animals collected, and any other pertinent information.**



E.R Hall
1945

Species-account
Sylvilagus audubonii

July 12 -- 11mi. N + 5½ mi. E Cheyenne, 5950 ft, Laramie Co, Wyo. At the Pole Creek Farm (on U.S.D.A. Topo. map), with buildings now unoccupied, we (Setzer) shot 6 rabbits - 2 ads. + yg. of various ages. This was at about 8 P.M. When frightened from their feeding, the rabbits ran to the shelter of the sheds, pile of troughs, and floor of bldgs. This was on the upland — ¼ mi. or more from Pole Creek, which has short sparse willow growth only in clumps at this place.

July 13. 1½ mi. E Horse Creek P.O., 6500 ft, Laramie Co, Wyo. One yg. (6077 of E.R.H.) was shot at the Smith Ranch, at 4:30 P.M., as the rabbit dashed from closely grazed pasture to the shelter of a post-pile.

July 15. 8 mi. E Horse Creek, at Whittaker Ranch, 6700 ft, Laramie Co, Wyo. Hubert shot an adult which he earlier learned hid for safety under the house there that was deserted.

July 18. 6½ mi. SW Meriden, 5200 ft, Laramie Co, Wyo. Two taken here as we drove to our camp. Skulls and measurements were saved. Each was a nursing female.

July 21. Yesterday Setzer shot a young animal on the gravelly hill above Horse Creek (south of it) about ½ mi. from where I shot a young short-eared cottontail. Today the sheep-herder brought us another long-eared young young animal of about the same size; I think we shall not prepare it as a specimen.

July 24. Kinney Ranch, 6800 ft, 21 mi. S Bitter Creek, Sweetwater Co, Wyo. Hubert Hall saved skull of one and Ben shot another.

FIGURE 3. *Species account page, July 1945.* **From E. Raymond Hall's field notes used as an example in his manual, "Collecting and Preparing Study Specimens of Vertebrates," 1962, p. 7. The account for each species could include information such as locality, vegetation, local conditions of terrain, behavior, habits, etc. about individuals of that particular species that were shot, collected, or simply seen. References to specimens collected are made via the collector's number.**

Labeling of specimens also merits more than a full page in Hall's manual, beginning with his admonition: "A complete, authentic label for a mammal in most instances is scientifically more valuable than the skin to which it is attached"[31] (see Figure 4). Finally, instructions for the preparation of the specimens occupy the bulk of the manual, with instructions on how to prepare a small mammal such as a mouse occupying six full pages. The prescriptions for the materials to be used for specimen preparation are equally detailed: "For pocket gophers and wood rats use No. 20 wire; for a larger *Peromyscus* use No. 22; for small pocket mice use No. 24; for tails of the smallest bats use No. 24 or even No. 26 wire." And so are the instructions for note taking and labeling: "Use only Higgins Eternal Black Ink"; "For threading the labels we use Star Brand, white, 6-strand, mercerized, size-10 cotton thread manufactured by the American Thread Company."[32] The result is a perfectly standardized product (see Figure 5).

The contrast with Shankar's comments on lab notebooks could hardly be starker. Yet one would be hard pressed to interpret this meticulous system of record creation without a detailed analysis of Grinnell's methodological and theoretical views.

Grinnell's main goal as a scientist was to study how environmental changes drive the process of organic evolution. Unlike paleontologists, who study series of fossil specimens that may be millions of years apart, Grinnell intended to study evolution at work, in action. In a laboratory, this is usually approached by choosing to study organisms with a very short life span, so changes in a population's composition can be tracked through hundreds of generations. But Grinnell thought that artificial laboratory conditions essentially altered the process under study. So he opted for establishing an institution that would conduct that study beyond his own career as a researcher. By institutionalizing stringent record creation standards, the MVZ itself would become that ideal researcher whose life span would be commensurate with the timescale of its object of study.

Studying how environmental evolution drives organic evolution required, for Grinnell, the gathering of a long series of snapshots of specific environmental complexes. The specimens collected and their connected field notes embodied those snapshots, samples of the characteristics of the environment and its inhabiting organisms in particular times and places. In the words of philosopher James Griesemer, they were "remnant" or "material models," "tangible

[31] Hall, "Collecting and Preparing Study Specimens," 9.

[32] Hall, "Collecting and Preparing Study Specimens," 12, 13, 15.

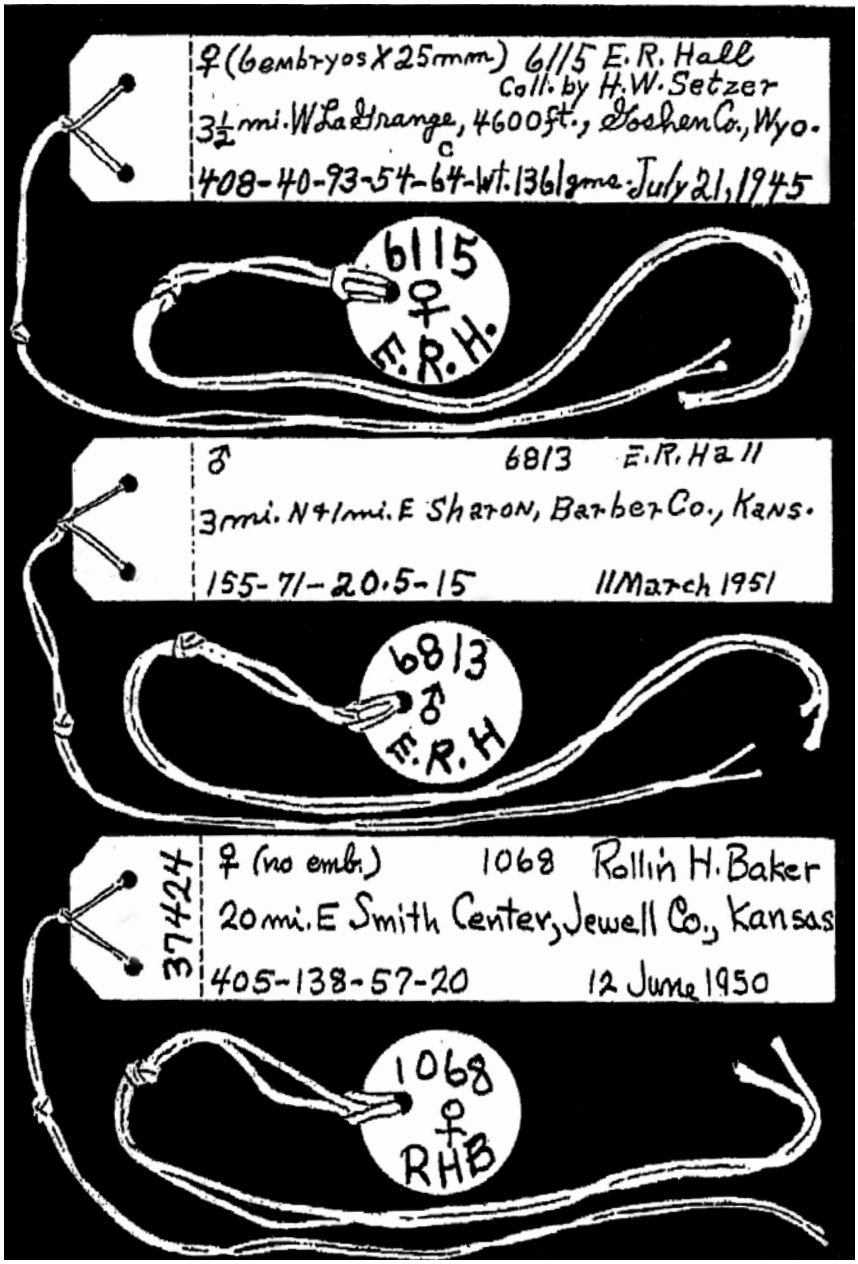


FIGURE 4. **Labels filled out. The rectagular labels are for stuffed skins; the round labels are for uncleaned skulls and skeletons. E. Raymond Hall, "Collecting and Preparing Study Specimens of Vertebrates," 1962, p. 10. The summary information on labels (sex, locality, date, measurements) corresponds to that in the catalogue for the same collector's number.**

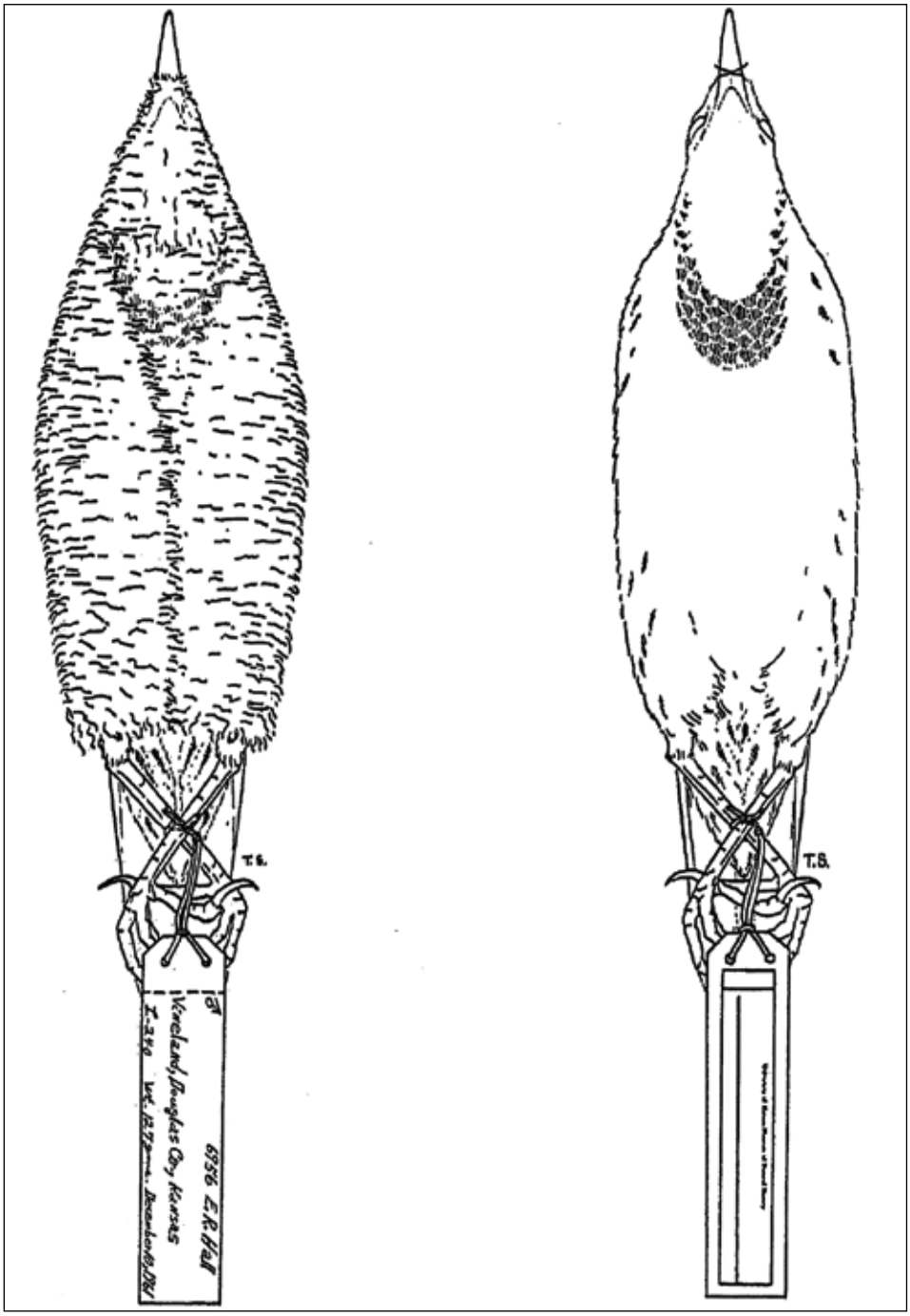


FIGURE 5. Skin wrapped in thin layer of cotton (on left), laid on back to dry. Dried skin (on right) from which cotton wrapping has been removed. E. Raymond Hall, "Collecting and Preparing Study Specimens of Vertebrates," 1962, p. 34.

representatives" that stood in the museum for the environment and the organisms (taxa, not individuals) themselves.[33] The scientists would then use them in their construction of theoretical models for systematic study over extended periods of time.

Specimens as Records

What does this brief examination of the MVZ's record creation practices tell us about the nature of records? It forces upon us the need to be cautious when making statements about records without proper analyses of their functional contexts, which, in the case of "scientific records," include specific theoretical and methodological contexts of record creation and recordkeeping.

Let me briefly explore, in connection with this specific case study, three aspects of records that recent analyses of the concept in archival theory have touched upon: materiality, representation, and the triad evidence/memory/accountability. In doing so, I will evaluate how well recent reformulations of the concept of *record* capture the specific nature of scientific records.

Materiality

Archival thinkers traditionally work in a textual world. And yet, from time to time, even before the era of electronic records, the possibility of nontextual records puzzles them. Jenkinson wondered, in the passage quoted at the beginning of this article, about what he called "natural evidences annexed…to documents" (in his hypothetical case, an elephant).[34] The European documentalist school has no problem considering natural objects "documents," in the sense of "informative things," but this does not correspond to our concept of record.[35] "Could an apple be a record?," asked Hans Hofman in a conference on the nature of the record as a way to "put the concept of record in a different perspective."[36] This question brings to the fore a dimension of records that the literature of archival theory appears to have mostly neglected: the material aspect of records. A recent article by Ala Rekrut calls for "reading records as

[33] James Griesemer, "Material Models in Biology," *PSA: Proceedings of the Biennial Meeting of the Philosophy of Science Association I* (1990): 79–93; Griesemer, "Modeling in the Museum."

[34] Jenkinson, *Manual of Archives*, 7. His solution to the puzzle is on the same page: since the administration receiving the item would be obliged to send the elephant to the zoo before it reached the archivist, "the problem is an Administrative, not an Archive one."

[35] Michael Buckland, "Information as Thing," *Journal of the American Society of Information Science* 42 (1991): 351–60. The familiar example from Suzanne Briet is an antelope.

[36] Hans Hofman, "Lost in Cyberspace—Where Is the Record?," in *The Concept of Record: Report from the Second Stockholm Conference on Archival Science and the Concept of Record, 30–31 May 1996* (Stockholm: Swedish National Archives, 1998), 115.

material culture," but it mainly focuses on the need to appreciate the material aspects of records for description, appraisal, valuation, and preservation, as well as the symbolic significance of materiality.[37] The interaction between materiality and recordness that I will briefly touch upon would be better expressed by turning around the title of Rekrut's article: to what extent can material culture be read as record?

Let us begin with a brief look at how museum studies looks at material culture. A much-repeated definition by James Deetz provides a good starting point. According to Deetz, material culture is "that section of our physical environment that we modify through culturally determined behaviour."[38] Scholars in museum studies, applying linguistic theory to the study of material culture, have arrived at some ideas that are reminiscent of archival theory's view of records. Similar to the way archival theorists view records as interrelated, museum students view material culture as "a system of interdependent artefacts in which the value of each artefact results solely from the simultaneous presence of the others."[39] Musealia (i.e., museum objects) are "materialized results of work in which human characteristic forces manifest themselves. These objects are selected, acquired from the social as well as natural environment by museum work, and then preserved, decoded and purposefully utilized."[40] This two-stage view of museum objects also evokes the life-cycle model of the record, with objects living a double life, first in connection with human activity and then as documentation of such activity: "object[s] separated from [their] actual reality and transferred to a new, museum reality in order to document the reality from which [they were] separated."[41]

In trying to find "'cross-overs and analogies" between museology's view of material culture and archival science's concept of records, Hugh Taylor tries to bring archival science "closer to the cultural world of the museum and related disciplines" in his article " 'Heritage' Revisited: Documents as Artifacts in the Context of Museums and Material Culture." Using the map as an example of material-culture-as-record, he finds the common ground between archival and museum objects in a conception of records as " 'instruments' for the conduct of affairs or relationships."[42]

[37] Ala Rekrut, "Material Literacy: Reading Records as Material Culture," *Archivaria* 60 (2005): 11–37.

[38] Quoted by Susan M. Pearce, "Museum Studies in Material Culture," in *Museum Studies in Material Culture*, ed. Susan M. Pearce (Washington, D.C.: Smithsonian Institution Press, 1991), 2.

[39] Susan M. Pearce, "Objects in Structures," in *Museum Studies in Material Culture*, 48.

[40] K. Schreiner, quoted in P. van Mensch, "Methodological Museology; or, Towards a Theory of Museum Practice," in *Objects of Knowledge*, ed. Susan M. Pearce (London and Atlantic Highlands, N.J.: Athlone Press, 1990), 145.

[41] Z. Z. Stransky, cited in van Mensch, "Methodological Museology," 142.

[42] Taylor, " 'Heritage' Revisited," 10.

Does the materiality of the specimens collected and housed by the MVZ pose a problem for our considering them records? It seems that, on the contrary, they represent a good case for this search for common ground between the worlds of archives and museum theorists: the specimens are parts of the physical environment that have been separated from that reality, being created as records in the course of the activities of the members of an organization, the MVZ. They were modified through cultural behavior and made part of a system of interdependent elements in which their value has become inseparable from the other elements. In this process, and by becoming part of a highly standardized system of record creation and recordkeeping, they have acquired documentary value about the reality from which they were separated. Their materiality does not seem to impede meeting the qualifications of recordness even from a diplomatics perspective: they have a stable content, a fixed documentary form, an archival bond with other records, an identifiable context, are the result of an action, and were created by and for the appropriate persons.

More importantly, the complex formed by specimens, field notes, maps, and photographs fits perfectly well with recent characterizations of records as infrastructure and instruments. The propositional and mathematical theories expressed in traditional scientific products (articles, books) comprise the superstructure of the knowledge-creating enterprise that we call science (in Grinnell's case, a system of statements regarding the effects of geography on evolution). The heterogeneous complexes of records that are used in the daily routines of scientific life and then are obliterated in the process of scientific production would play the role of the infrastructure that makes that production possible. They are like instruments in the sense that they play an intermediary role between humans and nature: they are the material tools of human investigation, the means of "getting at nature" and making a record of it. Or, as Shankar puts it, they occupy the "intermediate space" between the material world and the realm of scientific fact, the "transitional state" between data and scientific formulations.[43] Their variety in the case of Grinnell's system of specimens, field notes, and maps reflects the diversity of the scientific enterprise. We usually think of infrastructure and instruments as material entities, so the materiality of specimens makes them fit our prototypes of infrastructure and instruments even better than do paper documents.

Representation

Specimens, field notes, and maps also indicate the variety of meanings of a concept that is intimately connected with the scientific enterprise: representation. Theories and models, the ultimate goals of scientific work, are commonly

[43] Shankar, "Ambiguity and Legitimate Peripheral Participation," 158.

referred to as representations of the natural world (the main difference being that theories are presumed to be true, whereas models are usually known to be false: their importance rests mainly in their heuristic value). Specimens, maps, and the descriptions in field notebooks lie at different points along the spectrum between the concrete reality itself and abstract scientific theories. Together, they form a material model built from the remnants of the specific assemblages of organic and inorganic elements from specific times and places.

This representational quality is at the center of Yeo's definition of record. As Yeo says, "the purpose of many representational systems is to provide surrogates for things that are unavailable or difficult to access."[44] In Grinnell's case, the difficulty lies in modeling aggregates of organisms and environmental factors, with the additional problem of having to do this at different points on the evolutionary time-scale. The system of specimens, notes, and maps allows for this representation.

Finally, it is worth pointing out that this case represents two tiers of activity: the activity described (the co-evolution of geography and organisms) and the activity of the creator in describing it (Grinnell and his collectors creating their system of records). From a diplomatic perspective, this would mean probative records in which the activity described is procedurally separate from the creation of the record.

But we can also analyze this double dimension of representation from a different perspective. The system of field notes and specimens championed by Grinnell was also in a way representing *him* as a particular kind of practitioner of science. At the time when he established the MVZ, the development of experimental, laboratory-based life science disciplines like genetics was quickly pushing natural history to the periphery of legitimate scientific practice. Grinnell's choices of what to represent through his specimen-cum-field notes system sent a dual message: 1) it was a way of distancing himself from more traditional, "old-fashioned" natural historians, and it was also 2) a way of showing that his brand of natural history was rigorous and capable of the procedural standardization that we identify with laboratory disciplines. The first message is exemplified by his argument for the collection of series as opposed to the traditional reliance on "type" specimens, which he considered as mere "random samples" of populations: he was representing himself as an advocate of a modern, "population" view at odds with nineteenth-century conceptions and museum practices.[45] The second message can be seen in his discussion with an editor who chided his use of field itinerary information in his scientific work as "amateurish." Grinnell replied that the itinerary "embodies a description of the conditions under which

[44] Yeo, "Concepts of Record (1)," 341.

[45] J. Grinnell to R. Osgood, 12 August 1927; Osgood to Grinnell, 19 August 1927, Museum of Vertebrate Zoology, Correspondence Files, University of California, Berkeley, Folder "Osgood, Wilfred H. 1908–1930."

field work was conducted," and that as an "outline of methods" it was as relevant as the methodological section in a laboratory biology paper.[46] The collecting and field notes system thus represented more than the assemblages of organisms and ecological conditions: it re-presented Grinnell as a thoroughly modern biologist with a methodological sophistication comparable to that of any laboratory biologist.

Evidence, Accountability, Memory

What activities do the MVZ specimens really document? For Grinnell, and for current naturalists, they document the activities of nature (they possess informational value). For us, they document his own activities as biologist and museum builder (they have evidential value). But, as scientific records, the MVZ specimens-field notes system has also a third kind of value: value as scientific evidence for Grinnell's views of how nature works. This third value seems to be intermediate between the two kinds of archival value mentioned above: the record as scientific record documents not only nature and the scientist, but also the scientist's account of nature.

Shankar emphasizes the importance of accountability in the creation of laboratory records, talking of laboratory notebooks as "the primary mechanism of insuring that conditions and results are recorded for the sake of replicability."[47] A traditional view of type-specimens in natural history would also point toward this accountability-centered view of scientific records. However, my example of the MVZ records seems to point in a different direction, more along the lines of Jennifer Meehan's view of an archival notion of evidence uncoupled from accountability requirements and more linked to a memory function.[48] This archival notion of evidence suggests that record use assumes a relationship to a past event, whereas the evidence concept underlying scientific replicability seems devoid of this temporal dimension (in the same way that a recipe is timeless).

Grinnell's recordkeeping system seems an example of what Geoffrey Bowker calls "memory regimes" or "sets of memory practices": attempts to "store the information that is necessary in order to replicate in small the archive of the history of life."[49] Natural historians in the eighteenth and early nineteenth centuries commonly used the metaphor of an archives. Buffon (among others) compared the labors of naturalists "rummaging in the archives of the world" to

[46] W.E. Ritter to J. Grinnell, 19 November 1907, Box 16, Joseph Grinnell Papers, Bancroft Library, University of California, Berkeley; Grinnell to Ritter, [20] February 1908, Box 10, William E. Ritter Papers, Bancroft Library, University of California, Berkeley.

[47] Shankar, "Recordkeeping in the Production of Scientific Knowledge," 371.

[48] Jennifer Meehan, "Towards an Archival Concept of Evidence," *Archivaria* 61 (2006): 127–46.

[49] Geoffrey Bowker, *Memory Practices in the Sciences* (Cambridge, Mass.: MIT Press, 2005), 109.

those of the civil historians who consult titles and other such records. Grinnell continued this tradition by creating the MVZ as a memory institution where evolution could be studied beyond a single person's (or team's) life span. Establishing procedures such as those guiding the collection and preservation of specimens and notes gives an institution a memory. Through this procedural infrastructure, past and future are able to meet. Grinnell surely had this in mind when he instructed his students: "Write *full* notes, even at risk of entering much information of apparently little value. One cannot anticipate the needs of the future, when notes and collections are worked up."[50]

Just as Meehan introduced her archival concept of evidence in an attempt to move beyond viewing evidence and memory as a dichotomy, preferring to reconfigure them as "two sides of the archival coin or as overlapping areas of the 'archival heartland'," Yeo's definition offers a way out of our conceptualization of records as exclusively providing evidence, or memory, or information, or accountability, or symbolic values. All of these, Yeo argues, are "affordances" of a record.[51]

Conclusion

In this paper I have used the case of a complex system of scientific records as a way of exploring Yeo's conception of the record and continuing the task of problematizing the nature of the record beyond its traditional bureaucratic-administrative environment. Focusing on the system for field-note taking and specimen preparation established by Grinnell in the early twentieth century, I have briefly explored several aspects of record-making (materiality, representation, and the triad evidence/accountability/memory) and showed the pertinence of Yeo's conception in the analysis of natural history records. I have also tried to contribute to the discussion of scientific recordkeeping recently initiated by Shankar, by examining scientific records and their related practices in a context different from the contemporary laboratory. I have shown that all of the possible affordances of records are variously represented in different kinds of scientific records, reflecting the heterogeneous set of practices we call science.

By pursuing the analysis of scientific record-making and recordkeeping, we are contributing to the scrutiny of an increasingly important area of scientific activity, as scientific work becomes more and more dependent on databases and archives. Yet by bringing to bear the tools of archival science in this area of recordkeeping, we are also widening the bounds of our own discipline, making it relevant beyond its traditional realm of the legal/business/administrative world.

[50] "Suggestions as to Collecting," course handout in Grinnell Papers, Bancroft Library, University of California, Berkeley; quoted by Star and Griesemer, "Institutional Ecology," 417, n. 29.

[51] Yeo, "Concepts of Record (1)," 230.