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A Scientometric Appreciation of Robert J. Baker's Contributions to Science and Mammalogy

David J. Schmidly
University of New Mexico, djschmidly@gmail.com

Robert D. Bradley
Texas Tech University, robert.bradley@ttu.edu

Emma K. Roberts
Texas Tech University, emma.k.roberts@ttu.edu

Lisa C. Bradley
Texas Tech University, lisa.bradley@ttu.edu

Hugh H. Genoways
University of Nebraska - Lincoln, h.h.genoways@gmail.com

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A Scientometric Appreciation of Robert J. Baker's Contributions to Science and Mammalogy

David J. Schmidly, Robert D. Bradley, Emma K. Roberts, Lisa C. Bradley, and Hugh H. Genoways

Abstract

This article describes Robert James Baker's academic pedigree and genealogy, his scientific productivity (number of publications), his citations, his students, his contributions to his university and scientific societies, his personality in relation to his scientific achievements, his legacy, and a personal note of appreciation by individuals who worked with him and knew him well. His accomplishments are compared with other dominant personalities in the field of mammalogy, both historical and contemporary. The paper builds on the 2018 obituary authored by Hugh Genoways and others that was published in the *Journal of Mammalogy,* but includes a much more quantitative and qualitative analysis of his scientific accomplishments and research productivity.

Key words: citation counts, contracts, grants, h-index, m-value, personality, publications, Robert James Baker, students

Introduction

This article explores the remarkable career of Robert James Baker (RJB), who died quietly at his home on 30 March 2018, thereby ending a career that spanned six decades at one institution, Texas Tech University (TTU). RJB's obituary was published shortly after his death, and it chronicles his remarkable career, including a listing of his publications, his numerous master's, doctoral, and post-doctoral students, as well as other highlights of his personal and professional life (Genoways et al. 2018). By any measure, his scientific achievements were substantial, and one could even say legendary—449 scientific publications, 98 graduate students produced, thousands of undergraduates taught and introduced to science, and numerous awards and honors bestowed during his career in recognition of his many achievements.

Using a scientometric approach to examine quantitatively and qualitatively his scientific achievements and research productivity, we delve much more deeply to interpret them in light of the recent literature regarding the careers of other highly productive and creative scientists. Each of the authors knew RJB for many years, in two cases (DJS and HHG) for more than 50 years. And because all of us worked and socialized with him and knew him well, we provide our perspective of his personality traits and strengths that contributed to his scientific creativity and impacts on the broad field of science and particularly mammalogy.

The notion of how to identify or readily measure scientific excellence has been elusive and argumentative (see Jackson and Rushton 1986), although several indicators of scientific excellence have been proposed in the past two decades to assess productivity and impact. These include: total number of publications in refereed journals; total number of citations; journal impact or index factors; frequency of appearance as first, middle, or senior author in collaborations; the number of different journals in which the research has been published; the number of grants awarded each year; and the number of papers presented at national scientific meetings (e.g., see Bartholomew 1982; Babu and Singh 1998; Panarctos and Malesios 2009; Kreiman and Maunsell 2011; Acuna et al. 2012; and Gibson et al. 2015).

Biologists have largely followed this model for professional credit, although those interested in systematics and evolutionary biology also contribute knowledge in nontraditional ways that are typically more difficult to quantify or assess in terms of scientific merits, such as collecting biological specimens for natural history collections. Collecting and curating biological specimens builds and strengthens the basic infrastructure on which biodiversity knowledge is built, and this knowledge provides data critical for many disciplines beyond systematic biology (McDade et al. 2011).

We have considered all of these facets in examining the life and career of RJB. We draw attention to his publications and citation counts, his work with a legion of undergraduate and graduate students, his contributions to natural history collections, and his success in acquiring funding to support his research and that of his students. In addition, we have provided an overview of his academic pedigree and his personality traits as they contributed to his legacy. Finally, we have compared his research record with deceased highly published mammalogists as well as with some contemporary colleagues with highly regarded credentials and accomplishments.

Baker's Academic Pedigree, Genealogy, and Early Collaborators

Figure 1 presents the academic pedigree for RJB. It was generated utilizing various sources, including two articles (Jones 1991; Whitaker 1994) about the academic propinquity and genealogy of 20th century mammalogists, and by examining curriculum vitae, university and faculty webpages, pedigrees, obituaries, and biographies of many scientists included in the pedigree (e.g., RJB, Joseph Grinnell, J. Knox Jones, Jr.).

RJB's academic pedigree and genealogy (see Fig. 1) trace back to two prominent academic programs in mammalogy in the first half of the 20th Century—at the Museum of Vertebrate Zoology (MVZ), University of California Berkeley, and at the Museum of Natural History, University of Kansas (KU).

The MVZ program at Berkeley was led by Joseph Grinnell, considered by many to be the academic father of mammalogy (Jones 1991; Schmidly et al. 2017; Schmidly and Naples 2019). Grinnell began training doctoral students in mammalogy, and three of his best-known students became important figures in the genealogy of Baker. Walter P. Taylor was Grinnell's first Ph.D. student in mammalogy, and after leaving Berkeley he went on to establish the Cooperative Wildlife Units at Texas A&M University and then at Oklahoma State University. William B. Davis, another Ph.D. student of Grinnell, left Berkeley in 1938 to start the mammalogy program at Texas A&M University, and E. Raymond Hall, probably Grinnell's best-known student, left Berkeley in 1944 to establish a program at the Museum of Natural History at KU. Taylor, Davis, and Hall were the academic forefathers of RJB.

One of Davis' master's students at Texas A&M, Bryan Glass, assumed a position at Oklahoma A&M University, now Oklahoma State University (OSU), in 1946 and later completed his Ph.D. there in 1952 under the direction of Walter Taylor, who ran the Coop Unit at OSU. In 1963, after completing his bachelor's degree from Arkansas A&M College (now the University of Arkansas at Monticello), young Baker (then 21 years of age) entered the program at Oklahoma State and completed his Master's degree under Glass in 1965. The title of his thesis was "Systematics and Variation of *Myotis subulatus*." This was the beginning of Baker's long-standing "love affair" with the biology of bats.

Hall, following his move from Berkely to KU in 1944, established a dynasty in mammalogy that lasted three decades (see Schmidly and Naples 2019). One of his most successful Ph.D. students, E. Lendell Cockrum, took a position at the University of Arizona where he, too, established a graduate program in mammalogy. Following the completion of a master's degree, RJB entered that program and completed his Ph.D. work in two years in 1967. His Ph.D. dissertation involved nectar-feeding bats and was titled "Karyotypes of Phyllostomid Bats (Class, Mammalia; Family, Phyllostomidae) and Their Evolutionary Implications." At the time, this was considered to be pioneering research and it directly impacted future research on the systematics and evolution of mammals.

After receiving his doctoral degree, RJB accepted employment as an assistant professor in the Department of Biology at Texas Tech University. The university had an incipient program in mammalogy that was started in 1962 by Robert L. Packard, another doctoral student of Hall. Packard, who was directing master's students in mammalogy, was a prominent figure in the decision to hire Baker.

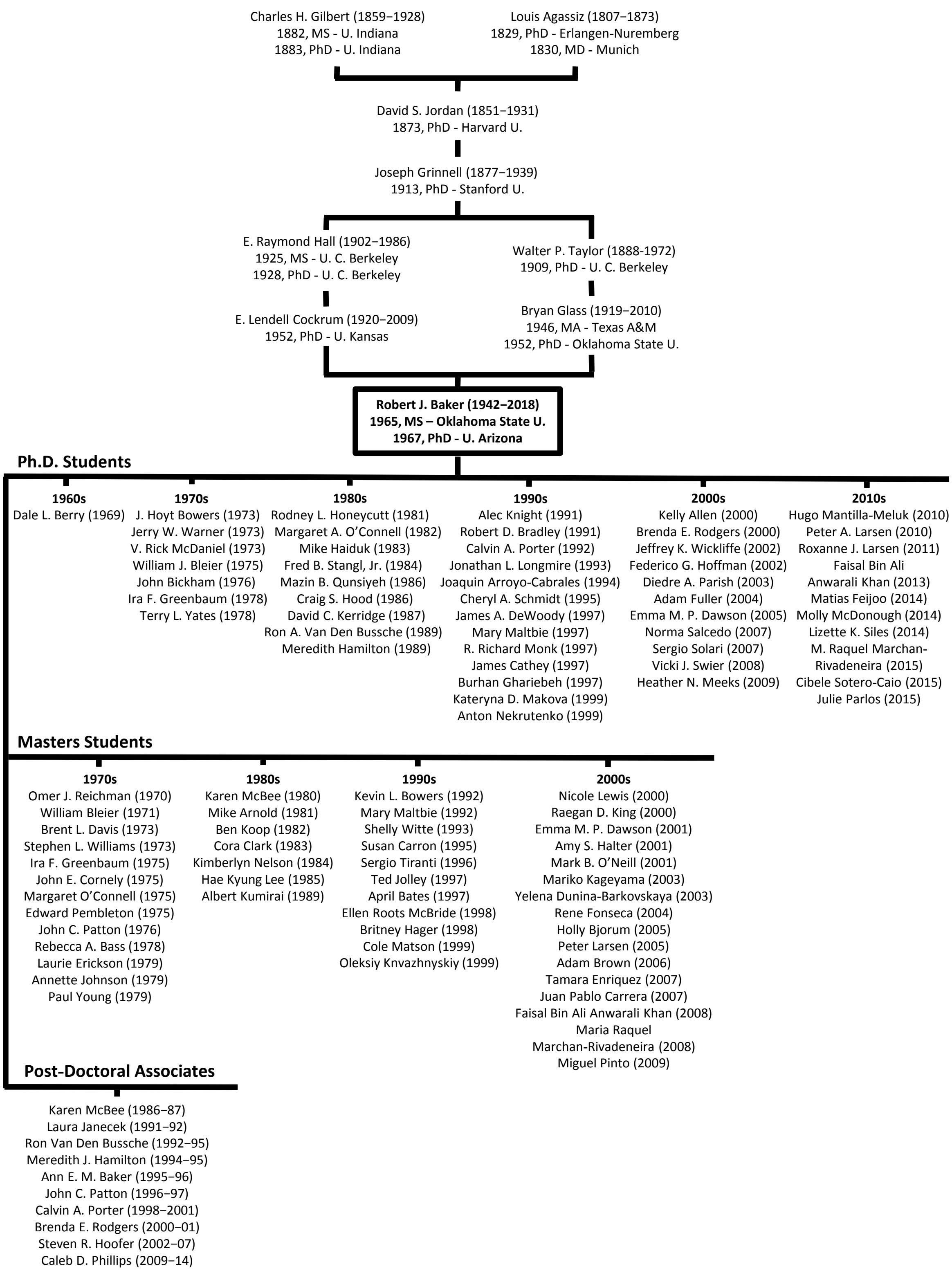

Figure 1. Robert J.Baker's academic pedigree, including his master's and doctoral students and post-doctoral associates.

Shortly after RJB joined Packard on the faculty, TTU made an institutional commitment to establish mammalogy as a major education and research focus of the university. Following the model used by E. Raymond Hall at KU, the institution made infrastructure investments to support the mammal collection and established three major publication outlets (*Occasional Papers*, *Special Publications*, and *Museology*). Other mammalogists soon followed Packard and Baker to TTU, most notably J. Knox Jones Jr., who was recruited as Dean of the Graduate School and Professor of Biological Sciences (and later became Vice President for Research) in 1971. The three mammalogists, together with a few other people, were instrumental in efforts to expand the Museum at the university and to establish the Natural Science Research Laboratory (NSRL) as a major research center and collection repository for mammal specimens. Over RJB's career at TTU, 13 other professional mammalogists joined the TTU faculty or staff. As explained below, RJB took great advantage of this institutional commitment by enhancing his publication horizons and recruiting outstanding students to participate in his graduate research program (see L. Bradley et al. 2005 for a history of mammalogy at TTU).

Another important association that RJB had during his graduate studies at University of Arizona and beyond was with James Patton, a fellow graduate student, and T. C. Hsu, Director of the Division of Cell Biology at M. D. Anderson Cancer Center in Houston. Hsu was instrumental in training a number of mammalogy graduate students in the new methods of mammalian cytogenetics. Besides Baker and Patton, they included Alfred Gardner, Dean Stock, and James Mascarello, all of whom made important contributions to the emerging field of mammalian cytosystematics (Hsu 1979). In the early 1960s, Hsu, with his research partner Sen Pathak, discovered how to isolate mitotic chromosomes of human tissue culture cells using a hypotonic solution, which led to the modern method for preparation of non-overlapping chromosomes in mammalian karyotypes. A significant breakthrough occurred in 1966, when Hsu, Baker, and Patton and a few others participated in a research trip to the Patagonia Mountains in Arizona where a major step was taken in adapting this technique to work under field conditions (Patton 2005). RJB continued his association with Hsu for many years, which included publishing three papers together in 1968 and 1970 that focused on the sex-chromosome systems of phyllostomid bats (see RJB bibliography in Genoways et al. 2018). In 2014, RJB and some of his students described and named a new genus (*Hsunycteris*) and tribe (Hsunycterini) of phyllostomid bats in honor of Hsu (Parlos et al. 2014).

METHODS

The two major quality indicators in our scientometric analysis of RJB's academic career are based on publication counts and citation counts, respectively. In addition, we have considered his students and their careers, his grant and funding sources, and his specimen and ancillary collection contributions to natural history museum collections. This information was obtained from several sources, including his published obituary (Genoways et al. 2018), his personnel file in the Department of Biology at TTU, his curriculum vitae, specimen catalogs and other documentation associated with the TTU mammal collection at the NSRL, and the personal knowledge of the five authors of this paper who knew RJB, collectively, for almost 150 years.

A yearly data matrix (1965–2018) of his publications was created based on the following information: total number of papers published; number of papers for which citation counts were available; number of database papers published in peer-reviewed outlets; total number of citations; and the average number of citations per paper. Each of his 445 papers was coded as follows: (1) journal or outlet of publication including the name of journal/outlet and year published; (2) sequence of authors for each paper—whether the paper was sole authored, co-authored (with RJB as either lead or second author), or multiple authored by more than two individuals (with RJB as the lead, secondary, or last author); (3) nature of the relationship of RJB to other publication authors—whether the paper was authored with a professional colleague (from Texas Tech or another institution), an undergraduate student, a graduate student, or a post-doctoral associate, or some combination of these groups; (4) subject organism of the paper, whether it was a non-organism paper or about a specific group of organisms (plants, parasites, invertebrates, or vertebrates—fish, amphibians and reptiles, birds, or mammals); papers on mammals were further broken down into mammals in general, bats, rodents, or other (insectivores, primates, carnivores, edentates, or ungulates); and (5) *s*ubject area of the paper was assigned according to the following areas: an edited volume, book review, letter, encomia or obituary; taxonomy, systematics, evolution; natural history; genetic mechanism; ecotoxicology-radiation; collection management; wildlife-resource management; zoonoses-disease; or history of science. (Note: At the time of preparation of this article, the authors were aware of 445 total papers that were published or in press. Therefore, all data and calculations throughout this paper are based on that total of 445, and do not reflect the additional four papers, published in this volume and listed in the text of the Results, herein, that had not yet been submitted or accepted.)

From these data we made numerous tabulations, including number of publications per year, articles in 5-year aggregated intervals, and total publications each decade of his professional career (age 23–33; 34–44; 45–55; 56–66; and 67–76); the 20 journals that published at least five of his articles; and the number of papers published according to the sequence of authors, the group of organisms discussed, and the scientific subject of the paper. In addition, we made several calculations, including average number of papers published per year; percent and average number of data-based articles (i.e., excluding book reviews, obituaries, and other non-data publications) in peer-reviewed journals per year; and percent and average number of papers with citation counts per year. The results of these calculations and tabulations are presented in a series of tables or graphs (see Results).

Citation counts were determined for each of his papers using the Web of Science database (WOS). The total number of citations for each paper was determined for each year (1965 to 2017) and then arrayed into a citation increment range as follows—0–50; 51–100; 101–150, and so on thru 650. Citation counts were summed for each decade of his career (1960s, 1970s, 1980s, 1990s, 2000s, and 2010s), and the average annual rate of citations (calculated as the sum of citations divided by the number of years since first publication) was determined for each of those decades. The average article rate of citation (calculated by dividing the total number of citations for that year by the number of papers published that year) and the median of the average article rate of citation were determined. These data also are presented in either tables or graphs.

The Thompson Reuters Impact Factor (IF) was used to rank peer-reviewed journals. The IF is a metric of mean citations per article in a given journal and is calculated annually based on the number of citations in a given year of those citable articles that were published during the two preceding years (see McDade 2011). The IF was determined for each of the scientific journals that published his papers using information from the most current year.

Google Scholar, a web-based search engine that indexes scholarly literature, was used to calculate RJB's h-index. A scientists' h-index is defined as the highest number of his or her articles that have each received at least that number of citations (Hirsch 2005). For example, if you have an h-index of 20, that means that you have 20 papers with at least 20 citations. To make this calculation, the citation indices for each of RJB's articles were ranked in descending order. The largest number of articles that were cited at least that many times generated the h-index. The advantage of the h-index is that it combines productivity (number of papers produced) and impact (number of citations) into a single index number. Both high productivity and impact are required for a high h-index; neither a few highly cited papers nor a long list of papers with only a handful of (or no) citations will yield a high h-index. Thus, the h-index is the result of the balance between the number of publications and the number of citations per publication, and it has been promoted by many, including *Science* (Holden 2005) and *Nature* (Ball 2005), as a new measure of research performance that provides a robust evaluation of the scientific output of a researcher. Because h depends on scientific age, it has been determined that dividing the index number by scientific age, to calculate the m value, creates a more accurate picture of research performance (Hirsch 2005; Kelly and Jennions 2006).

For comparative purposes, a literature search was conducted to determine h- and m-values for other evolutionary biologists, and the h-index was calculated for three other distinguished biologists, and contemporaries of RJB, who published important papers about mammals—John Avise at the University of Georgia, James Brown at the University of New Mexico, and James Patton at the University of California at Berkeley. Avise and Brown are members of the National Academy of Sciences, and Brown and Patton, along with RJB, served as President of the American Society of Mammalogists.

Information was obtained for 120 students who worked in RJB's lab, including 22 undergraduate, 48 master's, and 50 doctoral students, as well as 10 post-doctoral associates. The number of students who published with him was determined, and the career of each student was assigned to one of the following categories: academia, government agency, doctor or dentist, private sector, museum-zoo, public education, and NGO or foundation.

A complete list of RJB's grants and contracts, along with the sponsoring entity, was obtained from his curriculum vitae and personnel file, including specific awards from the National Science Foundation (NSF) and the National Institutes of Health (NIH).

The TTU specimen catalogs were used to determine the number of specimens he collected, including the number of tissue vials deposited in the Genetic Resources Collection (GRC) at the NSRL. The number of specimens prepped and deposited as vouchers, including the number of tissue vials preserved from voucher specimens, was determined directly from RJB's personal catalog. He also deposited specimens and tissues in other museums and collections, but those data were not readily available.

Finally, to assess RJB's publication legacy in mammalogy, we examined the published obituaries for 17 deceased, well-published naturalists/mammalogists, and determined for each the total number of papers published as well as the number and nature of papers published in the *Journal of Mammalogy* (feature article or note versus a book review, letter to the editor, or obituary).

RESULTS

The basic data about RJB's publication and citations counts are presented in Table 1. Tables 2–10 and Figures 2–5 present various tabulations, calculations, and graphed depictions of the data as described below.

RJB's Publications

Robert J. Baker's list of publications, as reprinted in his obituary (Genoways et al. 2018), included 438 titles over his career from 1965 to 2017. Since his death, four additional papers have appeared in print, bringing the total number to 442. The titles of these papers are as follows;

439. Montero, B. K., M. Sagot, C. D. Phillips, R. J. Baker, and E. H. Gillam. 2018. Geographic variation of contact calls suggest distinct modes of vocal transmission in a leaf-roosting bat. Behavioral Ecology and Sociobiology 72:125. https://doi.org/10,1007/s00265-018-2543-1.

440. Kwiecinski, G. G., S. C. Pedersen, H. H. Genoways, P. A. Larsen, R. J. Larsen, J. D. Hoffman, F. Springer, C. J. Phillips, and R. J. Baker. 2018. Bats of Saint Vincent, Lesser Antilles. Special Publications, Museum of Texas Tech University 68:1–68.

441. Pedersen, S. C., G. G. Kwiecinski, H. H. Genoways, R. J. Larsen, P. A. Larsen, C. J. Phillips, and R. J. Baker. 2018. Bats of Saint Lucia, Lesser Antilles. Special Publications, Museum of Texas Tech University 69:1–61.

442. Solari, S., C. G. Sotero-Caio, and R. J. Baker. 2019. Advances in systematics of bats: towards a consensus on species delimitation and classifications through integrative taxonomy. Journal of Mammalogy 100:838-851.

In addition, seven papers that include RJB on the author-line are included in this volume, thus bringing his total publication record to 449.

443. Hoffmann, F. G., R. N. Platt II, H. Mantilla-Meluk, R. A. Medellín, and R. J. Baker. Geographic and genetic variation in bats of the genus *Glossophaga*. This volume.

444. Parlos, J. A., M. A. Madden, L. Siles, F. A. Anwarali Khan, C. G. Sotero-Caio, K. L. Phelps, R. J. Baker, and R. D. Bradley. Temporal patterns of bat activity on the High Plains of Texas. This volume.

445. Wichman, H. A., L. Scott, E. K. Howell, A. R. Martinez, L. Yang, and R. J. Baker. Flying around in the genome: characterization of LINE-1 in Chiroptera. This volume.

446. Thompson, C. W., F. B. Stangl, Jr., R. J. Baker, and R. D. Bradley. Ecological niche modeling identifies environmental factors influencing hybridization in ground squirrels (Genus *Ictidomys*). This volume.

447. Swier, V. J., R. D. Bradley, F. F. B. Elder, and R. J. Baker. Primitive karyotype for Muroidea: evidence from chromosome paints and fluorescent G-bands. This volume.

448. Marchán-Rivadeneira, M. R., D. F. Alvarado-Serrano, B. Mueller, R. Strauss, and R. J. Baker. Patterns of fluctuating asymmetry and shape variation in *Myodes glareolus* from Chernobyl, Ukraine. This volume.

449. Porter, C. A., O. G. Ward, C. J. Cole, and R. J. Baker. Distribution and expression of ribosomal DNA in the composite genomes of unisexual lizards of hybrid origin (Genus *Aspidoscelis*). This volume.

Also, we are aware of another four papers that are under preparation and, if eventually published, that would increase the publication count to 453. Those potential papers include the following:

450. Siles, L., and R. J. Baker. Revision of the pale-bellied *Micronycteris* (Chiroptera, Phyllostomidae) with a description of a new species from Central America. In preparation.

451. Parlos, J. A., C. D. Phillips, J. C. Cokendolpher, S. J. Robertson, J. K. Krejca, and R. J. Baker. Genetic boundaries in endemic, troglobitic *Cicurina* spiders from Bexar County, Texas. In preparation.

452. Parlos, J. A., C. D. Phillips, S. Solari, and R. J. Baker. Phylogenetic reconstructions and multiple lines of evidence for species of *Dermanura.* In preparation.

453. Korstian, J., R. N. Platt II, B. Faircloth, T. C. Glenn, D. A. Ray, and R. J. Baker. Ultraconserved elements reveal the complexity of genus *Myotis* in the New World. In preparation.

RJB published at least one paper in every year of his career from 1965 to 2018 (Table 1 and Figure 2) with an average of 8.4 papers per year. Eighty-three percent of his papers were data-based and published in peer-reviewed journals (average of 6.9 per year). Ninety-one percent of his papers had citation counts available (average of 7.6 per year). The grand total of published pages in his papers was 6,483; subtracting out the pages of the 4 edited volumes lowers that number to just over five thousand (5,067), averaging just under 12 pages per article (11.7).

The fewest number of papers he published in a single year was two (1965, 1966, 1969, and 2015); the highest number was 17 in 2001 and 2003 (Table 1). In 19 different years (1978–1981, 1984–1985, 1988, 1991, 1996, 1998, 2000–2001, 2003, 2006–2007, 2009, and 2012–2014) he published 10 or more papers. Over a 45-year period from 1970 to 2015, he published 410 papers (92.8% of the total). His most productive periods were 1978–1982 and 2000–2004, with 59 and 61 publications, respectively, followed by 2006–2010 (52 papers, see Table 1). His period of peak publication productivity (almost 120 publications) occurred when he was between 56 and 66 years old (Fig. 3). A comparison of his research productivity in the first half of his career (1965–1991) with that of the second half (1992–2018/19) again speaks to his consistency with 203 papers (45.6% of the total) published in the former period compared to 239 (54.4%) in the latter.

RJB published in 127 different publication outlets, including 97 different peer-reviewed journals. During most of his tenure at Texas Tech, the university maintained a large number of mammalogists on its faculty and staff, and RJB took strategic advantage of this by publishing with many of these individuals, such as Hugh H. Genoways (48 publications), Robert D. Bradley (43; some as a graduate student, see below, and some as a faculty colleague), Ronald K. Chesser (37), Carleton J. Phillips (25), Clyde Jones (12), J. Knox Jones, Jr. (11), and David J. Schmidly (11). He also published with non-TTU faculty from other institutions, including 13 papers with Holly A. Wichman (University

Table 1. Publication and citation counts for Robert J. Baker's scientific articles, 1965–2018. Number of data-based papers indicates those containing original data. Total citations per paper were determined from the Web of Science online indexing service.

Year of publication	Number of papers published or in press	Number of papers with citation counts	Number of data-based papers	Total citations	Average citations per paper
1965	2	2	1	24	12.0
1966	2	2	2	47	23.5
1967	4	4	4	256	64.0
1968	6	5	5	207	41.4
1969	2	2	2	95	47.5
1970	8	8	6	398	49.8
1971	6	6	6	169	28.2
1972	11	11	11	353	32.1
1973	6	6	6	224	37.3
1974	6	6	6	220	36.7
1975	7	7	7	250	35.7
1976	9	9	9	337	37.4
1977	4	4	2	90	22.5
1978	12	11	10	472	42.9
1979	16	13	7	805	61.9
1980	11	11	10	443	40.3
1981	13	11	11	478	43.4
1982	7	7	7	521	74.4
1983	7	7	7	278	39.7
1984	11	10	9	298	29.8
1985	7	6	6	138	23.0
1986	4	4	4	397	99.2
1987	4	4	4	188	47.0
1988	12	10	12	321	32.1
1989	4	4	4	234	58.5
1990	6	6	6	738	123.0
1991	16	14	13	936	66.8
1992	9	6	6	253	42.2
1993	5	5	5	163	32.6
1994	5	5	4	161	32.2
1995	3	3	3	97	32.3
1996	14	10	12	319	31.9
1997	7	5	4	375	75.0
1998	14	12	9	304	25.3
1999	8	7	6	256	36.6
2000	11	11	9	576	52.4

Table 1. (cont.)

Year of publication	Number of papers published or in press	Number of papers with citation counts	Number of data-based papers	Total citations	Average citations per paper
2001	17	17	13	1,221	71.8
2002	8	8	8	481	60.1
2003	17	16	13	746	46.6
2004	8	6	6	144	24.0
2005	7	6	4	98	16.3
2006	12	10	10	821	82.1
2007	11	9	9	191	21.2
2008	8	8	7	207	25.9
2009	12	12	9	233	19.4
2010	9	9	9	214	23.8
2011	9	8	6	123	15.4
2012	10	10	10	225	22.5
2013	10	10	9	131	13.1
2014	10	10	6	131	21.8
2015	2	2	2	13	6.5
2016	5	4	3	39	9.8
2017	4	4	4	8	2.0
2018–2019*	7	4	6	NA	NA
Totals	445	403	367	16,447	NA

* Includes publications in press.

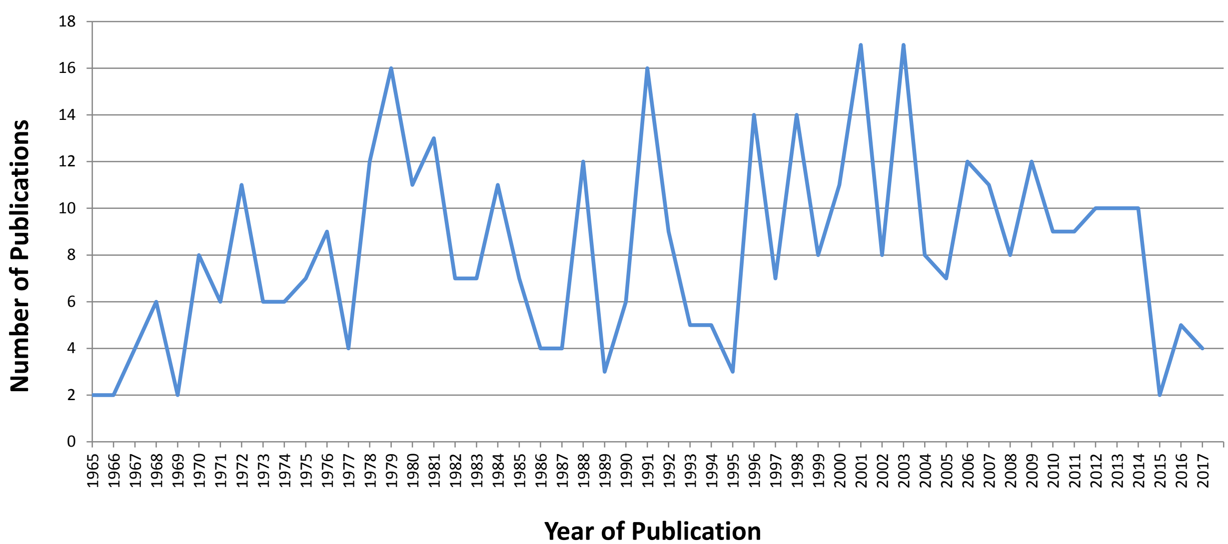

Figure 2. Robert J. Baker's publications by year.

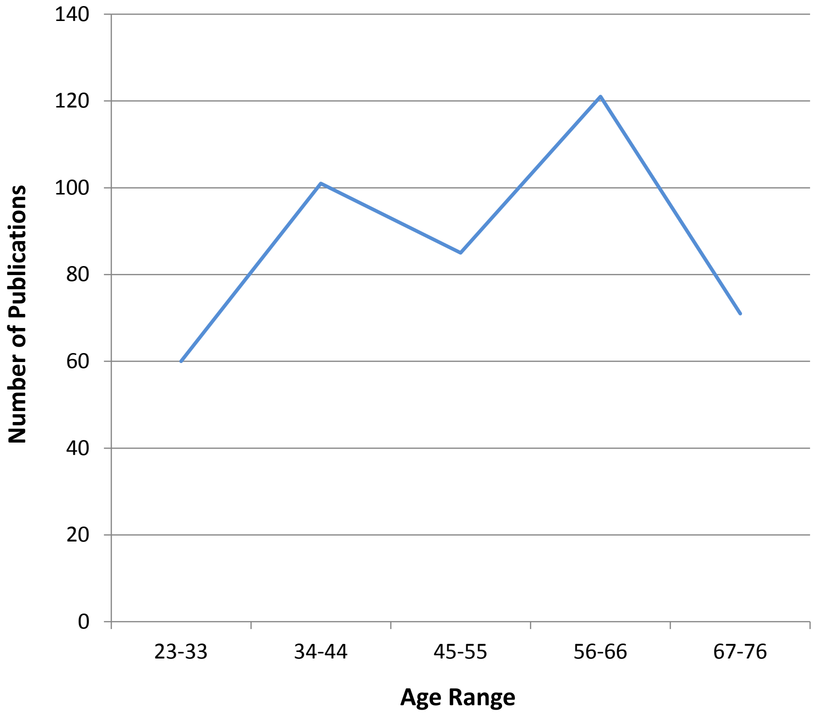

Figure 3. Robert J. Baker's publications by his age.

of Idaho), 12 with Sergey P. Gaschak (International Radiological Laboratory, Ukraine), nine with Michael H. Smith (University of Georgia), and five with Loren K. Ammerman (Angelo State University).

Table 2 lists the 20 journals that published the greatest number of his papers. He published approximately 15 percent of his papers (total of 66) in the *Journal of Mammalogy*, more than any other mammalogist of his generation. These papers have been cited 3,263 times for an average citation rate of 55.3 citations per article (Table 2). Ninety of his papers (20%) appeared in Texas Tech sponsored publications (e.g., *Occasional Papers* and *Special Publications*) and 354 (80%) appeared in other outlets. He had numerous papers in *Systematic Biology* (21 papers) and *Evolution* (13 papers), two high impact journals in his field; these papers have been cited 1,117 and 747 times, respectively. *The Southwestern Naturalist* and *Mammalian Species* each published 14 papers in which he was an author. He published 11 papers, collectively, in the journals *Science*, *Nature*, *BioScience*, and *Proceedings of the National Academy of Science*, all considered among the most prestigious journals in the biological sciences. These papers have been cited 1,383 times (Table 2). Toward the end of his career, as his research interests broadened, he published in other journals, including *Environmental Toxicology & Chemistry* (11 papers), *Molecular Ecology* (8 papers), and the *Journal of Heredity* (8 papers).

Mammals were by far the most common subjects of his publications, accounting for 360 (80.9%) of the total number of papers published (Table 3). Among his mammal papers, 194 (53.9%) were about bats, 110 (30.6%) were about rodents, 41 (11.4%) addressed mammals in general, and 15 (4.2%) were about other groups of mammals (insectivores, primates, carnivores, edentates, and ungulates). He published 20 papers (4.5% of the total) on reptiles, birds, fish, and vertebrates in general; two papers on plants; and five about invertebrates. Sixty of his papers (13.5%) did not involve a specific group of organisms.

Analysis of his papers by subject matter (Table 4) reveals that almost half of them (203 or 45.6%) were in the fields of taxonomy, systematics, and evolution. Another 35% covered general natural history (19%) and genetic mechanisms (16%). The remaining 19% covered a broad array of topics from ecotoxicology

Table 2. Journal and citation counts for journals with at least five scientific articles published by Robert J. Baker. Journal impact factors are provided in parentheses after the title, where available.

Journal	No. of papers and percent of total	Citation count	Citations/article
Journal of Mammalogy (2.139)	66 (14.8%)	3,263	55.3
Occasional Papers, Museum of TTU	63 (14.2%)	1,941	32.4
Systematic Zoology-Biology (8.523)	21 (4.7%)	1,117	58.8
Special Publications, Museum of TTU	17 (3.8%)	492	44.7
The Southwestern Naturalist (0.244)	14 (3.2%)	335	23.9
Mammalian Species	14 (3.2%)	745	57.3
Evolution (4.201)	13 (2.9%)	367	26.2
Environmental Toxicology and Chemistry (2.951)	12 (2.7%)	518	43.2
TTU, other publications	10 (2.2%)	43	7.2
Cytogenetics and Cell Genetics (1.455)	10 (2.2%)	519	51.9
Journal of Heredity (3.961)	8 (1.8%)	231	28.9
Molecular Ecology (6.086)	8 (1.8%)	409	51.1
Annals of the Carnegie Museum (0.750)	5 (1.1%)	137	27.4
Proceedings and Transactions, National Park Service	5 (1.1%)	131	26.2
Genetica (1.207)	5 (1.1%)	201	43.2
Molecular Phylogenetics and Evolution (4.419)	5 (1.1%)	152	30.4
Science (37.205), Nature (40.137), Bioscience (5.378), and PNAS (9.661)	11 (2.5%)	1,383	125.7
Totals	287 (64.6%)	11,984	36.5

and radiation (6%) to collection management (3%) and wildlife management (2.5%).

RJB was sole author of only 23 papers (5.2%) compared to 113 (25.4%) that were co-authored and 309 (69.4%) that were multiple authored (Table 5). Of the latter group, he was the last author on 162 (52.4%) of his papers. In total, he was sole or lead author for about a third of his papers (131 papers; 29.4% of the total), and he was a secondary or last author on 314 (70.6%). He was last author on 237 (53.3%) of his total publications.

For those that knew RJB, this statistic should not come as a surprise. Robert did not like authoring papers by himself. He wanted input from others—he believed in the adage of surrounding yourself with the best people possible and borrowing their brains! He felt bouncing ideas around and challenging others to think would help improve his papers. Further, he liked to share the credit. He wanted others to be involved so that they could improve their CVs, and he truly enjoyed writing with others.

Citation Counts of RJB's Publications

Citation counts from the Web of Science (WOS), an online scientific citation indexing service of Clarivate Analytics, were available for 403 of RJBs 445 papers (90.6%). Papers that could not be counted included

Table 3. Tabulations of Robert J. Baker's papers by topic and groups of organisms.

Category	No. of papers	% of total papers
Non-organism paper	60	13.5
Mammals	360	80.9
Bats	194 (53.9%)	
Rodents	110 (30.6%)	
Other (insectivore, primate, carnivore, ungulate)	15 (4.2%)	
Mammals in general (checklists, surveys)	41 (11.4%)	
Other vertebrates	20	4.5
Reptiles	9 (45.0%)	
Birds	7 (35.0%)	
Fish	1 (5.0%)	
Vertebrates in general	3 (15.0%)	
Invertebrates	3	0.7
Plants	2	0.4
Totals	445	100.0

Table 4. Tabulation of Robert J. Baker's papers according to subject areas.

Subject	No. of papers	% of papers
Taxonomy, systematics, evolution	203	45.6
Natural history	85	19.1
Genetic mechanisms	71	16.0
Ecotoxicology, radiation	27	6.1
Edited volumes, reviews, letters, obituaries	26	5.8
Collection management	14	3.1
Wildlife resource management	11	2.5
Zoonoses, diseases	4	0.9
History of science	4	0.9
Totals	445	100.00

Table 5. Tabulation of Robert J. Baker's papers according to the number of authors and his position on the author line.

Category	No. of papers	% of papers
Sole author	23	5.2
Co-author	113	25.4
Lead	(38)	(33.6)
Second	(75)	(66.4)
Multiple authored (more than 2)	309	69.4
Lead	(70)	(22.6)
Secondary	(77)	(25.0)
Last	(162)	(52.4)
Totals	445	100.00

some book reviews and letters to editors, chapters in edited volumes, species accounts in mammal books, contributions to newsletters, certain checklists of species, a few Texas Tech publications, some government proceedings and transactions, and papers in press or newly published.

A search of each of his publications in the WOS revealed a total citation count of 16,447 (Table 1). The average annual rate of citations for his papers was 310.3. A search in Google Scholar produced slightly fewer citations (15,853). These two databases use slightly different time frames and they index different journals, which accounts for the discrepancy.

The average and median annual rate of citation for his papers was 39.3 and 36.2, respectively. The distribution of the citations was significantly skewed, with 76% of the articles cited fewer than 50 times; 16% between 51 and 100 times; 4% between 101 and 150 times; 3% between 151 and 200 times; and 2% more than 200 times (Table 6). According to the WOS search results, eleven of his papers were never cited and an additional 11 were cited only one time.

The peak years for citations (Fig. 4) were: 2001 (1,221 citations; mean = 82.1 citations/article); 1991 (936; mean = 66.8); 2006 (821; mean = 82.1); 1979 (805; mean = 61.9); and 1990 (738; mean = 123). The average number of citations per article over RJB's career was generally consistent except for the last few years of his life (Table 7). The average annual rate of citations (calculated as the sum of citations divided by the number of years since the first publication) steadily increased from the 1960s until the end of the first decade of the 21st century, after which it also declined (Table 7).

RJB's 10 most cited papers are listed in Table 8. The two most highly cited papers were theoretical contributions about the genetic species concept in mammals that appeared in the *Journal of Mammalogy*. Four of the most highly cited papers appeared in the first decade of the 21st century, three in the 1990s, two in the 1980s, and one in the 1960s (Table 8).

The top journals, in terms of impact factor, in which RJB papers appeared were: *Nature*, *Science*, *Proceedings of the National Academy of Science*, *Systematic Biology*, *Molecular Ecology*, *Bioscience*, and *Molecular Phylogenetics and Evolution* (see Table 2). His most impactful papers (calculated by dividing the number of citations by the publishing journal's impact factor for that year, divided by the number of years since the article was published) were the two papers on the genetic species concept (co-authored with Robert D. Bradley) that appeared in the *Journal of Mammalogy* in 2001 and 2006.

Table 6. Analysis of citation counts for Robert J. Baker's 403 indexed papers. Citation counts were obtained from the Web of Science online indexing service.

Citation count range	No. of papers	% of papers
0-50	308	76.42
51-100	65	16.12
101-150	16	3.97
151-200	5	1.24
201-250	2	0.49
251-300	1	0.25
301-350	2	0.49
351-400	1	0.25
401-450	0	0.00
451-500	0	0.00
501-550	0	0.00
551-600	2	0.49
601-650	1	0.25
Total	403	

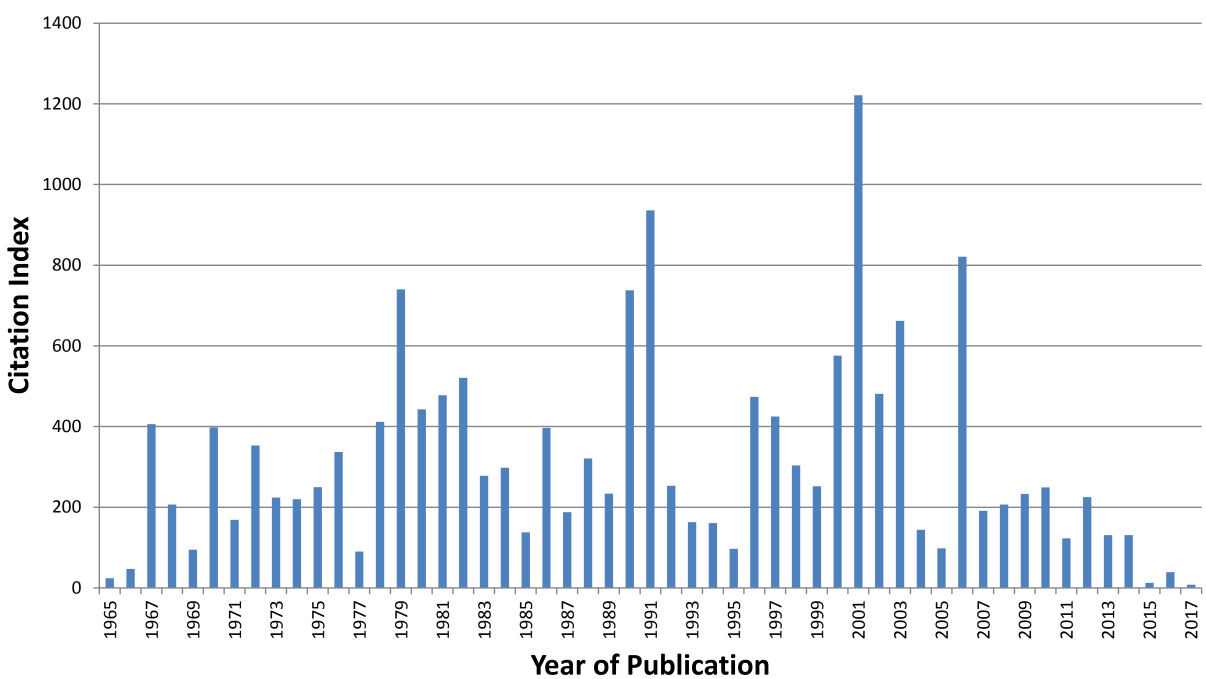

Figure 4. Annual citation counts for Robert J. Baker's publications.

Table 7. Publication and citation counts of Robert J. Baker's 403 indexed papers by decade. Citation counts were obtained from the Web of Science online indexing service.

Decade	No. of papers	Citation count	Average citation count per article	Average annual rate of citation*
1960s	15	629	42.0	125.8
1970s	81	3,318	41.0	331.8
1980s	74	3,296	44.5	329.6
1990s	73	3,602	49.3	360.2
2000s	103	4,718	45.8	471.8
2010s	57	884	15.5	110.5
Totals	403	16,447		

* Calculated as the sum of citations divided by the number of years since first publication.

Table 8. The 10 most cited articles published by Robert J. Baker.

Title	Journal	Year	Journal Impact Factor	No. of citations
A test of the genetic species concept: cytochrome-*b* sequences and mammals	Journal of Mammalogy	2001	1.630	642
Speciation in mammals and the genetic species concept	Journal of Mammalogy	2006	1.630	597
Distribution of non-telomeric sites of the $(TTAGGG)_n$ telomeric sequence in vertebrate chromosomes	Chromosoma	1990	4.021	586
Evidence for biased gene conversion in concerted evolution in ribosomal DNA	Science	1991	37.205	392
Use of "lysis buffer" in DNA isolation and its implications for museum collections	Occasional Papers, Museum of Texas Tech University	1997	NA	336
The ecology and evolutionary history of an emergent disease: hantavirus pulmonary syndrome	Bioscience	2002	5.378	310
Speciation by monobrachial centric fusions	Proceedings of the National Academy of Science	1986	9.661	287
Karyotypic evolution in bats: evidence of extensive and conservative chromosomal evolution in closely related taxa	Systematic Biology	1980	8.917	217
Diversification among New World leaf-nosed bats: an evolutionary hypotheses and classification inferred from digenomic congruence of DNA sequence	Occasional Papers, Museum of Texas Tech University	2003	NA	184
Karyotypes and karyotypic variation of North American vespertilionid bats	Journal of Mammalogy	1967	1.630	180
Total				3,731

H-index and M-value

The h-index for all of RJB's publications for which citations were available (15,853 in the Google Scholar database) was 65, meaning that 65 of his papers were cited at least 65 times. The m-value, derived by dividing the h-index score by his scientific age (53) was 1.23. By way of comparison, the h-indices and the m-values of Avise and Brown were higher (h = 102 and 106; m = 2.27 and 2.08, respectively). Patton's (h = 63; m =1.2) was nearly identical although slightly lower than that of RJB.

RJB's Influence in Teaching and Mentoring Students

RJB began working with graduate students soon after his arrival at Texas Tech. A list of his 48 Master's and 50 Ph.D. students was provided in his published obituary (Genoways et al. 2018), and they also are listed in Figure 1 of this publication. In his 48 years on the Texas Tech faculty, there were only seven years (1967, 1968, 1972, 1974, 1977, 1988, and 2012) in which he did not graduate a master's or a doctoral student.

In the early stages of his academic career, as might be expected, he worked more with master's than doctoral students, but this changed in the 1980s when he became more involved with doctoral students (Fig. 5). His production of Ph.D. students peaked in the 1990s and early part of the 21st century. Beginning with the 1990s and continuing throughout the remainder of his career, RJB also became involved with several post-doctoral associates who worked in his laboratory. These, too, were listed in his obituary (Genoways et al. 2018) and have been included in Figure 1.

He published papers with all but six of his Ph.D. students, and he had more than 10 publications with 14 of them, including 43 with Robert D. Bradley, 32 with Ronald A. Van Den Bussche, 21 with Jeffrey K. Wickliffe, 20 with Meredith Hamilton, and 17 with Calvin A. Porter. He published with 37 of his master's students; the largest number of papers was written with John C. Patton (9 papers), Stephen L. Williams (8), and Ben F. Koop (7). He published with all but one of his 10 post-doctoral associates, including 16 papers with Brenda Rodgers, 12 with Steven R. Hoofer, and 11 with Caleb D. Phillips.

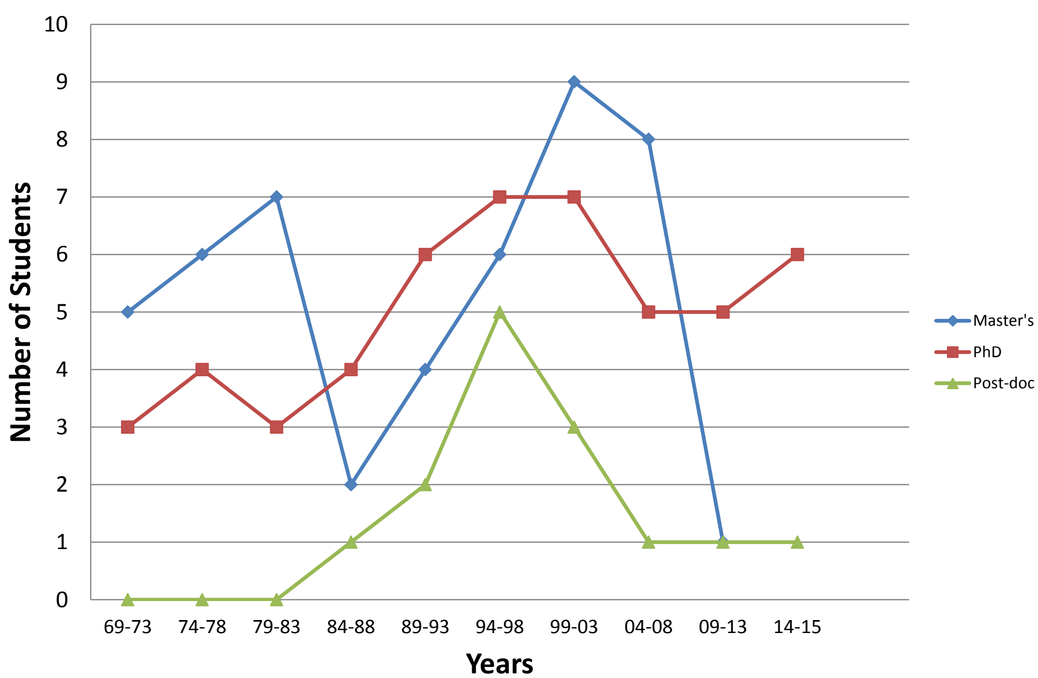

Figure 5. Robert J. Baker's master's and doctoral students and post-doctoral associates in 5-year periods throughout his career.

Table 9. Educational achievements and career fields of undergraduate and graduate students of Robert J. Baker.

Category	Undergraduate student*	Master's student	Doctoral student
Education			
Obtained Master's degree	2	48	NA
Obtained Ph.D. degree	10	24	50
Obtained medical/dental degree	7	1	0
Employment			
Academia	8	21	39
Federal/State agency	2	2	3
Private Sector	1	6	3
Medical Doctor or Dentist	8	1	0
Public Education	0	0	1
Museum/Zoo	0	5	2
Foundation/NGO	0	1	0
Unknown/deceased	3	12	2

* Undergraduate students who published with Robert J. Baker while an undergraduate.

An examination of the careers of RJB's graduate students (Table 9) reveals that of his 50 doctoral students, 39 (78%) have had careers in academia; nine others worked in federal agencies, the private sector, public education, or museums. Of his 48 master's students, 24 completed Ph.D. programs (7 under RJB at Texas Tech) and 21 ultimately became employed in academia; others went to work in museums or zoos, federal or state agencies, the private sector, NGO foundations, or in public education. All total, 60 of his graduate students (61.2%) received a Ph.D. at Texas Tech or some other institution and worked in academia.

The academic institutions where RJB's students worked include well-known public and private universities, several smaller state and regional universities, community colleges, and international institutions. The list of public and private colleges and universities in the U.S. where his students worked or currently work includes the following: University of California-Santa Barbara, North Dakota State University, Baylor University, Texas A&M University, Eastern Washington State University, Purdue University, Hebrew Theological College, Oklahoma State University, University of Georgia, Penn State University, University of Utah, Duke University, University of Minnesota, University of Michigan, the City University of New York, Wayland Baptist University, Northern Kentucky University, Arkansas State University, University of New Mexico, Pepperdine University, Harvard University, Lamar University, Midwestern State University, Loyola University, Sul Ross State University, Texas Tech University, Xavier University of Louisiana, Colorado State University, University of Pittsburgh, Tulane University, Mississippi State University, and the College of Charleston. Three of his former students are employed at community colleges (Lone Star College and Richland College in Texas and Tulsa Community College in Oklahoma). RJB also placed students at international universities in seven different countries: Universidad de Antigua (Medellin, Colombia), Universidad del Quindo (Colombia), Universidad de la Republica (Uruguay), Universidade Federal de Pernambuco (Recife, Brazil), Universidad Nacional de la Pampa (Argentina), University of Malaysia (Sarawak, Malaysia), Bethlehem and Birzeit universities (Palestine), Malaspina College (British Columbia, Canada), and the University of Victoria (Canada).

RJB began teaching undergraduate students as soon as he arrived at Texas Tech, offering courses in histology, cytology, general zoology, the Biological Status of Man, but his favorite course was Freshman Biology for Non-majors, which he taught for more than 20 years (Genoways et al. 2018). It has been estimated that he taught several thousand students in this course (including, curiously, John Hinckley, Jr., who shot President Ronald Reagan on 30 March 1981).

He was also a huge supporter of undergraduate research, and many undergraduates worked in his laboratory. His curriculum vitae listed 22 undergraduate students that authored research papers based on work they did in his laboratory, including eight papers by Laura E. Wiggins, five by Amanda J. Wright, and four by Amy B. Baird. Of those 22 undergraduate research students, 19 pursued and obtained graduate degrees. Two obtained Master's degrees, and ten received Ph.D. degrees and work at the following academic institutions: University of Texas at Brownsville, University of Texas at Austin, U.S. Military Academy-West Point, Baylor University, Purdue University, University of Georgia, University of North Texas, University of Houston Downtown, and Texas Tech University. In addition, seven of the 22 undergraduate researchers went to medical or dental school and are now practicing in those professions.

RJB's Grants, Contracts, and Financial Support

Throughout his career, RJB was able to secure funding to support his research and graduate education programs. Through grants and contracts, he was awarded nearly $16 million (in 2018 dollars) from 31 different granting agencies (Table 10). He received 15 grants from the National Science Foundation (NSF), with almost 30 years of continuing funding from that agency totaling almost 3 million dollars. His NSF grants included the following:

1. Karyotypic studies of phyllostomid bats, 1968–1970;

2. Karyotypic studies of the Phyllostomidae, 1971–1972;

3. Extension of karyotypic studies of the Phyllostomidae, 1973;

4. Evolutionary studies of phyllostomatid bat faunas in Caribbean Islands (with Hugh H. Genoways), 1974–1975;

5. Chromosomal change in mammalian evolution (Chiroptera: Phyllostomatidae), 1976–1978;

6. Chromosomal studies of Phyllostomatidae, 1980–1982;

7. Chromosomal races of the white-footed mouse, *Peromyscus leucopus*, 1983–1984;

8. Updating and enhancement of the Recent mammal collections, Texas Tech University (with Robert Owen), 1986–1988;

9. Dynamics of a hybrid zone between chromosomal races of the white-footed mouse, *Peromyscus leucopus*, 1986–1989;

10. REU: Evolutionary genetics and dysgenesis in a naturally occurring hybrid zone in *Peromyscus leucopus*, 1990;

11. Repetitive DNA sequences in genome organization of phyllostomid bats: test of a molecular model for chromosomal divergence, 1992–1995;

12. Enhancement of collections and safety at the Museum of Texas Tech University (with Robert D. Bradley [P.I.], Clyde Jones, David J. Schmidly, and Richard Monk), 1998–1999;

13. Development of an integrated network for distributed databases of mammal specimens, 2001–2003;

14. Collection enhancement, enlargement, and compactorization at the Natural Sciences Research Laboratory (with Robert D. Bradley), 2006–2008; and

15. Natural history: Development of a liquid nitrogen system for the Genetic Resources Collection, Natural Sciences Research Laboratory, Museum of Texas Tech University (with Robert D. Bradley), 2015–2018.

RJB also received two funded grants from the National Institutes of Health:

Table 10. Categories of research funding for Robert J. Baker. All values have been converted to 2018 dollars.

Agency and Other Sources	Total funding
Federal Research Agencies	
National Science Foundation	$2,980,500
National Institutes of Health	$359,000
Smithsonian Foreign Currency Program	$578,000
U.S. Department of Agriculture	$354,000
U.S. Department of Commerce, Advanced Technology Program	$270,000
U.S. Fish and Wildlife Service	$36,000
Sandia National Laboratories	$175,000
National Park Service	$143,000
U.S. Department of Defense	
Fort Bliss	$873,000
Defense Threat Reduction Agency	$200,500
U.S. Department of Energy	
Pantex Treatment Facility	$125,500
Chernobyl	$1,308,500
Texas State Agencies	
Texas Parks and Wildlife Department	$315,750
Texas Tech University Office of Research Services	$123,500
Texas Department of Transportation	$72,000
Texas State Line Item (Biodiversity Database)	$3,680,000
Texas State Line Item (Genetic Identification of Cotton Cultivars)	$3,510,000
Texas Tech University faculty grants	$72,000
Texas Agricultural Experiment Station	$30,500
Texas Higher Education Coordinating Board	$78,500
Foreign Governments/Agencies	
New Brunswick Wildlife Trust Fund	$7,000
Health Protection Agencies, United Kingdom	$40,500
Private Sources	
Individuals - James Sowell	$230,000
Unidentified companies	$21,000
Foundations	
American Philosophical Society	$7,100
CH Foundation	$131,500

Table 10. (cont.)

Agency	Total funding
Conservation Organizations and Other	
Welder Wildlife Foundation	$40,000
National Fish and Wildlife Foundation	$58,000
National Geographic Society	$31,000
Texas Nature Conservancy	$23,000
State of Alaska (bear research)	$44,000
Total (approximately; in 2018 dollars)	$16 million

1. Ecology of emerging arena viruses in southwestern U. S., 1997–2000;

2. Mammalian genomes: stasis and change, 2001–2005.

Several other sources of funding for RJB also deserve mention because they provided support not only for his own research but also for institutional building at Texas Tech. He received funding from two line items provided by the Texas Legislature. Line item funding was the state equivalent to directed federal appropriations or "earmarks." Unless rescinded, this money was included annually in the TTU budget for the stated purpose of the work. One of the line item projects involved the development of a biological inventory and database of mammals on state-owned properties with the primary goal of providing an archival record of the mammalian biodiversity that was present in Texas at the turn of the 21st century and developing an electronic database of Texas mammals that could be accessible to state biologists and those in leadership roles in the development of wildlife management and conservation policies (see L. Bradley et al. 2005). This project supported the growth of the research collections at the Natural Science Research Laboratory (NSRL) at Texas Tech. The second line item project was for the genetic identification of species and cotton cultivars, and it was used to support the work of graduate students in his genetics lab in the Department of Biology who worked on the project.

One of us (DJS) introduced RJB to Jim Sowell (JS), a member of the Board of Regents at Texas Tech and a leading benefactor of the institution. When Professor Baker showed him the collections at the NSRL and explained the nature of his work and the numerous student publications that had resulted from that work, Sowell was so impressed that he offered to financially underwrite the cost of RJB's field trips to foreign countries to support his program. Overall, JS provided $230,000 in support for field studies, and in recognition of this support, RJB named a species of bat, *Carollia sowelli*, in his honor.

RJB received more than $1 million in funding to collaborate on a project at Chernobyl, the site of the world's largest nuclear accident. For this work Robert had to educate himself on methods and theory in ecotoxicology and radiation biology, recruit and train students from Ukrainian universities, and establish international collaborations. These collaborations continued for several years and resulted in more than 40 scientific publications focused on Chernobyl research.

RJB's Field Work and Contributions to Natural History Collections

Robert's fieldwork took him around the world, including five continents and 26 countries. He spent almost three years in the Neotropics, including the Caribbean Islands, collecting bats, as well as five total months, over a several year period, in the Chernobyl nuclear disaster zone, studying the impact of radiation on mammalian populations (for details of his field work, see Genoways et al. 2018). From these trips he accumulated a large amount of data and specimens that have been deposited in various natural history collections.

In his fieldwork, RJB emphasized special collections that included more than the traditional "skin and skull" specimens for mammals. He pioneered the idea of cross-referencing museum specimens with information on karyotypes and various tissues. The frozen tissue collections he started are invaluable because many of the samples came from species and regions that are now heavily depleted. Without such a resource, studies of the evolution and systematics of mammals would be next to impossible to conduct, especially given the political and financial cost of expeditions. As a result of his vision, several other collections, including those at Texas A&M University, the Museum of Southwestern Biology (University of New Mexico), and Carnegie Museum of Natural History, now have special collections based on the model promoted by Robert. Other collections also have mimicked Robert's approach.

The NSRL contains specimens or specimen parts from 10,131 individuals that RJB was given at least partial credit for collecting. Materials archived from these specimens include standard museum vouchers, specimens preserved in ethanol, karyotypes, frozen tissues, lysis-preserved tissues, blood samples, parasites, fecal matter, and stomach contents. He also deposited an unknown number of specimens at other institutions in the United States and in foreign countries (e.g., Ukraine, Mexico, and Ecuador) where specimen sharing was required in order to obtain collecting permits. He spent a lot of time conducting field work in the Neotropics, including the Caribbean, Mexico, and Central America, where he conducted research on the evolution and systematics of New World bats.

Baker's personal catalog listed 4,711 specimens as the total number of voucher specimens that he prepared (standard museum specimens and those preserved in ethanol). Of those, 2,911 were deposited at the NSRL with the remainder, because of collaborative research arrangements, housed at the Carnegie Museum of Natural History in Pittsburgh, Pennsylvania, and the Texas Cooperative Wildlife Collection at Texas A&M University. For much of his career, RJB conducted karyotype work using both field and laboratory preparations of stained chromosomes. The NSRL houses an estimated 475 boxes of karyotype slides from this work with up to 100 slides per box. There are also thousands of negatives and printed photographs of karyotype preparations. Many frozen tissues in the GRC at the NSRL came from RJB's work. These include 16,453 tissue vials from specimens he collected and another 3,005 from specimens that he prepped. A large number of other tissues resulted indirectly from his work in the form of specimens and samples provided by graduate students and collaborators on funded research projects. All of these specimens and ancillary materials are available for other scientists to access and study.

RJB's Record in Mammalogy and Service to Scientific Societies

When his publication record is compared with that of other deceased, well-published naturalists-mammalogists, RJB clearly emerges among the individuals at the top of the list (Table 11). Of the 17 mammalogists listed, he ranks number 3 behind only Joseph Grinnell and C. Hart Merriam, two of the early giants in the field. (It should be noted that only 12% of Grinnell's papers were about mammals; most of his work was on birds.) So, by any measure, RJB was one of the most prolific mammalogists of his era. In many respects, Robert had an impact on mammalogy equivalent to that of Grinnell and Merriam. Grinnell made a lasting impact on the legacy of mammalogy by the students he taught and trained, whereas Merriam contributed more to biological surveys and the cataloging of diversity throughout the United States. Robert's career encompassed both of the contributions made individually by these two men. First and foremost, he was an educator and contributed to the next generation of mammalogists. At the same time, his studies of biodiversity and commitment to museum science overlapped with Merriam's main emphasis.

RJB was a major contributor and leader in the American Society of Mammalogists (ASM). As shown in Table 2, during his career he was the leading publisher of articles in the ASM's publication outlet, the *Journal of Mammalogy*. Also, between 1965 and 2016 he attended every annual meeting of the ASM and at most of them either he or one of his students presented scientific papers or posters. By examining the index of abstracts for the annual meetings, we determined that papers or posters were presented by RJB or his students every year except for 1973–74, 1980, 1994, 2000, 2007–2008, 2010, 2012, and 2014. Over a 6-year period from 2000 to 2006, the Baker group presented 37 papers or posters. He served in many leadership positions in the ASM, including elected and editorial positions as chronicled in his obituary. He served as President of ASM from 1994 to 1996, and he received the three major awards given by the society (Merriam,

Table 11. The publication records of deceased well-published naturalists/mammalogists.

Name	No. Papers	No. in JM	Feature/Note	Other*
Grinnell, J.**	554	12	11	1
Merriam, C. H.	490	9	9	1
Baker, R. J.	**445**	**66**	**57**	**9**
Miller, G. S., Jr.	399	49	33	16
Jones, J. K., Jr.	368	73	39	34
Hall, E. R.	349	61	48	13
Hoffmann, R. S.	247	29	13	16
Hamilton, W. J.	233	45	36	9
Layne, J. N.	229	23	21	2
Goldman, E. A.	206	47	43	4
Osgood, W. H.	205	29	22	7
Choate, J. R.	201	33	28	5
Jones, C.	200	36	21	15
Davis, W. B.	191	31	30	1
Hoffmeister, D. F.	137	31	28	3
Yates, T. L.	130	15	15	0
Findley, J. S.	100	49	46	3
Hooper, E. T.	90	34	29	5

* Includes book reviews, letters to the editor, and obituaries.

** Only 67 of Grinnell's 554 papers (12%) were about mammals.

Grinnell, and Jackson) and was elected Honorary Member—the only person in the history of the ASM to accomplish this.

He also was active in numerous other scientific societies, including the Southwestern Association of Naturalists and the Texas Society of Mammalogists, where he held important elected positions and received recognition for his contributions and leadership. His work in various scientific organizations is discussed in more detail in his obituary (Genoways et al. 2018).

DISCUSSION

What makes a good scientist and what constitutes evidence of scientific excellence? According to the Mertonian sociology of science, the primary criterion for a scientist's quality derives from the objective of science—extending certified knowledge (Sonnert 1995). The scientists who contribute the most to the growth of scientific knowledge are thought to perform their role as scientists the best. Because the standard way of communicating scientific research findings is through publication, this metric is widely adopted as the appropriate measure of a scientist's performance.

We also know that superior scientific performance is a disproportionately rare phenomenon, with a small minority accounting for a disproportionate impact (Jackson and Rushton 1986; Rushton 1988). Most significant publications are authored by a small proportion of researchers, and the majority of citations reference a relatively small pool of articles. This is why highly cited researchers wield a vastly disproportionate influence in their fields (Parker et al. 2010).

Two theories, based on research by social scientists, have emerged about how to best predict scientific productivity and creativity. D. K. Simonton (2004) has argued that highly prolific scientists are more successful in producing high-impact work compared with their less productive peers. He also concluded that scientists can increase their number of creative and high-impact works only by increasing their publication output; in other words, scientific creativity is a "probabilistic consequence" of research quantity. The second theory, developed by R. S. Burt (1992, 2004) and known as the theory of "structural holes," argues that individuals who live in the intersection of "social worlds" are more likely to select and synthesize cognitive alternatives into "good ideas." According to Burt's theory, individuals who bridge "structural holes" have access to multiple views, information, and perspectives, a fact that explains why they develop more novel and better ideas than their peers.

Heinze and Bauer (2007) have combined elements of both of these theories into a flowchart to illustrate the factors associated with highly creative scientists (see Figure 6). The premise behind this chart is that it is not only the sheer quantity of publications that causes scientists to produce pieces of work; in addition, their ability to effectively communicate with their colleagues and address a broader work spectrum creates important dimensions of the creative process.

Overlaying RJB's achievements on this chart (Fig. 6) demonstrates his research creativity. His number of publications (445) is prodigious for a naturalist-mammalogist. Publication is regarded as an indispensable part of science, and sustained and substantial publication favors creativity (Bartholomew 1982). The more research one completes, the more apt one is to make an original contribution. The simple number of peer-reviewed journal papers has been shown to be strongly and significantly associated with the number of collaborators and thus the size of the co-author network (Heinze and Bauer 2007). Furthermore, the number of publications and annual productivity rate of a scientist is known to widen the spectrum both of the journals that scientists publish in and the amount of citations their articles achieve (Sonnert 1995).

In many fields a scientist's annual productivity rate has been demonstrated to be a powerful predictor of quality, with a large number of publications being indicative of a larger number of higher-quality publications (Sonnert 1995). RJB averaged more than eight-papers per year over his 53-year publishing career, but he had several periods in his career where he sustained a much higher rate of publication. Creative individuals have been shown to go through "hot streaks" of peak productivity over a relatively short period when they produce their best work (Timmer 2018). The average hot streak for a scientist has been estimated to last 3.7 years (Timmer 2018), and RJB certainly had his "hot streaks" (see Table 1). From 2000 to 2004, for example, he authored a total of 61 papers, which equates to an average of one paper per month over a 5-year period. Similarly, from 1978 to 1982, he nearly matched this output, publishing 59 papers. Another era of extremely high productivity occurred from 2006 to 2010 when he appeared on the author-line of 52 papers. Three "hot streaks," over a span of four decades, is far above the average for most scientists. The period from 1978 to 1982 was the time that chromosome banding studies came to fruition in Robert's lab, and he and his students began publishing papers on the theoretical aspects of chromosome evolution and speciation, as well as many data-oriented chromosome papers. The periods 2000–2004 and 2006–2010 were when RJB was heavily involved in the Chernobyl work, with many papers being published about both genetics and ecotoxicology.

George Bartholomew, the eminent zoologist, has noted another and even more important reason for publishing. The more deeply, continuously, and productively one is immersed in research, including the final and compelling discipline of publishing, the greater the opportunity for favorable serendipity (Bartholomew 1982). We see this in many aspects of RJB's career. While collecting material on field trips in support of his numerous grants to study karyotypic and genetic evolution in mammalian populations, RJB and

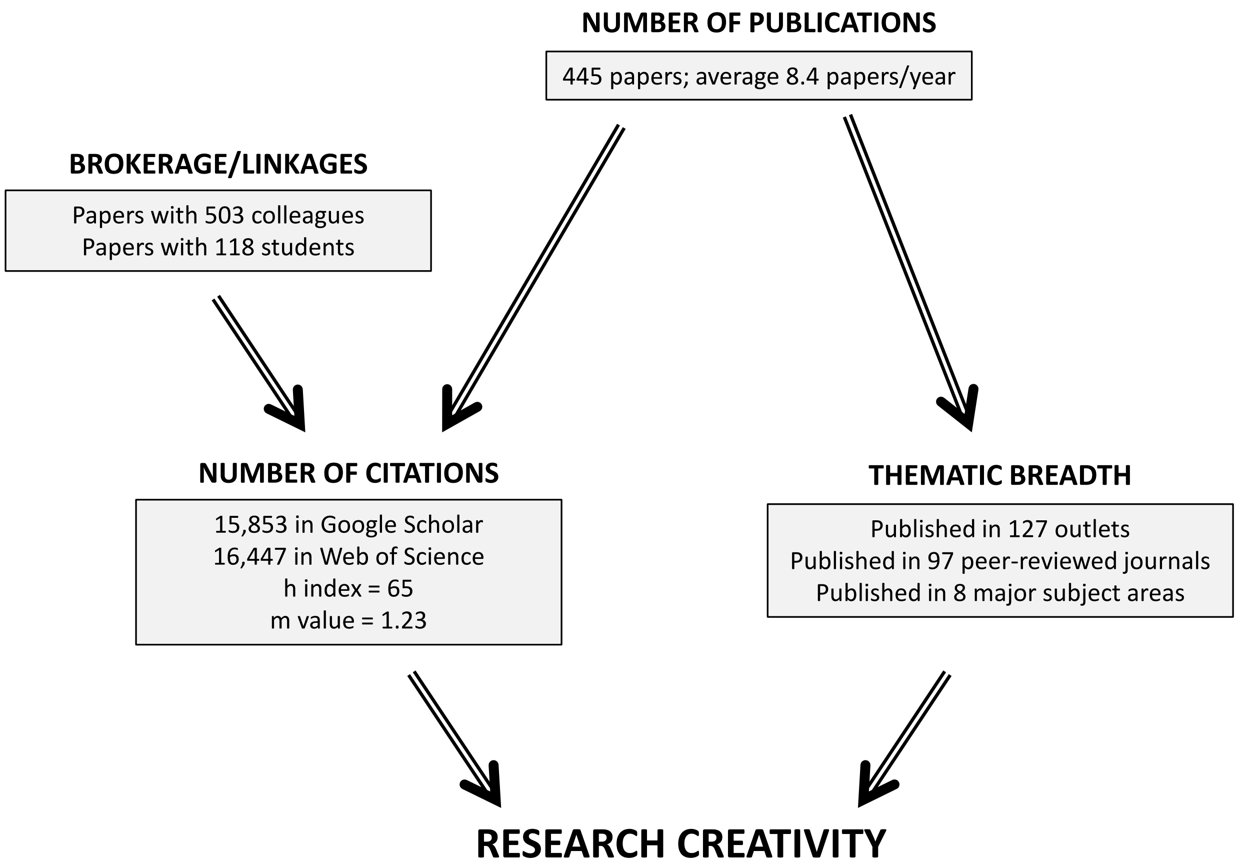

Figure 6. Flow chart of four key factors in determining research creativity. Information shaded in gray depicts key RJB data for each factor. Adapted from Heinze and Bauer (2007).

his collaborators made basic natural history observations for which specimens were collected to document findings about the distribution and natural history of species. He published these results in addition to his work on systematics and evolution, thereby expanding the publication horizon of his field research.

RJB's preferred method of publication was clearly collaborative; 416 of his 445 papers involved collaborators, including many of the 130 students who worked in his program. He published with all but 18 of his 130 students and post-docs (six doctoral students, 11 master's students, and one post-doc), and the author-line of his papers included an almost unbelievable number of 503 different individuals! On many papers he took the last authorship, especially toward the end of his scientific career. Last place on the author list is often reserved by senior biologists for all publications coming out of their labs or research programs (see Sonnert 1995).

A key aspect of the publication record of any scientist is the popularity and prestige of the journal(s) where the research is published (Olden 2007). Currently, the Thompson Reuters Impact Factor (IF), calculated as the average number of times that articles published in a specific journal in the past two years were cited in the current year, is recognized as the de facto measure of journal "quality," despite its known limitations (see Alberts 2013). However, the quality of an article is not necessarily correlated with the quality of the journal in which it is published (McDade et al. 2011), and in many fields the average journal prestige does not always correlate significantly with publication productivity and the average rate of citations per article (Sonnert 1995).

The IF was never intended to evaluate individual scientists, but rather as a measure of journal quality (Garfield 2006). Also, the IF (along with the Science Citation Index [SCI] and h-index) shares the shortcoming that not all serials are indexed for the system, thereby artificially reducing the estimated impact of biodiversity publications. Notably, a number of important journals in systematic biology, especially those that publish monographs, are not included. Books—whether edited volumes or individual contributions—are not included in the SCI. Also, impact factors have been shown not to work very well for taxonomic journals (Krell 2000), and there is some suggestion of a taxon bias with higher citation rates for biologists working on 'popular' organisms (Kelly and Jennions 2006).

RJB published in many prestigious journals including *Science*, *Nature*, *Proceedings of the National Academy of Science*, *Systematic Biology*, *Bioscience*, and *Evolution*. But some of his most important papers in mammalogy were published in the *Journal of Mammalogy*, which has a lower journal impact factor than the journals listed above. Also, 20 percent of his papers were published in Texas Tech publications (primarily *Occasional Papers* and *Special Publication* series at the Museum), which include many longer taxonomic revisions and biodiversity papers, and these publications are not indexed for impact factors.

From basic accounts about the distribution and natural history of bats and other mammals to insightful, paradigm-making papers, RJB's work covered many groups of taxa (mammalogy, ornithology, herpetology, ichthyology, parasitology, malacology, and botany) and several biological disciplines (genetics, systematics, taxonomy, evolution, biogeography, ecotoxicology, radiation biology). However, the majority of his publications were about mammalian systematics and evolution.

Few would argue that some publications contribute more than others to scientific knowledge and are thus of higher quality. For this reason, citation counts have been proposed as another good indicator of scholarly impact and excellence in research, even though the rate at which papers accumulate citations varies across disciplines (Kelly and Jennions 2006). Robert's number of citations (16,624 in Web of Science and 15,853 in Google Scholar) is quite high for any published naturalist. His 10 most cited papers (see Table 8) have been cited 3,731 times, which makes up almost a quarter of his total number of citations.

Despite the alleged limitations of the measure (see above), RJB's h-index of 65 is considered quite high. Inspection of a sample of 18 evolutionists and ecologists ranked by Thompson Scientific as "highly cited" yielded a mean h-index of 45.0 with an 11.45 standard deviation (Kelly and Jennions 2006). Likewise, his m-value of 1.23 is considered high for his scientific discipline. For example, William D. Hamilton, Edward O. Wilson, and Stephen J. Gould all have m-values of less than 1.0, and no one would argue about their ranking as highly influential evolutionary biologists (Kelly and Jennions 2006). However, when compared with John Avise, an evolutionary biologist at the University of Georgia, and James Brown, an ecologist at the University of New Mexico (both in the National Academy of Sciences), RJB's h/m values are quite a bit lower (65/1.23 for RJB compared to 102/2.27 and 106/2.08 for Avise and Brown, respectively), although Robert published more papers than either one of them. Both Avise and Brown wrote numerous papers that provided broad overviews of phylogeography and macroecology, respectively, and they also published books. RJB's more synthetic papers (e.g., genetics species concept and ideas about chromosome evolution across groups) received considerable attention, but Avise and Brown reached a broader audience, thus enhancing exposure of their writings. RJBs h-index of 65 is virtually the same as that of James Patton's (h index of 63 and m value of 1.21) among current systematic mammalogists, as these two contemporaries and colleagues generally published in the same subject area, with many papers appearing in the *Journal of Mammalogy*.

The advantages that h-index and m-value are thought to have over other citation-based indices of counting publications is to favor those authors who produce a series of influential papers rather than those authors who either produce many papers that are soon forgotten or produce a few that are uncharacteristically influential (Kelly and Jennions 2006). However, while they are easily computable, the validity of using h-index and m-value has been questioned for some scientific fields because the rate at which papers accumulate citations varies across disciplines (Kelly and Jennions 2006). For example, comparisons among highly cited scientists have revealed that h-index values tend to be lower for evolutionary biologists and ecologists than for researchers in other fields (e.g., cell and biomedical scientists). Also, works in systematics often remain in use for decades, and longevity of impact may be a particularly valuable metric (McDade et al. 2011). For these reasons, in the fields of ecology and evolution the h index and associated values should be considered alongside other indices that rely on citation and publication count to assess research performance (Kelly and Jennions 2006).

RJB's thematic breadth is reflected in the 127 different publication outlets, including 97 different peer reviewed journals, and the broad subject matter coverage of his papers, ranging from contributions in systematics and taxonomy to ecotoxicology, radiation biology, and collection management. Publishing in many different journals and on many different subjects leads to fewer overlapping populations of scientists who cite the work, and hence higher growth potential for articles. Also, it has been demonstrated that the number of publications in leading journals can increase the visibility of a scientist's other papers, past and future (Acuna et al. 2012). Scientists who connect disciplinary communities or research fields also have a higher probability of exposure to alternative ways of thinking and behaving, and their linkages to otherwise disconnected researchers produces a broader disciplinary spectrum in their scientific work (Heinze and Bauer 2007). Evidence of all of these trends appears in RJB's scientific accomplishments.

According to Goodenough (1993), the goal of every scientist is the achievement of "eureka" moments, the ineffable experience of discovering some of the "truths" of nature, of finding the "unity of life." Because field work was a major component of his scientific work, and because of his intense interest in speciation, some of RJB's biggest "eureka" moments came in discovering taxa of mammals new to science. He described and named 18 new species and subspecies as well as 11 higher-level taxa. All of these are listed in his obituary (Genoways et al. 2018).

Examining hypothetical phylogenetic trees also produced "eureka" moments for him. One of his greatest joys was looking at the latest and greatest phylogenetic tree that was produced in his lab. In the early days, when phylogenies were deduced mentally and trees were drawn by hand, Robert could be a royal "pain in the ass." Sometimes it would take days to generate the synapomorphies and pathways for a phylogeny and another day or so to actually draw the tree. Once computer algorithms (i.e. PAUP) and graphic programs (i.e., MacDraw and later PowerPoint) became available, the student work load decreased somewhat—but Robert made up for it by redoubling his directives to "try this outgroup" or "add these to the ingroup"! The increase in data analyses unleashed the "Baker monster" in an entirely new dimension!

Robert's ability to distill or identify a publishable unit was uncanny. He could assess the importance of a dataset and calculate whether sufficient evidence was there to move the manuscript forward or if additional data were needed. Typically this calculation was made earlier in the experimental design state; therefore, most of his projects had a definitive termination point. Many of his graduate students (e.g., Robert Bradley, John Bickham, and Rodney Honeycutt, personal communication) think that this is one of the most important things that Robert taught his graduate students.

Many scientists reach their highest level of creativity when they face the need to improvise, when they lack adequate large infrastructure, and when they work with deficient funding (Medina 2006). We see this in RJB's career. In 1986, at the pinnacle of his publishing career, when his funding for chromosome research was winding down, he took a leave of absence from Texas Tech and spent a year with Rodney Honeycutt, one of his former Ph.D. students, at Harvard University learning some of the new techniques of molecular biology. He did this to prepare his students to be more "cutting edge," but also to open new vistas for his own research. This new learning opportunity opened the door for expanding his research horizons and led to a period of enormous publication activity in the 1990s and the first decade of the 20th century (see Table 1). He also learned to wear a sport coat and tie at Harvard!

Robert was often criticized, especially by some administrators during his annual evaluations, for publishing too many multiple authored papers and for publishing too many papers with his students. His response was always to note that he was in the business of education and that experience in completing the publication process in research was critical to a student's ultimate success. He was known to say "the research is never completed until the published reprint of the paper is in your hand." To him, one of the greatest accomplishments was to see a student complete the hard work of publishing a paper. He was certainly successful in his endeavor, as he published more than 100 papers with his students, and he continued to publish papers with many of them after they had left his program and established their own careers. For example, he appears on the author-line of 112 papers with four of his graduate students (Robert Bradley, Ronald Van Den Bussche, Meredith Hamilton, and Calvin Porter) published while they were students and after they had completed their doctoral programs. Interestingly, these four students were contemporaries from 1986 to 1990. They represented a synergistic group in an exceptionally collaborative phase of RJB's program.

Several aspects of Robert's career go against the dogma in the literature about creativity in scientists. For example, several studies have pointed out that individuals who receive doctorates from and/or are appointed to high prestige universities are more likely to be productive and win recognition than scientists at universities lower in prestige (Rushton 1988; Babu and Singh 1998). Clearly, Robert J. Baker did not fit that profile. Neither Oklahoma State nor the University of Arizona, at the time that Baker attended, was considered a prestigious university. Similarly, Texas Tech University (then known as Texas Technological College) lacked a Ph.D. program in biology and most of the other sciences. He joined a university better known for undergraduate education programs, and he spent his entire academic career there helping to build the university into a significant academic and research university that is now recognized among the top 100 research institutions in the United States. Today, Texas Tech is recognized as one of the leading centers for mammalogy in the country, and RJB played a primary role in creating that reputation (L. Bradley et al. 2005).

The literature on scientific publication in many fields shows a relationship between aging and research productivity in academic scientists, with some suggestion that, on average, scientists become less productive as they age (Levin and Stephan 1991). Whether productivity peaks early or builds slowly, much of the data reveals a decline in productivity for many scientists from the ages of 25 to 65 (Horner et al. 1986). Clearly, that was not the pattern for RJB, who was remarkably consistent in authorship of papers. In fact, some of his most productive years were between the ages of 58 and 68. Scientists who are productive and publish many papers tend to remain productive throughout their careers although some decrease their publication rates after middle age because of competing commitments. Some scientists as they age spend less time in research and a larger proportion of time in administrative positions. This was not the case for RJB.

Social scientists have estimated that the age at which highly cited scientists produce their most cited papers is between 37 and 50 years (Garfield 1981). Again, we see an exception in RJB. His two most highly cited papers about the genetic species concept in mammals (discussed above) appeared in 2001 and 2006 when he reached the age of 59 and 64, respectively. He remained highly productive (both in number of publications and citation counts) until his retirement in 2015. This followed the tragic death of his son Bobby in 2012, which had a dramatic impact on both Robert and his wife Laura, and the onset of major health challenges following years of fighting diabetes and heart problems.

Highly creative scientists often seem to experience a midlife transition from a more empirical to a more theoretical focus in publications (Jackson and Rushton 1986). Most scientists prefer research driven by theoretical concerns rather than social benefits, as scientific reputations are typically founded on contributions to ongoing scientific debates (Kelly and Jennions 2006). We see evidence of this early in RJB's career. In 1978, he and Hugh Genoways published a paper in the *Special Publications of the Philadelphia Academy of Sciences* (cited 150 times) describing the island biogeography of bats in the Caribbean Basin. This was the first comprehensive account of the distribution of bats across a large oceanic archipelago, and it formed the basis for numerous comparative analyses in island biogeography that continue today (Schmidly et al. 2017).

Beginning in 1979, at the age of 37 (a dozen years after receiving his doctoral degree), RJB began to publish papers about theoretical issues in systematics and evolution. The first of these publications emphasized systematics and chromosomal evolution in mammals, including three seminal papers published with one of his Ph.D. students, John Bickham, "Canalization model of chromosomal evolution" (published in 1979 in the *Bulletin of the Carnegie Museum of Natural History* and cited 153 times), "Karyotypic megaevolution model of chromosomal evolution" (1980 in *Systematic Zoology* with 217 citations), and "Monobrachial model of chromosomal speciation" (1986 in *Proceedings of the National Academy of Science* with 287 citations).

These early theoretical papers were followed by numerous contributions refuting the dogma of deme size models of chromosomal evolution. These papers included an article published in *Cytogenetics and Cell Genetics* with Michael Haiduk, Lynn Robbins, and Duane Schlitter (1981, "Chromosomal evolution in African megachiroptera: G- and C-band assessments of the magnitude of change in similar standard karyotypes") that was cited 32 times, a paper published in *Systematic Zoology* with Ben Koop and Michael Haiduk (1983, "Resolving systematic relationships with G-bands: a study of five genera of South American cricetine rodents") that was cited 78 times, and an article in *Evolution* with Ronald Chesser (1986, "On factors affecting the fixation of chromosomal arrangements and neutral genes") that was cited 44 times. At about the same time another series of papers followed that addressed computer modeling of chromosomal and genetic evolution. These included a paper with Ronald Chesser, Ben Koop, and R. A. Hoyt in the journal *Genetica* (1983, "Adaptive nature of chromosomal rearrangements: differential fitness in pocket gophers") that was cited 35 times, a paper in *Systematic Zoology* (1984, "Karyotypic megaevolution by any other name: a response to Marks") that was cited 12 times, and a paper published in *Current Mammalogy* (1987, "Role of chromosomal banding patterns in understanding mammalian evolution") that was cited 96 times. He also continued to publish papers proposing classifications for phyllostomid bats, including a paper published in *Systematic Zoology* in 1989 that has been cited 111 times. In that same year he published an article in the journal *Evolution* (cited 119 times) concerning hybrid zones between genetically distinct populations. At the time, it was considered the premier study of that subject.

In the 1990s, RJB began publishing papers about gene conversion and genome evolution and organization. The most highly cited of these papers ("Evidence for biased gene conversion concerted evolution in ribosomal RNA") was published in 1991 with David Hillis, Craig Moritz, and Calvin Porter in *Science* and was cited 392 times. He published several papers on genome evolution and organization, the most cited of which was a paper published in *Chromosoma* in 1990 and written with nine other authors, "Distribution of non-telomeric sites of the $(TTAGGG)_n$ telomeric sequence in vertebrate chromosomes," that received 586 citations.

In 1994, RJB initiated his collaborative work at Chernobyl, resulting in 40 publications about the impact of low-level radiation on mammals. Overall, this research showed that current radiation doses near Chernobyl were not sufficient to yield high mutation rates or prevent population maintenance, which was contrary to the scientific dogma at that time (Genoways et al. 2018). Initially, however, RJB's Chernobyl research resulted in a publication in *Nature* in 1996 about levels of genetic change in rodents that was featured on the cover of the magazine and received 87 citations. Unfortunately, that paper had to be retracted because of bad data (see Genoways et al. 2018 for a full discussion), and a 1997 paper in the same journal included the corrected data. The lack of any significant mutation rate, documented in the retracted paper, was met with opposition by several groups wanting to use the Chernobyl accident as an activist campaign against nuclear energy. Robert, with his colleague Ronald Chesser, eventually responded with an article in 2000 in the journal *Environmental Toxicology and Chemistry* (cited 67 times) suggesting that protection from human impact provided by the exclusion zone was actually beneficial to wildlife and an unintended consequence of the accident.

In 2001 and 2006, Robert, along with his former student and subsequent colleague Robert Bradley, proposed the genetic species concept for mammals in two seminal papers ("A test of the genetic species concept…" and "Speciation in mammals and the genetic species concept") that were published in the *Journal of Mammalogy* and have been cited 597 and 642 times, respectively. These are the two most highly cited papers for which RJB was on the author-line.

In 2014, toward the end of his career, RJB joined with several of his colleagues and students to produce two important papers in the area of collection management. These papers (Baker at al. 2014 and R. Bradley et al. 2014) addressed the value of natural history collections, issues regarding their long-term growth and care, and the cost of curation and long-term care of mammal specimens in natural history collections. These papers were among the most comprehensive ever published about this subject.

RJB conducted his work in what has been termed the lab-field border of biology (see Kohler 2002 for a discussion), and he worked within the paradigm of evolution. While much of his fieldwork involved picking field sites that could provide "natural experiments" to test evolutionary theory, his work in the lab focused on the application of modern scientific technological advances to test hypotheses based upon his field data. His creativity appeared early and was evident in every decade of his career. He was an early pioneer in the adoption of karyotypes and the study of chromosomes for use as population markers to determine species distinction and interpret phylogenetic relationships in mammals, particularly bats. One of his earliest papers, "Karyotypes and karyotypic variation in North American vespertilionid bats," published in the *Journal of Mammalogy* in 1967, remains on the list of his most cited papers with 180 citations (see Table 8).

At critical junctions in his career, he adopted new pioneering techniques to keep his lab on the "cutting edge" of scientific work about important questions in systematics and evolution. In the decade of the 1970s, he advanced his chromosome research to include the use of in situ hybridization and G- and C-banding techniques. This resulted in several research papers in high-quality journals such as *Systematic Zoology* (e.g., 1979 with John Patton, "Chromosomal homology and evolution of phyllostomatoid bats" that received 117 citations) and in the journal *Evolution* (e.g., 1978 with Ira Greenbaum and Paul Ramsey, "Chromosomal evolution and the mode of speciation in three species of *Peromyscus"* that was cited 60 times). Keeping up with advances in technology, especially in such a dynamic field as genetics, is one of the most difficult challenges that anyone can have in their career, and Robert was obviously very good at it.

Also in the 1970s, he incorporated starch gel electrophoresis to produce several important papers that contributed to his growing reputation in science. These articles were published in *Evolution* (1975 with Robert Selander, Donald Kauffman, and Stephen Williams, "Genic and chromosomal differentiation in pocket gophers of the *Geomys bursarius* group" that received 84 citations), *Systematic Zoology* (1976 with Ira Greenbaum, "Evolutionary relationships in *Macrotus*…" that was cited 57 times), and *Comparative Biochemical Physiology* (1976 with Donald Straney, Michael Smith, and Ira Greenbaum, "Biochemical variation and genic similarity of *Myotis velifer* and *Macrotus californicus*" that received 12 citations).

In 1986, he took a one-year sabbatical from Texas Tech to work at Harvard with one of his former students, Rodney Honeycutt, to learn some of the techniques of modern molecular biology. This move helped to further broaden his scientific repertoire, which began to show up in his publication record in the 1990s; this was one of the most productive periods of his career. Significant papers from this era included topics such as in situ hybridization, restriction enzyme mapping, and eventually DNA sequences. Some of his most important papers were published in the journals *Evolution* (1989 with Scott Davis, Robert Bradley, Meredith Hamilton, and Ronald Van Den Bussche, "Ribosomal DNA, mitochrondrial DNA, chromosomal and allozymic studies on a contact zone in the pocket gopher, *Geomys*" that was cited 119 times), *Chromosoma* (1990 with Meredith Hamilton and Rodney Honeycutt, "Intragenomic movement, sequence amplification and concerted evolution in satellite DNA in harvest mice, *Reithrodontomys* …" that received 70 citations), and a special volume published by the American Museum of Natural History to honor the contributions of Karl F. Koopman (1991 with Rodney Honeycutt and Ronald Van Den Bussche, "Examination of monophyly of bats: restriction map of the ribosomal DNA cistron" that has been cited 32 times).

Systematic biologists increasingly contribute knowledge in nontraditional ways that were previously ignored in the broader scientific arena (see McDade et al. 2011). For example, they submit data to central repositories from which data can be retrieved and used by others (e.g. GenBank), and through their field and curatorial work in collections help to build basic infrastructure to study biodiversity. We see evidence of these contributions through RBJ's work. As described in his obituary (Genoways et al. 2018), he was a tireless collector of scientific specimens and associated ancillary data (tissues, karyotypes, etc.). At the time that Baker joined the biology faculty at TTU, the mammal collection contained about 5,000 specimens; today, the collection numbers more than 140,000 specimens. While other mammalogists who worked at Texas Tech and their students contributed to the growth of the mammal collection, RJB certainly played a prominent role not only in contributing specimens but also by securing institutional and outside funding to provide critically needed infrastructure to support the collections (L. Bradley et al. 2005).

Similarly, he worked on interdisciplinary and transdisciplinary research projects, using bioinformatics and genomics, to link heretofore disparate fields of science to address broader societal problems associated with natural resource management issues. For example, he and his colleague, Nick Parker, joined with one of us (DJS) in the use of bioinformatics as a major tool for planning how the Texas Parks and Wildlife Department might address conservation and recreation issues in the State in the 21st century (see Schmidly et al. 2002). Unfortunately, the results of this work were completely ignored by Texas politicians and as a result the park system is dealing with many problems today. This really rankled Baker, who told one of us (DJS) that he never wanted to be involved again with a project in which good science was ignored in favor of bad politics!

During the last few years of his research career, Robert was obsessed with being able to use genomics and next generation sequencing methods to address research questions in the context of phyllostomid bat evolution and the genetic architecture of chromosomes. Although his untimely death precluded the fruition of his dream, he did see some projects published, including a paper published in the journal *Molecular Ecology* (2012 with 10 different authors, "Microbiome analysis among bats describes influences of host phylogeny, life history, physiology and geography" with 70 citations), a second paper in the journal *PLoS ONE* (2014 with nine authors, "Dietary and flight energetic adaptations in a salivary gland transcriptome of an insectivorous bat" with six citations), and a third paper in *Frontiers in Ecology and Evolution* (2015 with Caleb Phillips, "Secretory gene recruitments in vampire bat salivary adaptation and potential convergences with sanguivorous leeches" with seven citations).

Some scientists make huge contributions through their mentoring of students and generosity with ideas, skills, and time (Kelly and Jennions 2006). Although RJB made major scientific accomplishments through his research and publications, his greatest impact may well be through the students (undergraduate and graduate) that he trained. As John Steinbeck once said, "I have come to believe that a great teacher is a great artist, and that there are as few as there are other great artists. Teaching might even be the greatest of the arts since the medium is the human mind and spirit." (Steinbeck 2003).

The supervision of Ph.D. students, who have projects related to their supervisor's research, has been found to have an independent effect on scientific productivity. Graduate students are regarded as an important resource in research activities. They do much of the time-consuming data collection and data analysis work, and as supervisors, faculty may become co-authors of publications with graduate students. Recent studies have shown that more productive scientists are more than twice as likely to have large groups of graduate students than are less productive scientists. Similarly, a positive correlation has been demonstrated between the number of graduate students faculty supervise and their productivity (Kyrik and Smeby 1994).

Although it is difficult to obtain comparable numbers, it seems doubtful that any mammalogist has produced more undergraduate and graduate students and post-docs (130) who published on mammals than RJB. More than three-quarters of his Ph.D. students hold academic appointments at American and international universities and continue to publish work on mammals. The most effective graduate supervisors tend to be dedicated, productive researchers who have achieved eminence in their own fields, and they work closely with their students, often in the form of collaboration on published research (Morales et al. 2017). Through close personal interaction and collaboration, an eminent graduate supervisor models and transmits to the student an insider's tacit knowledge of how science is pursued and what it takes to be successful in scientific research (Schwartz no date). Clearly, RJB exhibited all of these attributes in his work with students.

Participation of women in the field-oriented vertebrate biological sciences was almost non-existent prior to 1960, and mammalogy certainly followed this trend. The reasons for this are myriad—not many women in any of the sciences, family obligations, belief that women could not withstand the rigors of domestic and international fieldwork, lack of opportunities, and the difficulty of breaking through in a male-dominated area of study. However, beginning in the late 1960s and early 1970s, women were entering these fields, including mammalogy (Genoways and Freeman 2001). RJB did not start this trend, but as graduate advisor he certainly accepted and supported women graduate students. His first female graduate student was Margaret A. O'Connell, who entered his program in 1973, completing a MS in 1975 and a Ph.D. in 1982. Her graduate work included rigorous fieldwork in West Texas and New Mexico and in Venezuela. She is currently Professor in the Department of Biology at Eastern Washington University. Several other "pioneering" women received graduate degrees during the 1970's and 1980's, including MS students Rebecca A. Bass, Laurie Erickson, Anette Johnson, Karen McBee, Kim Nelson, and Hae Kuyng Lee, and Ph.D. student Meredith J. Hamilton. In total, 22 of RJB's MS graduates (46%), 18 of his Ph.D. graduate students (36%), and five (50%) of his post-doctoral associates were women. In later years, more women were probably attracted to mammalogy as the laboratory phases of the work came to dominate studies in the discipline. However, all of RJB's female students, and in fact all his students' incorporated strong field-oriented elements as well as the laboratory studies.

Robert's graduate students also were very successful in receiving awards for their research work. Between 1972 and 2015, the American Society of Mammalogists (ASM) granted 45 Shadle fellowships, recognizing accomplishments in mammalogy by a graduate student, and six of these went to RJB students (William Blier in 1972, Ira Greenbaum in 1977, Craig Hood in 1984, Ronald Van Den Bussche in 1988, Robert Bradley in 1990, and Sergio Solari in 2005). Two of his students, Sergio Solari (2006) and Peter Larsen (2010) also won ASM Fellowships, the highest student award given by the society (first awarded in 2001).

It was one of the disappointments of his career that Robert was not admitted to the National Academy of Sciences (NAS). For most of his years at TTU, the university did not have any faculty members in any of the national academies, and Robert wanted to be the first. Two of us (DJS and RDB) made attempts to promote his candidacy but we were not successful for reasons that were never divulged. Our opinion was that without anyone inside the academy to promote his cause that it would be difficult to achieve. Today, TTU has faculty members in the National Academy of Engineers and recently hired its first member of the NAS (Texas Monthly 2018). The institution still lacks a "home-grown" member of the NAS.

RJB's Personality

What personality traits accounted for RJB's prodigious productivity? If you knew him well, and understood his personality, it is not difficult to ascertain why he was so successful. And, from the literature (see below) it becomes evident that his profile is not unlike that of many other highly productive and creative scientists.

Using the Disc Model of Human Behavior (Rohm 2005), RJB would be characterized as having a "high D personality style" (dominant, direct, demanding, decisive, determined, doer). High Ds are a powerful group of people who are made to be world-changers with a vision (Rohm 2005). They are known to be intense, knowing two speeds in life—zero and full throttle… mostly full throttle. They communicate in a very direct manner, saying what they mean and meaning what they say. They decide quickly—almost effortlessly and with confidence, and they like control and choices. They would rather do something and take a risk versus doing nothing at all. They are results-oriented and are willing to overcome challenges as necessary to meet their goals. D's are passionate, and they can be tremendously loyal. While they can be seen as being all about "getting-it-done," they also have feelings and personal needs that may not be apparent. Those who work with a high D learn not to take everything that a D does or says personally—especially when a D is on-task. They are wired to achieve their goals, but it is amazing how much a D type person can relax after checking off the task at hand. Until then, they are focused and determined. Even with an orientation toward task, D types can be very caring. They often express their feelings by doing something for others—often behind the scenes.

Several studies have attempted to explore the personality disposition in the creativity of university scientists who produce superior scientific work (Rushton et al. 1986; Parker et al. 2010). Many, like RJB, seem to exhibit classic type A behavior (aggressive, incessantly struggling, time oriented, hostile when frustrated). Other factors identified that influence research productivity and distinguish creative individuals from their peers are: a high level of initiative and radical imagination; energy, curiosity, and motivation; a strong personality and well-articulated self-concept; intelligence and learning capability; professional commitment and preparedness to take risks; persistence in situations of failure; cognitively complex with a particular thinking style; fortunate to enjoy a supportive institutional context; and distinctive goal orientations and concerns for advancement. RJB exhibited all of these traits, and with his type A and high D personality styles, he was driven to set high standards for himself and his students.

Variations, of course, can be expected but anyone who knew RJB well would recognize these traits both in how he perceived his work and his life. He was more than willing to admit to his "type A" personality and he seemed to try to live daily by his motto "anything worth doing is worth overdoing." To those who did not know him well and could not appreciate his strong personality and put his forthrightness into context, he could come across as intimidating when, in fact, he never intended to convey that impression. As a type 1 diabetic, he sensed that he had a limited amount of time to accomplish what he wanted in life (see his obituary for more detail about how this disease impacted his life; also see Baker 2005). He moved at top speed, especially when he was on a field trip. He had incredible drive and talent. Whenever he decided to act, he expected everyone to get on board. One of his favorite mantras came from General George Patton, "Lead, follow, or get the hell out of the way."

He also knew how to relax and have fun, which contributed to his creativity. He loved his ranch and being outdoors on his property, and he loved to train dogs and work with cattle. Hunting was a favorite pastime, and some of his best ideas came from discussing science with colleagues while on duck, pheasant, deer, or elk hunting excursions. He also loved his family, including his children April and Bobby, Laura, his wife of 39 years, and his grandchildren. The greatest tragedy of his life was the death of his son at the young age of 26. This affected both him and Laura in profound ways, both personally and professionally, from which they never fully recovered. More about RJB's personality and life can be found in his published obituary (Genoways et al. 2018).

A Personal Note of Appreciation

The purpose of this article was not to portray RJB as a genius or a saint, for he was not. Like most of us he had his demons and issues. He could be "quick tempered" and "go off" at a moment's notice, especially if he was in the midst of an intense productive period or under stress. There could be considerable lightning and thunder, but usually the mood quickly shifted to a gentle rain. But he had many good qualities—he enjoyed life, both professionally and personally—and he loved his friends, both professional and personal. We wish we had a nickel for every occasion that he bought flowers and sent them to someone he thought he may have offended or who took the time to help him out.

He especially enjoyed the outdoors and fieldwork. He loved the land and all of its products. In many ways, he was happiest while in the field, collecting bats, rodents, or other critters, but he also loved his work in the lab and he had a passion for collections and scientific databases. He adored his family, with all his heart, and his golden retrievers. He was equally at home on a farm or ranch, working cattle and raising crops, fishing, hunting for waterfowl, game birds, and large mammals. And, he enjoyed sharing these passions with his friends.

His record of achievement includes not only the sheer quantity of publication and citation counts, but also training and mentoring students to effectively communicate and work with other colleagues to address a broader work spectrum in biology. By any reasonable definition and criteria, he was a productive, creative scientist and one of the most successful mammalogists ever to live. He left a strong legacy in mammalogy with the many students that he mentored that continue to work in the field. In all of these regards, he will be remembered and missed.

No greater accolade can be bestowed on a professor than that from his students. One of RJB's doctoral students, Rodney Honeycutt (personal communication to DJS), provided these comments in a letter of appreciation that was written to RJB on the occasion of his retirement from Texas Tech in 2015:

> "Robert, I thought this day would never come. I guess I always assumed you were invincible in terms of never actually standing down from your position at Texas Tech University. Perhaps it is just my way of being sad for the fact that all of us are getting older and beginning to realize that we are fast approaching the twilight of our careers.
>
> Throughout my 31 years as a university professor, I truly believe that one's greatest legacy is the contribution made to the next generation of scientists. Remembrance through publications and science citation indices are ephemeral, and as I am constantly reminded by my undergraduates, even great scientists are seldom recollected, unless their names will appear on impending exams. Although you have amassed an exceedingly impressive academic record, I feel that the best memories of you will be in the hearts and minds of all gathered to celebrate your retirement. Clearly, Robert, you are both loved and respected.
>
> Each of us [your students] came to Texas Tech as unfinished canvases, exposing promising outlines and many imperfections. In essence, we were like Michelangelo's unfinished sculptures struggling to become free from the marble. I remember talking with you for the first time about coming to Texas Tech and working in your program. You said, "If you are not already a good scientist, I cannot make you one. All I can do is knock off the rough edges." Well, I had a hell of a lot of rough edges, and you did not spare the hammer and chisel.
>
> When I was a postdoc with M. J. D. White in Australia, he lamented about his lack of ability to attract outstanding graduate students during his tenure as Professor of Genetics at Melbourne University. In contrast, Michael said that Spencer 'Spinny' Smith-White, a botanist at the Sydney University, was the major advisor for many of the prominent geneticists in Australia at that time. This was despite the fact that 'Spinny' was neither a Fellow of the Royal Society nor a foreign member of the National Academy of Science in the United States. Michael was both. After meeting 'Spinny,' it became clear to me why he was such a successful mentor. He created an academic atmosphere that encouraged his students to be independent, creative, argumentative, and enthusiastic. Many of his students worked on projects far from 'Spinny's' interest, but all were first class thinkers and scientists.
>
> Robert, I am unsure as to how much planning went into the establishment of your program at Texas Tech, but to me the program definitely mirrored 'Spinny's' program in Australia. You always demonstrated an uncanny ability to get the best from us without micromanaging. You allowed us to grow and to take a leadership role in the program. We learned how to work as a team, how to both present and defend our research, and how to become active members of our discipline. I can tell you that many of my junior professors would benefit from exposure to Robert Baker's program. It taught me how to be self-sufficient as a scientist, and I am personally grateful for your support, encouragement, and guidance.
>
> Finally, Robert, one of the greatest honors I received is when you took your sabbatical with me at Harvard. It was a role reversal, and I appreciate the humble way you approached learning new things. You even got to see me throw a Baker temper tantrum. The apple does not fall far from the tree.
>
> Thanks, Robert, for being my mentor and friend. You changed my life, and I will always have fond memories of my time in the Baker program. In fact, I have your picture with a bat net that stands behind my desk. When I look at that photo, I wait for that chisel to knock off another rough edge.
>
> I remember the lifelong friends and colleagues that I made at Texas Tech. We were and are a family, and you are definitely our academic father. Have a great retirement, Robert!
>
> Love, Rodney"

Another one of Robert's Ph.D. students, John Bickham, made these remarks in his encomium statement about Robert, which is germane to his remarkable talent:

> "A great thing about working in the field of science is that you get to meet many brilliant people. Some are humble, others are not. Some are fun to be with, and to work with, and others are not. Some you want to be friends with, and others you don't. Robert was definitely one that you wanted to be around! Like all successful scientists, Robert had a brilliant mind and was a deep thinker. But you might not detect it in casual conversation because he had a very down-to-earth way of talking to people. But the sharpness of his mind became apparent when you worked together on papers, or if you challenged him to any kind of serious discussion from politics to poetry. But that is not what made him great in my view. Rather it was his intelligence in combination with his tireless drive, outstanding leadership ability, and his personal charisma that set him apart from many of the greats of our field of science. In mammalogy, he will always be a legendary figure. With his passing, he takes his place among the legends, among the people on whose shoulders we stand."

Finally, there is this testimonial from Amy Bickham Baird, an undergraduate student who worked in Robert's lab:

> "When I decided to go to Texas Tech for my bachelor's degree, Robert became my mentor. Robert treated me like his graduate students, assigning me independent research projects and requiring me to present my results at local, national, and international meetings. At first, I was terrified of public speaking, but Robert knew that challenging me to do it would be valuable for my future. Of course, he was right, and I am so thankful that he pushed me out of my comfort zone. As a sophomore, he let me travel to Chernobyl to participate in a conference and see my research sites first-hand. I did not know how unique my undergraduate research experience was at the time, I just knew that I loved it. I ended up publishing 4 papers and giving about 10 talks at meetings in my 3 years at Tech. No other mentor could get that kind of productivity from an undergraduate!"

Amy went on to complete her Ph.D. at the University of Texas, and is currently a tenured faculty member at the University of Houston Downtown Campus.

CONCLUSION

Robert's publication record along with the citations of his work speaks for itself. By any definition he was prolific and creative. Although evaluating his mentoring of graduate students was more subjective, the sheer volume of students and their placement in academic institutions attest to arguably his most significant long-term influence on biological science and on mammalogy.

Robert clearly was one of the most influential mammalogists of the latter half of the 20th century and the early part of the 21st century. His cadre of students and extended program seeded through these students, who became established at other institutions, led the approach to evolution and systematics into the 21st century and were instrumental in incorporating the latest laboratory techniques in genetics, adding arrow after arrow of evidence to the systematist's quiver. Starting with karyotyping and chromosome banding, through the heyday of protein electrophoresis, restriction enzyme mapping, initial forays into DNA sequencing, to incorporation of a genomic approach, Robert was at the forefront throughout his career. The only other person with similar impact during this same time period would be James L. Patton of the Museum of Vertebrate Zoology at the University of California-Berkeley, who was a fellow Ph.D. student, colleague, and friend of Robert's. Both became giants in the field of mammalogy and systematic biology.

We close our tome to Robert James Baker with a poem about both life and death. Robert enjoyed poetry (his favorite poet was Nikki Giovanni, for whom he named a new species of bat, *Micronycteris giovanniae*) and to us it represents a fitting tribute to a friend that we loved and respected both in life and death. The poem, shown below, was written in 1903 by Edmund Vance Cooke. One of us (DJS) showed this poem to Robert, and he agreed that it was pertinent. We believe that he would appreciate having it included in a volume honoring his work.

"How Did You Die?"

Did you tackle that trouble that came your way
With a resolute heart and cheerful?
Or hide your face from the light of day
With a craven soul and fearful?
Oh, a trouble's a ton, or a trouble's an ounce,
Or a trouble is what you make it.
And it isn't the fact that you're hurt that counts
But only how did you take it?

You are beaten to earth? Well, well, what's that?
Come up with a smiling face,
It's nothing against you to fall down flat,
But to lie there—that's disgrace.
The harder you're thrown, why the higher you bounce;
Be proud of your blackened eye!
It isn't the fact that you're licked that counts;
It's how did your fight and why?

And though you be done to death, what then?
If you battled the best you could;
If you played your part in the world of men,
Why, the critic will call it good,
Death comes with a crawl, or comes with a pounce,
And whether he's slow or spry
It isn't the fact that you're dead that counts
But only, how did you die?

This poem says volumes about RJB and the way he lived life. He lived with passion, courage, and intensity. He fought a terrible disease for most of his life, but refused to let it define him or bring him down. He committed his life to the good work of science and efforts to better understand the natural world. He died with dignity, and we believe knowing that he had done his best! To us he was not only a good friend but a valued colleague and inspiring mentor.

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Addresses of authors:

DAVID J. SCHMIDLY

Department of Biology
University of New Mexico
Albuquerque, NM 87131 USA
djschmidly@gmail.com

ROBERT D. BRADLEY

Department of Biological Sciences and the Museum
Texas Tech University
Lubbock, TX 79409 USA
robert.bradley@ttu.edu

EMMA K. ROBERTS

Department of Biological Sciences
Texas Tech University
Lubbock, TX 79409 USA
emma.k.roberts@ttu.edu

LISA C. BRADLEY

Natural Science Research Laboratory
Museum of Texas Tech University
Lubbock, TX 79409 USA
lisa.bradley@ttu.edu

HUGH H. GENOWAYS

University of Nebraska State Museum
University of Nebraska-Lincoln
Lincoln, NE 68588 USA
h.h.genoways@gmail.com

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