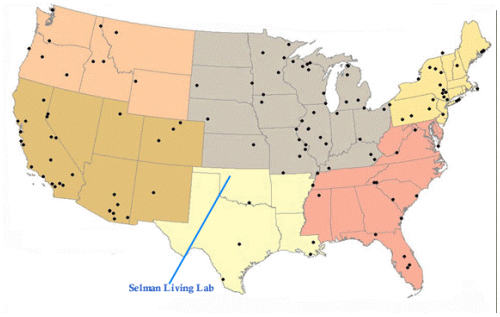
Selman Living Laboratory

Selman Living Laboratory Establishment: Located in northwestern Oklahoma 16 km SW of Freedom, Oklahoma, The University of Central Oklahoma's (UCO) Selman Living Laboratory (SLL), occupies 129.5 ha of mixed-grass-gypsum prairie in Woodward County. The SLL was part of the historic Selman Ranch, homesteaded in the early 1900s. Prior to that, it served as grazing lands, leased from Cherokee Native Americans, by large cattle companies including one from England. In 1998, Betty Selman was concerned about preserving the caves, springs, creeks and grasslands on the ranch for education and research. A grant in 1998 allowed the University of Central Oklahoma to purchase the biologically important Selman Cave System. Mrs. Selman donated 129.5 ha, an access road, and several other caves to UCO. More recently she donated 4 acres for astronomy facilities. This is the SLL.



Description of Education and Research Areas

Environmentally, the SLL is considerably different from all other outdoor living laboratories and field stations in North America. It offers scientists and educational groups a unique and different ecological experience upon which to frame both short-term experiments and long term monitoring projects.

Climate: Climatically, the SLL exists in a semiarid region with a mean annual temperature of 14.4 C and a mean annual precipitation of 60.5 mm. Between 1950 and 1995 there were 31 tornadoes in the area.

Geology: The SLL is located in the Cimarron Gypsum Hills which is topographically dominated by rolling hills and plains (Lardie, 1982). Geologically, this is an area of escarpments, which have developed on interbedded Permian gypsum and shales. Permian Redbed deposits of red sandstones, siltstone, gypsum, and shale are locally common. Common geological formations are the Cloud Chief, Garber Sandstone, Hennessey Shale, Blaine, and Dog Creek. Caverns and sinkholes present on the SLL have resulted from ground water flow dissolving away portions of the gypsum. Biologically, the topography and geology of the area contribute to a unique ecosystem. For example, Lardie (1978) indicated that the Cimarron Gypsum Hills are unique from a herpetological aspect in that certain western and eastern species may be more or less restricted to these hills in Oklahoma. In northwestern Oklahoma, the western diamondback rattlesnake is most commonly found in the gypsum hills (Lardie and Black, 1981).

Soils: The two major soil associations found on the SLL are the St. Paul-Carey-Woodward Association with gently sloping loamy redbeds and the Vernon-Cottonwood Association of dissected gypsum plains. The three main soil types in these associations are the Vernon-Cottonwood Complex, the Vernon Clay Loam of 5-12% slope, and the Lincoln Soils (Woodward County Soil Survey, 1963). These soils have developed under native grasses and in gypsum clay areas. Exposed gypsum rock exists in many areas.

Surface & Subsurface Hydrology: Salt Creek courses 1.2 km diagonally across the SLL. It is confluent with Trader Creek, which drains into the Cimarron River. Salt Creek supports a wetland riparian habitat. Underground springs surface on the SLL and drain to Salt Creek, as do streams from caves. Water in Salt Creek and that exiting the springs and caves has very high total dissolved solids (1825 ppm) due to calcium hardness (1455 ppm $CaCO_3$). Water quality information for the Selman Cave System exists in Black's (1971) cave biota publication.

Flora: The SLL is located in the Mixed-grass Plains region of Oklahoma, which is a transition area from the tall grass prairies of the east to the short grass high plains to the west. Over 200 plant species have been identified on the site. Both sod and bunchgrass forms occur depending on local edaphic conditions. Common grasses include little bluestem, silver beardgrass, bluejoint, Indian grass, switch grass, grama grasses, and buffalo grass. Sandy areas include such shrubs as sand sage, sand plum, and sumacs. Trees located on the site include hackberries, elms, tamarisk, cottonwood, chittamwood, and willow. Prickly pear and small mammalaria cacti, a variety of mosses, ferns, and liverworts, as well as a large variety of flowering annuals and perennials occur. Wetland forms include cattails, rushes, sedges, watercress and various algae. Because this ranch has been grazed for many years the opportunity exists to monitor secondary succession of a grazed mixed grass plains back to a more natural condition. The reclamation and preservation of native grasslands is a vital and important conservation concern of the present worldwide biodiversity preservation movement.

Fauna: Although gypsum caves are not as biologically rich in diversity as eastern limestone caves, many species of wildlife use them for shelter and overwintering sites. The Selman Cave System contains the largest (approximately 70,000) known hibernating colony of the cave myotis in Oklahoma. Few studies exist documenting what forms of biota actually occur in gypsum caves (Black, 1971). Surface forms include porcupines, mule deer, woodrats, grasshopper mice, pocket mice, kangaroo rats, deer mice, coyotes, foxes, skunks, jackrabbits, cottontail rabbits, badgers, raccoons, rattlesnakes, king snakes, garter snakes, night snakes, horned lizards, collared lizards, six lined racerunners, tiger salamanders, toads, frogs, various minnows, hawks, grassland bird species, bluebirds, great blue herons, prairie chickens, owls, scorpions, spiders, beetles, ants, bees, wasps and other insects and invertebrates.

Archeology/Paleontology: Surface artifacts, scrapers and projectile points, found on the SLL suggest it might be important archeologically. The significant 10,500-year-old Cooper Site located to the west in Harper County is where nomadic Folsom hunter-gathers drove a herd of 20 bison into a gully and used spears tipped with fluted points to kill them. Northwestern Oklahoma was seemingly an important part of their hunting territory .The Burnham site and other important archeological sites are located near the SLL. The reported remains of extinct wolves, bison, bear and giant-ground sloth bones from the Selman Cave System and nearby locales suggest the SLL is an important site for biologists interested in the reconstruction of past flora and fauna assemblages and the evolution of ecosystems through time.

Support: Many individuals, corporations, community groups, and government agencies believe in the concept of the SLL and have donated time, money, equipment, etc.: Mrs. Betty Selman; The Aldridge Foundation; Steve Maier, Northwestern Oklahoma State University; Mr. Paul Barby; Vice President Coffey, Oklahoma City University; Ms. Cheryl Swanson, Leonardo Learning Center; The University of Central Oklahoma Foundation; Mrs. Doris Selman; Oklahoma City Grotto; Mr. Ron Sutton & Ms. Mel Hickman, Okla. Department Wildlife. Conservation; Chris Christopher, Northwest Electric Co.; Mr. Jim Stevens, Evans Electric OKC; Oklahoma Department of Transportation; Mike Caywood and Alabaster

Caverns State Park; Adventure Scouts, Woodward; David Harbor, Great Plains Instrument Comp; Freedom Call; Mr. and Mrs. Vic Burnham; US Fish & Wildlife. Service; Woodward Co. Rural Water Dist.; Alva Concrete; Mr. Gene Wells, Mr. Phil Cloud & Family; Nature Conservancy; Wes Nixon; Mr. Jay Carnes, Ms. Gwen Fholer; Evans & Associates; Mr. Jim Powers; Mr. Ralph Triplett; Mr. Darren Hughes, Mr.Boyd Hughes, Woodward County Rural Water District; Mr. Scott Christenson, U. S. Geological Survey; The Freedom Call Newspaper, Biology Faculty, University of Central Oklahoma

Significant Research & Education Site: The SLL has been used for over 25 years for classes (hundreds of students) in Ecology, Mammalogy, Ornithology, Plant Taxonomy, Freshwater Biology, Entomology, Mycology, and Herpetology. This past year, over 100 individuals have visited the astronomy site for star shows. Undergraduate and graduate research at the site includes: monitoring bat populations, cave ecology, bat physiology studies, entomology studies, plant taxonomy projects, GIS layering of vegetation, wetland ecology, water quality studies, microbiological studies, and astronomy.

Significant biological research has dealt with bats (Kunz, 1973; Caire, 1988; Caire and Thies, 1988) batflies (Caire, Hornuff and Ports, 1981; Caire and Hornuff, 1982; Caire, Hornuff and Shorabi, 1985; Caire and Hornuff, 1986), the external parasites of the cave myotis (Veal, 1983), the external bacteria of bats (Zanowiak, Harrison and Caire, 1993), physiological studies of kidneys of hibernating bats (Caire, Haines and McMenna, 1982; Shackelford and Caire, 1993), hantavirus survey (Nesbitt et. al., 2001); electrophoretic investigations of albumin levels in hibernating and active bats (Wakeham, Bogenshutz and Caire, 1988), normal blood values of bats (Caire, Cox, and Levesy, 1981), and extinct wolves and bears (Black and Best, 1972). Caves a few miles north have yielded remains of giant ground sloths. The SLL caves have served an important educational role as the site of several masters theses (Veal, 1983; Wakeham, 1986; Zanowiak, 1987; Loucks, 1996) and data collection sites for several Ph.D. dissertations (Zeve, 1959; Kunz, 1973; Overal, 1980). Currently it is a study site of a MS thesis documenting what plants occur at the SLL (over 200 species identified) and a comparison of plant communities occurring on the gypsum outcrops, grasslands, riparian areas, springs, and other habitats. Research is also underway to describe a habitat that has not been characterized or described in ecological literature - the troglozone, a three-dimensional zone surrounding cave entrances.

Detailed Description of the Biological Significance of the SLL: Globally, the combination of mixed-grass prairies on gypsum outcrops, gypsum caves and the associated springs and wetlands in gypsum areas have not been the subject of long term biological studies anywhere in the world. A few studies have documented floral aspects of gypsum communities in Spain, Mexico, Africa and Australia (Parsons, 1976) but little else has been done. In North America, the fact that the SLL is situated in the gypsum-hills mixed-grass prairie and has extensive gypsum caves sets it apart from all other biological field stations. It is the only field station established in North America to study the biota of such an ecosystem. None of the NSF-Sponsored Long Term Ecological Research Programs (LTER) are monitoring this type of ecosystem. The adjacent Figure reveals locations of the members of the Organization of Biological Field Stations (OBFS). Establishment of the SLL filled a definite geographical

and biological gap that existed among field stations. The nearest field station is about 300 km away.

At the state level, few studies have involved the Oklahoma gypsum hills (Barber, 1979). The majority of the literature referencing this region of Oklahoma is descriptive simply providing the provenience of a particular species rather than detailing the ecosystem's nature and its synergistic interactions. Likewise, larger studies which include northwestern Oklahoma are general in scope and contain only general references to the region.

In the counties of Harper and Woods, as well as in Woodward County where the SLL is located, several species are classified as either endangered or as species of special concern at the federal and/or state level (Oklahoma Biological Survey data). This makes the SLL a conservatively significant site as a refuge for these species. The species listed for these three counties include: the Lesser Prairie Chicken, Interior Least Tern, Peregrine Falcon, Bald Eagle, Whooping Crane, Prairie Falcon, Ferruginous Hawk, Arkansas Darter, Texas Horned Lizard, and Swift Fox.

Caves are extremely sensitive and delicate ecosystems. The large gypsum caves at the SLL (the Selman Cave System, 4,573 m; Cattle Cave, 3,048 m) support five species of bats as well as other cave organisms. Cave systems also provide aquatic environments that include stream and pool habitats. Relatively little has been published on the ecology of gypsum caves in western Oklahoma. Black (1971) compiled a checklist of the biota known to occur in gypsum caves. However, no summary publication has updated any information since that time-over 25 years ago. The only water quality information for the Selman Cave System, and a few other gypsum caves, exists in an appendix of Black's (1971) cave biota publication. There are no studies that examine the relationships of the cave organisms to the unusual waters found in gypsum caves. Gypsum cave water is considered an unusual biological habitat because of high total dissolved solids (1825 ppm) due to calcium hardness (1455 ppm $CaCO_3$). A long term monitoring project being initiated at the SLL is to determine water parameters (e.g. total dissolved solids, total alkalinity, hardness, chlorides, pH, oxygen, transmittance, turbidity, nitrite nitrogen, nitrate nitrogen, ortho-phosphate, meta-phosphate, iron, sulfate, water temperature) in these caves, and the creeks and springs, in relation to the biota present.

Bats are an important component of the natural ecosystems of North America. However, populations are declining due to pesticides and habitat destruction. Of the 21 species of bats known to occur in Oklahoma, three are on the Federal Endangered Species list: the Indiana Bat, the Gray Bat, and a subspecies of Townsend's Big-eared Bat. Because these endangered species occur in eastern Oklahoma, most conservation efforts have been directed toward those species and rarely toward western forms. Little has been done to protect significant bat populations in western Oklahoma. For example, the migratory Mexican Free-tailed Bat establishes only a few very large (several hundred thousand to millions of individuals) maternity roosts in Oklahoma. These caves serve as some of the northernmost maternity roosts for the species. The Oklahoma Department of Wildlife Conservation (ODWC) recognized the biological significance of these caves and funded the purchase of one maternity cave. It has developed into a tremendous conservation educational tool. The ODWC provides public interpretive sessions and viewing opportunities of the evening exit flights of the millions of bats in the cave. This opportunity improves the public's awareness and understanding of the importance of bats in ecosystems. The ODWC cave is 1 km from the SLL and offers additional research and education opportunities for individuals at the SLL.

The cave myotis also needs protection because it masses by the thousands in a few isolated caves to hibernate. This species hibernates in the Selman Cave System at the SLL from October to late March. The Selman Cave System has the largest population of hibernating cave myotis in Oklahoma, in some years exceeding 50,000 bats. The SLL provides protection to the cave system and it becomes an excellent site for research and conservation education. When students and the general public experience the plight of America's ecosystems first hand, it is much easier for them to champion conservation and biodiversity causes` to others.

The Selman Cave System provides roosting habitat for other important species of bats: the big brown bat and the eastern Pipistrelle. The cave was utilized more extensively in the past than at present by another species, Townsend's big-eared bat, which seemingly has become less common through the

years. This species is especially prone to disturbance by humans. The pallid cave bat utilizes the cave system as a night roost. Numerous studies on bat ecology and conservation have been conducted at the Selman Cave System (see below under Significant Research & Education), and other caves on the SLL and in the immediate vicinity, are available for researchers and students.

The cave system is also utilized by numerous other forms of life (Black, 1971) which for the most part have not been studied extensively in gypsum cave systems. These include tiger salamanders; cave crickets, crayfish, various beetles and other insects, woodrats and mice, bat parasites and snakes. The gypsum caves are potential sites for significant archeological and paleontological studies since they serve as natural fossil traps. Few educational facilities in the United States include gypsum caves for study.

Bibliography of Publications Attributable to the SLL Site

Over the past 25 years, a variety of research projects have been conducted at the site and several masters theses and Ph.D. dissertations have involved data collected from the site. Research results have been published in reputable peer-reviewed journals and results and findings presented at national meetings. Listed below are the significant publications conducted at the SLL site:

Black, J., and T. Best. 1972. Remains of a gray wolf (Canis lupus) from Northwestern Oklahoma. Proc. Oklahoma Academy of Science. 52: 120.

Black, J. H. 1971. The cave life of Oklahoma: A preliminary study (excluding Chiroptera). Oklahoma Underground 4(1 & 2): 2-53.

Bozeman, S. 1994. Bat hibernation surveys. Oklahoma Underground, 17:40-43.

Caire, W. 1988. The status of Oklahoma bats. Nat. Spele. Soc. News, 5:88-89.

Caire, W. 1996. Survey for Townsend's Big Eared Bat in Northwest Oklahoma. United States Department of Wildlife Grant Report, USFW Tulsa OK.

Caire, W., B. Cox, and B. Levesy. 1981. Some normal blood values of the bat, Myotis velifer. J. Mamm., 62:436-439.

Caire, W., H. Haines, and T. McKenna. 1982. Urine osmolality and ion concentrations of hibernating Myotis velifer (Chiroptera: Vespertilionidae). J. Mamm., 63:688-690.

Caire, W., L. Hornuff. 1982. Wing morphology and flight behavior of the bat fly Trichobius major (Diptera: Streblidae). Southwestern Naturalist, 27:356-357.

Caire, W. and L. Hornuff. 1985. Overwintering population dynamics of the bat fly Trichobius major (Diptera: Streblidae). Southwestern Naturalist, 31:126-129.

Caire, W. and L. Hornuff and M. Ports. 1981. Geographic variation in wing areas and femur lengths of the bat fly Trichobius major (Diptera: Strebilidae). Southwestern Naturalist, 26:429-432.

Caire, W., L. Hornuff and N. Sohrabi. 1985. Stimuli used by Trichobius major (Diptera: Streblidae) to locate its bat host, Myotis velifer. Southwestern Naturalist, 30:405-412.

Caire, W. and M. Thies. 1988. Notes on the occurrence of morphological and color aberrations in bats from Oklahoma, Missouri, and Mexico. Proc. Oklahoma Academy of Science. 68:75- 76.

Caire, W., J. Tyler, B. P. Glass, M. Mares. 1989. The Mammals of Oklahoma. University of Oklahoma Press, 544pp.

Kunz, T. 1973. Population studies of the cave bat (Myotis velifer): reproduction, growth, and development. Occas. Pap. Mus. Nat. Hist., University of Kansas. 15: 1-43.

Loucks, L. 1996. Sex ratio variation of Myotis velifer (Chiroptera: Vespertilionidae) in Oklahoma. Unpubl. Masters Thesis, University of Central Oklahoma, Edmond, OK.

Nisbett, R.A., W. Caire, M.Stuart, G. Caddell, J. Crutcher, and C. Calisher. 2001. Serologic Survey of Oklahoma Rodents: Evidence for the presence of a Hantavirus and an Arenavirus. Proc. Okla. Acad. Sci. 81:53-66.

Overal, W. L. 1980. Biology and behavior of North American Trichobius batflies (Diptera: Streblidae). Unpubl. Ph.D. dissertation, University of Kansas, Lawrence.

Shackelford, I. and W. Caire. 1993 Variation in pH, volume, osmolality, sodium and calcium levels of the urine of hibernating Myotis velifer (Chiroptera: Vespertilionidae) from western Oklahoma. Southwestern Naturalist, 38:159-163.

Sohrabi, N. 1986. Albumin excretion by the bat, Myotis velifer. Masters Thesis, University Central Oklahoma, Edmond, OK. 34 pp.

Veal, R. A. 1983. Ecological aspects of the ectoparasitic fauna of hibernating Myotis velifer. Masters Thesis, Indiana State University, Terre Haute, Indiana, 63 pp.

Wakeham, N., R. Bogenshutz, W. Caire. 1988. Electrophoretic investigations of urinary proteins in insectivorous bats. I. Mamm., 69:651-653.

Zanowiak, D. 1987. Description of the external bacteria flora of the cave bat, Myotis velifer, during hibernation. Masters Thesis, University of Central Oklahoma, Edmond, OK.

Zanowiak, D., T. Harrison, and W. Caire. 1993. External bacteria of hibernating Myotis velifer (Chiroptera: Vespertilionidae). Southwestern Naturalist, 38: 73-76.

Zeve, V. H. 1959. Notes on the biology and distribution of Trichobius in northwest Oklahoma (Diptera: Streblidae). Proc. Oklahoma Academy of Science, 39:44-49.

Zeve, V .H. 1961. The comparative external morphology of Trichobius corynorhini Cockerell, 7: major Coquillett and 7: sphaeronotus Iobling (Diptera, Streblidae). Ph.D. Dissertation, Oklahoma State University, Stillwater.

Zeve, V .H. and D.E. Howell. 1962. The comparative external morphology of Trichobius corynorhini, 7: major, and 7: sphaeronotus (Diptera, Streblidae) Part I. The Head. Ann. Entomol. Soc. Amer. 55: 685-694.

Zeve, V .H. and D.E. Howell. 1963. The comparative external morphology of Trichobius corynorhini, 7: major, and 7: sphaeronotus (Diptera, Streblidae) Part II. The Thorax. Ann. Entomol. Soc. Amer. 56: 2-17.

Zeve, V .H. and D.E. Howell. 1963. The comparative external morphology of Trichobius corynorhini, 7: major, and 7: sphaeronotus (Diptera, Streblidae) Part III. The Abdomen. Ann. Entomol. Soc. Amer. 56: 127-138.

Additional Related Literature

Barber, S. C. 1979. Floristic components of the gypsum hills and redbed plains area of southwestern Oklahoma. Southwestern Naturalist, 24:431-437.

Black, I., and T. Best. 1972. Remains of a gray wolf (Canis lupus) from Northwestern Oklahoma. Proc. Oklahoma Academy of Science, 52: 120.

Black, I. H. 1971. The cave life of Oklahoma: A preliminary study (excluding Chiroptera). Oklahoma Underground, 4(1 & 2): 2-53.

Bozeman, S. 1994. Bat hibernation surveys. Oklahoma Underground, 17:40-43.

Caire, W. 1988. The status of Oklahoma bats. Nat. Spele. Soc. News, 5:88-89.

Caire, W. 1996. Survey for Townsend's Big Eared Bat in Northwest Oklahoma. United States Department of Wildlife Grant Report, USFW Tulsa OK.

Caire, W. 1996. Bats of Ft. Sill and the adjacent Wichita Mountains Wildlife Refuge, Oklahoma. Legacy Grant Report: Oklahoma Department of Wildlife Conservation.

Caire, W., B. Cox, and B. Levesy. 1981. Some normal blood values of the bat, Myotis velifer. I. Mamm., 62:436-439.

Caire, W., H. Haines, and T. McKenna. 1982. Urine osmolality and ion concentrations of hibernating Myotis velifer (Chiroptera: Vespertilionidae). I. Mamm., 63:688-690.

Caire, W., L. Hornuff. 1982. Wing morphology and flight behavior of the bat fly Trichobius major (Diptera: Streblidae). Southwestern Naturalist, 27:356-357.

Caire, W. and L. Hornuff. 1985. Overwintering population dynamics of the bat fly Trichobius major (Diptera: Streblidae). Southwestern Naturalist, 31:126-129.

Caire, W. and L. Hornuff and M. Ports. 1981. Geographic variation in wing areas and femur lengths of the bat fly Trichobius major (Diptera: Strebilidae). Southwestern Naturalist, 26:429-432.

Caire, W., L. Hornuff and N. Sohrabi. 1985. Stimuli used by Trichobius major (Diptera: Streblidae) to locate its bat host, Myotis velifer. Southwestern Naturalist, 30:405-412.

Caire, W., J. Smith, S. McGuire, and M. Royce. 1984. Foraging ecology of insectivorous bats in western Oklahoma. I. Mamm., 65:319-324.

Caire, W. and M. Thies. 1988. Notes on the occurrence of morphological and color aberrations in bats from Oklahoma, Missouri, and Mexico. Proc. Oklahoma Academy of Science, 68:75- 76.

Caire, W., J. Tyler, B. P. Glass, M. Mares. 1989. The Mammals of Oklahoma. University of Oklahoma Press, 544pp.

Glass, B. P. and C. M. Ward. 1959. Bats of the genus Myotis in Oklahoma. J. Mamm., 40: 194-201

Kunz, T. 1973. Population studies of the cave bat (Myotis velifer): reproduction, growth, and development. Occas. Pap. Mus. Nat. Hist., University of Kansas. 15:1-43.

Lardie, R. L. 1982. A preliminary checklist of the amphibians and reptiles of northwestern Oklahoma (excluding the Oklahoma Panhandle). Bull. Okla. Herp. Soc.. 7:36-78.

Lardie, R. L. and J.H. Black, 1981. The amphibians and reptiles of the Cimarron Gypsum Hills region in northwestern Oklahoma. Bull, Okla. Herp. Soc. 5: 76-125.

Loucks, L. 1996. Sex ratio variation of Myotis velifer (Chiroptera: Vespertilionidae) in Oklahoma. Unpublished Masters Thesis, University of Central Oklahoma, Edmond, OK.

Nisbett, R.A., W. Caire, M.Stuart, G. Caddell, J. Crutcher, and C. Calisher. 2001. Serologic Survey of Oklahoma Rodents: Evidence for the presence of a Hantavirus and an Arenavirus. Proc. Okla. Acad. Sci. 81:53-66.

Oklahoma Biodiversity Task Force. 1996. Oklahoma's Biodiversity Plan: A Sshared Vision for Conserving Our Natural Heritage. (Norman L. Murray, Editor). Oklahoma Department of Wildlife Conservation, Oklahoma City, Oklahoma, 129 pp.

Overal, W .L. 1980. Biology and behavior of North American Trichobius batflies (Diptera: Streblidae). Unpublished Ph.D. dissertation, University of Kansas, Lawrence.

Parsons, R. F. 1976. Gypsophily in plants-a review. Amer. MidI. Nat., 96:1-96.

Shackelford, J. and W. Caire. 1993 Variation in pH, volume, osmolality, sodium and calcium levels of the urine of hibernating Myotis velifer (Chiroptera: V espertilionidae) from western Oklahoma. Southwestern Naturalist, 38:159-163.

Sohrabi, N. 1986. Albumin excretion by the bat, Myotis velifer. Masters Thesis, University of Central Oklahoma, Edmond, OK. 34 pp.

Stanford, J. and A. McKee. 1999. Networking the Organization of Biological Field Stations (OBFS): An Action Plan for Environmental Research and Monitoring. Results of a Workshop May 17-22,1998 at The Nat. Center Ecosystem Analysis and Synthesis, Santa Barbara, California.

Veal, R. A. 1983. Ecological aspects of the ectoparasitic fauna of hibernating Myotis velifer. Masters Thesis, Indiana State University, Terre Haute, Indiana, 63 pp.

Wakeham, N., R. Bogenshutz, W. Caire. 1988. Electrophoretic investigations of urinary proteins in insectivorous bats. J. Mamm., 69:651-653.

Woodward County Soil Survey. 1963. United States Department of Agriculture in cooperation with Oklahoma Agriculture Experiment Station. Series 1960, No.6, 108 pp.

Zanowiak, D. 1987. Description of the external bacteria flora of the cave bat, Myotis velifer, during hibernation. Masters Thesis, University of Central Oklahoma, Edmond, OK.

Zanowiack, D., T.Harrison, and W. Caire. 1993. External bacteria of hibernating Myotis velifer (Chiroptera: Vespertilionidae}. Southwestern Naturalist, 38: 73- 76.

Zeve, V H. 1959. Notes on the biology and distribution of Trichobius in northwest Oklahoma (Diptera: Streblidae). Proc. Okla. Acad. Sci. 39:44-49.

Zeve, V.H. 1961. The comparative external morphology of Trichobius corynorhini Cockerell, 7: major Coquillett and 7: sphaeronotus Jobling (Diptera, Streblidae). Ph.D. Dissertation, Oklahoma State University, Stillwater, Oklahoma.

Zeve, V.H. and D.E. Howell. 1962. The comparative external morphology of Trichobius corynorhini, 7: major, and 7: sphaeronotus (Diptera, Streblidae) Part I. The Head. Ann. Entomol. Soc. Amer. 55: 685-694.

Zeve, V.H. and D.E. Howell. 1963. The comparative external morphology of Trichobius corynorhini, 7: major, and 7: sphaeronotus (Diptera, Streblidae) Part II. The Thorax. Ann. Entomol. Soc. Amer. 56: 2-17.

Zeve, V.H. and D.E. Howell. 1963. The comparative external morphology of Trichobius corynorhini, 7: major, and 7: sphaeronotus (Diptera, Streblidae) Part III. The Abdomen. Ann. Entomol. Soc. Amer. 56: 127-138.