FLEA NEWS is a twice-yearly newsletter about fleas (Siphonaptera). Recipients are urged to check any citations given here before including them in publications. Many of our sources are abstracting journals and current literature sources such as National Agricultural Library (NAL) Agricola, and National Library of Medicine (NLM) Medline, and citations have not necessarily been checked for accuracy or consistent formatting.

Recipients are urged to contribute items of interest to the profession for inclusion herein, including: Flea research citations from journals that are not indexed in Agricola or Medline databases, Announcements and Requests for material, Contact information for a Directory of Siphonapterists (name, mailing address, email address, and areas of interest - Systematics, Ecology, Control, etc.), Abstracts of research planned or in progress, Book and Literature Reviews, Biography, Hypotheses, and Anecdotes. Send to:

R. L. Bossard, Ph.D.
Editor, Flea News
bossardtech@gmail.com

Organizers of the Flea News Network are Drs. R. L. Bossard and N. C. Hinkle.

N. C. Hinkle, Ph.D.
Dept. of Entomology
Univ. of Georgia
Athens GA 30602-2603 USA
NHinkle@uga.edu
(706) 583-8043

Assistant Editor J. R. Kucera, M.S.
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Editorial

Dear *Flea News* Reader,

Robert E. Lewis, who capably edited *Flea News* from 1980 to 2000 and was the foremost authority on Siphonaptera, passed away on January 18, 2017. In the last volume of *Flea News* that he edited, he wrote: "Much has happened during that time to expedite the retrieval and dissemination of information, and resources are now available to the researcher that could only have been imagin-ed [sic] in 1980. This, coupled with the fact that the number of students of the Siphonaptera has seriously declined during this period and the cost of printing and postage has increased, has convinced me that the time has come to discontinue production of printed copies of *Flea News.*" (*Flea News* 60, July 2000).

Though I never met him, I communicated with Bob Lewis while I was working for R.E. Elbel (obituary in *Flea News* 62, June 2008), who corresponded voluminously with him. I remain grateful to Bob Lewis for allowing me to take over the editing of *Flea News*.

An obituary for Dr. Lewis, courtesy of Ralph Eckerlin, is found in this *Flea News*. We can look forward to seeing Bob's posthumous monograph, *The Siphonaptera of North America* (*Annals of Carnegie Museum*).

Yours in fleas,
R.L. Bossard, Editor, *Flea News*

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Announcements


The file is now available in the *Flea News* archive on the ESA Networks as Flea News 14 Addendum PRIMARY TYPE-SPECIMENS 1978.
The Cluff Hopla Flea Collection

Dr. Cluff E. Hopla (1917-2008) [obituaries in Flea News 63, J Med Entomology Vol. 46, no. 2: 173-174, and J Vector Ecol] was a world leader in medical entomology and zoonotic disease research. Although all of his students can attest that he was a virtual paragon of arthropod morphology knowledge, his primary interest was with fleas. When he died, his massive taxonomic collection of Siphonaptera was stored in boxes in his home, and in the laboratory of his friend and colleague, Dr. Michael Kennedy at the University of Memphis. Recently, his daughter, a medical doctor in Tennessee, contacted me at the Harold W. Manter Laboratory of Parasitology in hopes that we could help to make this important collection available again to the scientific community. The entire collection is comprised of over 40,000 individual slides. Almost all are fully identified, and beautifully mounted in balsam, one flea per slide. The strength of the collection is Nearctic, from a wide range of representative hosts, especially rodents. With the excellent quality of the slides, we hope to develop an online identification tool through the use of high-resolution digital photos. Without a doubt, the collection will become a valuable resource for the scientific community.

Many years ago, Dr. Hopla gave me the opportunity to go to the field in Utah with his friend and colleague, Robert Traub, touting me as just the person to help him collect the deer mice that he suspected to be infested with a new species of intradermal tungid fleas. As we prepared to leave, Hopla and Traub quipped that if they combined their large flea collections, they would at last rival the Rothschild and Jordan collections in Britain at the Natural History Museum in Tring. As we drove off, Hopla chanted “collect, collect, collect!” Now, as the Manter Lab begins the formidable task of organizing and preserving Hopla’s flea collection, I would like to solicit any interesting stories that you may have about Cluff, his career, his students, and his love of fleas. Also, it is clear from his notes that many specimens were loaned to colleagues through the years. This would be a good opportunity to send them back and get them repatriated to this important collection, so they too can be available for further study. Personally, I feel great about taking on this task, and giving back a little to the professor who believed in my future as a field biologist. But most of all, I am doing this because I know how much it would have meant to him.

Donald Gettinger
Harold W. Manter Laboratory of Parasitology
W 529 Nebraska Hall
University of Nebraska-Lincoln
Lincoln, Nebraska 68588-0514 USA
donaldgettinger@gmail.com

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Total Number, and an Updated Listing, of Flea Species of the World
(continued)

Mike Hastriter and I continue to update a list of all flea species in the world on the Flea News network (Entomological Society of America website). I thank everyone who is sending me corrections.

R.L. Bossard
Editor, *Flea News*

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**Featured Research**

New Fleas 2017


Two new flea species are described and illustrated, namely *Ctenophthalmus (Ethioctenophthalmus) leirsi* Beaucournu & Zewdneh n. sp. and *C. (E.) vanhoutteae* Beaucournu & Bereket n. sp. The first species is represented by both males and females, while the other is only represented by a single female that does not match any of the previous descriptions of species belonging to the Ethiopian flea fauna. In order to confirm the later species status, a revision of the genus *Ctenophthalmus* in Ethiopia is discussed herein along with the *Ctenophthalmus* taxa and localities recorded so far in this country.

[C. (E.) vanhoutteae Beaucournu & Bereket n. sp. ]

Hosts and Distribution

Articles:


Congressos:


Nuevos registros de pulgas parásitas de roedores sigmodontinos (Cricetidae) en localidades de Campos y Malezales y Bosque Atlántico Interior en la provincia de Misiones. Urdapilleta, M., Lareschi M. XXIX Jornadas Argentinas de Mastozoología. Del 18 al 21 de octubre de 2016, Santa Juan. Pág. 75


Red foxes (*Vulpes vulpes* (L.)) are widespread across Europe, tolerant of synanthropic ecosystems, and susceptible to diseases potentially shared with humans and other animals. We describe flea fauna on red foxes in Romania, a large, ecologically diverse country, in part because fleas may serve as an indicator of the risk of spillover of vector-borne disease. We found 912 individual fleas of seven species on the 305 foxes assessed, for an infestation prevalence of 49.5%. Mean flea load per fox was 5.8 (range 0–44 fleas), and flea detections were most abundant in fall and early spring. Fleas included generalists (*Ctenocephalides canis* (Curtis), 32.6% of all fleas), *Ct. felis* (Bouché, 0.1%), and
Pulex irritans L. (29.9%), the fox specialist Chaetopsylla globiceps (Taschenberg, 32.5%), mesocarnivore fleas Paraceras melis Walker (3.2%) and Ch. trichosa Kohaut (1.5%), and the small mammal flea Ctenophthalmus assimilis (Taschenberg), 0.1%), which is rarely or never reported from carnivores. There were significantly more female than male Ch. globiceps, Ct. canis, and Pu. irritans, and these three species were the most broadly distributed geographically. Diversity indices suggested reduced diversity in mountainous areas above 700 m. When compared to other flea studies on foxes in Europe, Romania had flea diversity near the median of reports, which was unexpected given Romania’s high ecological diversity. Notably absent prey specialists, compared to other studies, include Archaeopsylla erinacei (Bouché) and Spilopsyllus cuniculi (Dale). Further studies of possible disease agents in fox fleas could help elucidate possible risks of vector-borne disease in foxes, domestic animals, and humans as well.


Lagaropsylla signata (Wahlgren, 1903), previously known only from the Island of Java, Indonesia is redescribed and reported for the first time in Deer Cave, Gunung Mulu National Park, Sarawak, Malaysia (west coast of Borneo). Many were found clinging to the earwig Arixenia esau Jordan, 1909. A similar account of a phoretic flea (Lagaropsylla turba Smit, 1958) on the same species of cave-dwelling earwig has been reported in peninsular Malaysia in a well-documented association with the hairless naked bulldog bat, Cheiromeles torquatus Horsfield, 1824. The association of L. signata with A. esau is parallel to the evolution and co-existence with bats in Deer Cave just as in the case of L. turba, A. esau, and C. torquatus. The evidence suggests that L. turba and L. signata are obligate phoretic parasites whose survival depends on A. esau to access a bat host. Arixenia esau is reported for the first time in Deer Cave and the occurrence of L. signata on the island of Borneo represented a new record, previously being found only on the island of Java. Images of L. signata attached to A. esau are provided. Xeniaria jacobsoni (Burr, 1912), often associated with A. esau in other geographical areas, was not present in the material examined from Deer Cave. The natural history of the earwig genera Arixenia Jordan, 1909 and Xeniaria Maa, 1974 are discussed and summarized relative to their associations with phoretic fleas and their bat hosts.


Ecology


Competition during the Cenozoic expansion of the Rodentia may have contributed to ecological
niche reduction of pikas, which are now increasingly under threat as their habitat degrades under global climate change, while some rodents expand their ranges and overlap with pikas. Range overlap carries the possibility of disease spillover. Contemporary North American pikas are cold-adapted and relegated primarily to alpine environments where they subsist on relatively low-quality herbaceous diet. Yet their evolutionary ancestors were distributed geographically even into the subtropics. Here we examine historical and contemporary records of fleas on pikas (*Ochotona princeps*) from sites at different elevations in the Sierra Nevada and Rocky Mountains and the Pacific Northwest. We calculated indices of diversity from each site and spillover fraction, i.e., the proportion of fleas on pikas that have a preference for rodents. Across this range there are four pika specialist flea species, with no more than two of these per site, and 18 characteristically rodent flea species. Diversity is greatest in the Pacific Northwest and lowest in Montana. Rodent flea spillover onto pikas declines with elevation in the Rocky Mountains. These data provide evidence that rodents and pikas interact enough to allow considerable parasite spillover, and which could be exacerbated as pikas are increasingly stressed by climate change at lower elevations some rodent species expand up-elevation in the face of increasing global warming. With global climate change, both biotic and abiotic niche shrinkage demand our attention.


Sylvatic plague is one of the major impediments to the recovery of the black-footed ferret (*Mustela nigripes*) because it decimates their primary prey species, prairie dogs (*Cynomys* spp.), and directly causes mortality in ferrets. Fleas are the primary vector of *Yersinia pestis*, the causative agent of sylvatic plague. The goal of this research was to better understand the flea fauna of ferrets and the factors that might influence flea abundance on ferrets. Fleas from ferrets were tested for *Y. pestis* in a post hoc assessment to investigate the plausibility that some ferrets could act as incidental transporter hosts of fleas infected with *Y. pestis*. Fleas were collected from ferrets captured on the Lower Brule Indian Reservation in central South Dakota from 2009 to 2012. A total of 528 fleas collected from 67 individual ferrets were identified and tested for the presence of *Y. pestis* with a nested PCR assay. The predominant flea recovered from ferrets was *Oropsylla hirsuta*, a species that comprises 70–100% of the fleas recovered from prairie dogs and their burrows in the study area. *Yersinia pestis* was detected at low levels in fleas collected from ferrets with prevalence ranging from 0 to 2.9%; male ferrets harbored significantly more fleas than female ferrets. Six of 67 ferrets vaccinated against plague carried fleas that tested positive for *Y. pestis*, which suggests ferrets vaccinated against plague could inadvertently act as incidental transporter hosts of *Y. pestis*–positive fleas.

Erica L. Mize and Hugh B. Britten. 2016. Detections of *Yersinia pestis* East of the Known Distribution of Active Plague in the United States. VECTOR-BORNE AND ZOONOTIC DISEASES Volume 16, Number 2, 88-95. DOI: 10.1089/vbz.2015.1825


The goal of this study was to evaluate the role of habitat in determining ectoparasite distribution of *Peromyscus leucopus*. We tested the hypothesis that ectoparasite occurrence is associated with particular host environments and this association is stronger for ectoparasites with limited interactions
(i.e., ticks) than those with frequent interactions (i.e., lice). Ectoparasites from three different groups (Acari, Siphonaptera, and Phthiraptera) were collected from *P. leucopus* inhabiting a number of forested habitats in southern Michigan. Measurements of plant species structure and composition were collected and models were developed using quadratic discriminant function analysis to determine if habitats associated with ectoparasite presence were different from those associated with their absence. Mice parasitized by ticks were more likely to be found in areas having undergone a recent disturbance. Mice parasitized by ticks, fleas, and lice were more likely to be found in areas having tree species associated with dry soils. Our results show there is a distinct difference in habitats associated with the presence of ectoparasites, though we did not observe a stronger association of host habitat for ticks than for fleas or lice. This implies habitat should be included as an important component of assessments of the spatial distribution of ectoparasites.


Evolution


Pathology and Control


This article contains an updated presentation of the history of the origin and transcontinental spread of the bacterial pathogen of plague, *Yersinia pestis*, together with the achievements of the new scientific discipline of paleobiology. The development of the disease from its introduction into a rat colony, the unfolding of the plague epizootic, and the transitory phase into an epidemic are outlined together with the course and lethality of human illness. Recent advances in the study of the three modalities of plague disease with main clinical manifestations are presented with historical examples. Another important topic is the wide and expanding presence of black rats in Europe from the time of the early Western Roman Empire and the role of metapopulations of these rodents and rat fleas as the basis of bubonic-plague epidemics and the disseminative role of commercial transportation. The classical medical observations on bubonic plague, the role and the potential importance of plague
epidemics in Antiquity, also in the form of pandemic plague, are quite thoroughly presented together with the essence of the history of the two historical pandemics of plague of 541–767 and 1348–1670. The population mortality of plague and demographic effects, also of recurrence, are outlined. This leads to the history of the conquest of plague by the development of efficient antiepidemic measures. All so-called alternative theories of plague have been invalidated.


Microbial Symbiotes


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Ongoing Research

Abstracts related to fleas from the Society for Integrative and Comparative Biology Annual Meeting, January 4-8, 2017, New Orleans, LA

Host movement ecology and feeding behavior influence how resource provisioning affects parasitism for wildlife.

BECKER, DJ*; STREICKER, DG; ALTIZER, SA; University of Georgia; University of Glasgow; dbecker@uga.edu http://danieljbecker.weebly.com/

Food provided by human activities such as agriculture, recreational feeding, and conservation management can be less seasonal and more spatially reliable than natural resources, and subsequent changes to wildlife ecology can have profound impacts on host–parasite interactions. Wildlife species vary not only in their propensity to capitalize on anthropogenic food, but also in how their behavior and physiology respond to greater food availability. Here we conduct a phylogenetic comparative analysis of 284 host–parasite interactions across 55 wildlife species to identify species-level traits that influence whether resource provisioning increases or decreases measures of parasitism. Accounting for shared evolutionary history of wildlife species and uneven sampling effort, we found that effect sizes for bacteria, viruses, protozoa, and fungi were correlated with host home range, trophic level, and migratory status, suggesting wide-ranging species, herbivores, and migrants are prone to have increased microparasitism with supplemental feeding activities. In contrast, effect sizes for helminths and ectoparasites showed more variation that was partly explained by host dietary diversity. Generalist foragers had reduced macroparasitism with supplemental feeding, suggesting these species can shift foraging away from natural foods that serve as intermediate hosts...
Environmental and Endogenous Factors Predicting Flea Assemblages in Two California Chipmunks.

HAMMOND, T.T.*; PIGAGE, H.K.; Univ. of California, Berkeley; Univ. of Colorado, Colorado Springs talisintess@gmail.com

Documenting potential vector species is an important first step in understanding the dynamics of vector-borne diseases. Plague, caused by *Yersinia pestis*, is a bacterial disease transmitted by multiple flea species, which are hosted by a variety of small mammals. In the Sierra Nevada mountains, sciurids and their fleas are important in the maintenance and transmission of plague. While many of these species are regularly tested for plague, in some cases relatively little is known about the specific ectoparasite assemblages they host. In particular, flea communities of the lodgepole chipmunk (*Tamias speciosus*) and especially the alpine chipmunk (*T. alpinus*) have been characterized infrequently, and usually with low sample sizes. These species are not primary transmitters of plague – though *T. speciosus* is known to transmit and succumb to the disease – however, they are of broad interest because they have exhibited divergent elevational range shifts over the past century, possibly due to climate change. Therefore, characterizing ectoparasitism in these species may shed light on the dynamics of flea infestation and disease transmission in changing environments. Here we report results from a study of *T. alpinus* (N=298) and *T. speciosus* (N=1014) trapped and combed for fleas in 2013-2015. The primary goals are to characterize the relationships between flea species and abundance and (1) host species; (2) host endogenous factors (species, sex, mass, behavior); (3) environmental factors (temperature, habitat). Ultimately, this study will help to establish ecological baselines for the focal species and will clarify the relationships between host, fleas, and environment in a plague- and climate-change-relevant system.

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Pheromone-mediated Communication in a Bird Ectoparasite.

HARBISON, CW; AHMED, ZB; SULLIVAN, TJ; Siena College; charbison@siena.edu

Pheromone-mediated communication governs many aspects of insect behavior, population dynamics, and community ecology. For insect parasites, understanding the language of chemical communication may offer new insights into host-parasite interactions and provide novel strategies for combating parasites. Here, we study the possibility of pheromone-mediated communication in a feather-feeding louse (*Columbicola columbae*). These small parasites (~2 mm long) spend the large majority of their time hiding between the coarse barbs of flight feathers, and must periodically migrate to bird body regions to feed on insulative downy feathers. Using a Y-tube olfactometer, we show that lice readily move up the arm containing either male or female lice as compared to the arm without lice, demonstrating their ability to produce and orient to volatile pheromones. Interestingly, when forced to choose between an arm containing males and an arm with females, males strongly preferred the male arm while females preferred the female arm. This suggests the use of sex-specific pheromones. Finally, we show that pheromone production in lice appears to be dependent on their location on the host. Lice overwhelmingly moved up the arm towards those placed on flight feathers, whereas there was no...
preference for either arm when lice were placed on bird body feathers or kept in an arm without feathers. This suggests that lice produce pheromones only when located on their preferred host region (flight feathers), and can help explain their clumped distribution on flight feathers. We are currently working to determine the structures of volatile compounds produced by lice and to identify their use in pheromonal communication.

[No flea pheromones are known. - Editor].

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Thermo-orientation Influences Ectoparasite Navigation and Microhabitat Selection on Hosts.

HARBISON, CW*; BOUGHTON, RM; SHINE, PJ; MAGIERA, AL; Siena College; charbison@siena.edu

Many ectoparasites move to and exploit specific body regions after hosts are acquired. Often, migration routes to these preferred regions are predictable, which suggests parasite movement is directed. We used a model system consisting of feather-feeding lice (Columbicola columbae) and their bird hosts (Columba livia) to understand how thermal cues influence microhabitat selection and to reveal the control mechanisms governing thermo-orientation. We first determined whether lice responded to thermal cues, then tested whether thermo-orientation helped guide their repeated migrations between flight feathers (where they hide from bird preening) and bird body regions (where they feed). We found that lice can accurately direct their movements towards heat targets, can distinguish between temperatures found on bird body regions and those found on the flight feathers, and will alter their temperature preferences when starved towards those found on bird body regions where they feed. Taken together, these results indicate that host-generated thermal cues play an important role in louse movement and microhabitat selection on their hosts. Finally, we exposed lice with two and one antennae to temporal and spatial heat gradients and analyzed their paths using motion-tracking software to better understand the control mechanisms governing thermo-orientation. We found that lice were capable of orienting to heat targets using only idiothetic (internally stored information) control mechanisms. However, they likely rely on a combination of idiothetic and allothetic (external information) control mechanisms during thermo-orientation.

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Are Ectoparasites or their Bacterial Communities Correlated with the Endocrine Stress Response in Degus (Octodon degus)?

STROM, MK*; EBENSPERGER, LA; NOWAK, K; CALHOUN, K; TAIG-JOHNSTON, MR; HETTENÁ, A; ROMERO, LM; BAUER, CM; ABBOT, P; HAYES, LD; University of Tennessee-Chattanooga; Pontificia Universidad Católica de Chile; Tufts University; Pace University; North Dakota State University; Vanderbilt University; mstrom90@gmail.com

The endocrine stress response allows vertebrates to appropriately react to stressful stimuli such as predator presence, low food availability, and social instability. By releasing glucocorticoids (GCs) into the bloodstream, the endocrine stress response essentially redirects energy from unnecessary
physiological processes (e.g. reproduction, digestion) to those immediately necessary for survival (e.g. energy mobilization, heightened fight-or-flight response). Ectoparasitism may be one such stressor that elevates GC levels, yet the relationship between ectoparasite numbers and the endocrine stress response has not been well defined. We measured ectoparasite numbers and GC (cortisol) concentrations in two ecologically and geographically distinct populations of free-living degus (*Octodon degus*) in central Chile. Exotic fleas have been identified as the predominant ectoparasites in one population. Between populations, there may be variation in the ectoparasite species and their bacterial communities, potentially influencing cortisol levels. Thus, our aim is to explore the relationship between cortisol levels and ectoparasitism, including their associated bacterial communities, in two populations of degus.

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Effects of Parasitism on Host Reproductive Investment in a Rodent—Flea System.

WARBURTON, EM*; KHOKHLOVA, IS; KIEFER, D; KRASNOV, BR; Ben Gurion University of the Negev; warburte@post.bgu.ac.il

Individuals may alter their reproductive investment depending on the type of environment they encounter. Females experiencing stressful conditions might opt to alter sex ratios of litters or invest more into current rather than future reproduction. In the context of parasitism, these effects could manifest as parasitized mothers producing more female offspring, as in the Trivers-Willard Hypothesis, or producing offspring that reach maturity quickly. Our goal was to determine if infestation by fleas *Xenopsylla ramesis* and *Parapulex chephrenis* altered sex ratio or amount litter quality in two rodents: *Meriones crassus* and *Acomys caharinus*. Further, flea infestations included characteristic fleas, non-characteristic fleas, and a mix of the two to determine if number and type of fleas significantly altered host reproductive investment. We found no effect of infestation on sex ratio for either rodent species and no effect of infestation on litter mass, litter size, or pup mass gain in *A. caharinus*. However, treatment did have an effect on litter mass in *M. crassus*. Further, a significant interaction between treatment and litter size on pup mass gain in *M. crassus* indicated that small, parasitized litters gain the most mass. These results suggest that, at least in *M. crassus*, infested mothers produce offspring that mature more quickly but do not alter sex ratio of their litters in response to infestation. Thus, mothers may invest more in current reproduction when subjected to the stresses of parasitism.

**

Morphological Asymmetry and Habitat Quality: Using Fleas and Their Rodent Hosts as a Novel Experimental System.

WARBURTON, EM*; KHOKHLOVA, IS; KIEFER, D; KRASNOV, BR; Ben Gurion University of the Negev; warburte@post.bgu.ac.il

Morphological asymmetry is widely used to measure developmental instability and higher levels of asymmetry often correlate with decreased mating success, increased inbreeding, increased stress, and decreased habitat quality. Links between asymmetry and environmental quality provide a
novel context for host-parasite relationships because habitat a parasite experiences consists of host immunological and physiological processes. Parasites colonizing novel host species could therefore exhibit increased asymmetry due to decreased habitat quality. Our goal was to determine if asymmetry in fleas *Xenopsylla ramesis* and *Parapulex chephrenis* increased when their mothers were reared on species of rodents differing in their relatedness to the fleas’ principal host. We found significant asymmetry in femurs and tibiae of *X. ramesis* but asymmetry was not affected by host relatedness. However, tibae [sic, tibias] of *P. chephrenis* exhibited significant asymmetry and asymmetry was highest in fleas whose mothers were reared on hosts that were distantly related to the principal host. These results indicate that host species and, in turn, habitat quality significantly impacted asymmetry in *P. chephrenis*, a host specialist, but not *X. ramesis*, a more generalist flea. Therefore, fleas parasitizing multiple species may be better at compensating for developmental instability than host specialists when utilizing a novel host species. This suggests that host-switching events in host specialists may be constrained by the relatedness of the different host species in question.

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Social mechanisms shaping individual differences in ectoparasite loads of free-living ground squirrels.

**

WORKING, CL; SINGH, KS; RUSSELL, ID; GAMBOA, DA; SMITH, JE; Biology Dept., Mills College, Oakland, California 94613; jesmith@mills.edu http://www.JenniferElaineSmith.com

Social animals face trade-offs between the costs and benefits of group living. Parasite transmission is a widely-recognized cost of sociality because hosts often suffer from dual costs of parasites acting as stressors and/or vectors for disease. Despite these important fitness consequences, little is known about the social mechanisms facilitating the spread of ectoparasites from one individual to another in wildlife populations. Here, we studied the spread of fleas across free-living California ground squirrels, *Otospermophilus beecheyi*. *O. beecheyi* forage and socialize above ground, but seek refuge from predators in underground burrows. Importantly, there are documented cases of the fleas found on *O. beecheyi* carrying the bacterium, *Yersinia pestis*, the causative agent of plague. Thus, revealing modes of flea transmission in this species has important implications for the study of social evolution as well as for management of zoonotic diseases. In the field, we regularly live-trapped, marked and released squirrels at their points of capture. Upon its first capture of each week, we systematically combed each individual squirrel to sample and collect its fleas. Our results reveal consistent, individual differences in mean ectoparasite loads across time beyond those predicted by age and sex. We are currently analyzing the basal "stress" hormones of these individuals. We are also using social network statistics to test two, non-mutually exclusive hypotheses: 1) space-use overlap hypothesis and 2) social transmission hypothesis to determine whether spatial or social interactions best explain individual differences in flea numbers. Taken together, our results will reveal the importance of host traits in shaping parasite and disease networks in wildlife populations.
The North American Deer Mouse *Peromyscus maniculatus* as a Flea Host

by R.L. Bossard

The North American deer mouse, *Peromyscus maniculatus* (Pm), has the largest range of any small mammal in North America, occurring throughout the U.S., except for the SE, and from Canada to Mexico. The northern edge of Pm range is near the boreal-tundra transition near the latitude of the Arctic Circle (65° N), and the southern edge is near Mexico City (18° N). There are 26 subspecies of Pm.

Throughout much of its range, Pm is the commonest mammal (Armstrong et al. 2010). In northern boreal forests, Pm is often the only *Peromyscus* species.

Pm is a weed-like species with major effects on its community (Armstrong et al. 2010). Pm thrives in disturbance (often by sharing burrows with other mammals), serves as prey, and changes the dominant vegetation. The Ectoparasite Release Hypothesis posits that fleas help regulate Pm populations, and when fire removes the fleas, the resulting increase in Pm causes grass to replace forest (Zwolak et al. 2016).

The number of flea species (flea species richness) on a host species correlates with the host's geographic range (although richness is not correlated with host size or abundance) probably due to the number of flea habitats that the host contacts (Bossard 2014). As a result, Pm is infested with more flea species than any other North American mammal. Some of these fleas carry plague bacteria (Burroughs 1944, Allred 1952) and other microbial symbiotes (Barbour 2017). In southern California, Pm is "considered to be a primary reservoir for plague" (Davis et al. 2002).

Throughout the Pm range, its flea community changes dramatically. From North to South, *Aetheca thamba* is an important flea on Pm in Alaska and northern Canada, but upon reaching Manitoba the dominant Pm fleas are *A. wagneri* and secondarily *Orchopeas leucopus* (Buckner 1964), as they are in the western U.S. The flea species richness on Pm in Alaska and Canada appears reduced compared to southerly latitudes. Holland (1949, 1985) lists 37 Pm fleas in Alaska and Canada:

**Pm fleas in Alaska and Canada**

(flea species names are not necessarily updated)

*Aetheca thamba* (formerly *Monopsyllus thambus*)
*Aetheca wagneri* (formerly *Monopsyllus wagneri*)
*Atyphloceras artius*
*Atyphloceras multidentatus*
*Callistopsyllus campestris*
*Callistopsyllus terinus*
*Catallagia charlottensis*
*Catallagia chamberlini*
*Catallagia decipiens*
*Ctenophthalmus pseudagyrtes*
*Delotelis telegoni*
*Epitedia scapani*
*Epitedia wenmanni*
*Hystrichopsylla dippiei*
*Hystrichopsylla occidentalis*
*Malaraeus euphorbi*
*Malaraeus penicilliger*
In Mexico (near Mexico City at 18° N), *Pleochaetis mundus* is the most abundant flea on Pm. *Jellisonia* (*Jellisonia* breviloba breviloba, *J. breviloba barrerai*, *J. hayesi*, *Meringis alitepecten*, *Plusaetis apollinaris*, *P. matthesoni*, and *P. parus*) also occur there on Pm. *A. wagneri* and *O. leucopus* are not found (Acosta & Fernández 2015).

From West to East in the U.S., *Aetheca wagneri* is the most common flea in the west, (California (Davis et al. 2002) and Oregon (O'Farrell 1975)), usually followed in abundance by *Orchopeas leucopus*. There are local exceptions, as for example in central California, *Opisodasys keeni*, *Malareus telchinus*, and *Catallagia wymani* were the abundant fleas on Pm, and local habitat differences did not affect the Pm flea community (Murray 1957).

Continuing eastward, *A. wagneri* is still found at least as far as southwestern Nebraska (Howell et al. 2016), but then disappears, possibly at the central grassland and eastern forest transition zone, making *O. leucopus* the most common flea on Pm all the way to Nova Scotia (Wright 1979). Other common fleas on eastern Pm that are not in the west are *Conorhinopsylla stanfordi* (a flea that undergoes summer diapause in West Virginia), *Ctenophthalmus pseudagyrites* (found only east of the Rocky Mountains), *Megabothris asio*, *Megabothris quirini*, *Monopsyllus vison*, *Peromyscopsylla scotti*, and *Stenoponia americana* (a winter flea) (Benton & Altmann 1964, Whitaker & Corthum 1966, Wright 1979, Eckerlin 2016). It is unclear if the eastern flea community on Pm is richer than the western.

The latitudinal changes in the flea community on Pm appear to correspond to elevational changes (as Merriam's equation of latitude with elevation predicts). In the alpine life zone of Colorado, *A. thamba* replaces *A. wagneri*, and *Catallagia decipiens* replaces *C. calisheri*. Also found in higher numbers in the alpine are *Peromyscopsylla hesperomys* and *Malaraeus euphorbi*. Rarer at high elevations are *O. leucopus*, *Callistopsyllus deuterus*, and *Megarthroglossus* sp. and “strays from heather vole” *Megabothris abantis* and *Peromyscopsylla selenis* (Eads & Campos 1983).

The flea community on Pm changes seasonally as well (Campos et al. 1985): on southern Idaho Pm, “Fleas were taken every month of the year, but the greatest number of species (23) was taken in August, and the least number (11) in February” (Allred 1968).

In the Great Basin Desert of the western U.S. alone, there are at least 47 fleas found on Pm.
These fleas, and their season in southern Idaho or life zone in Colorado when known, include:


**Pm fleas in the Great Basin Desert**
(flea species names are not necessarily updated)

*Aetheca thamba* (alpine)
*A. WAGNERI* (year round)
*Amphipsylla sibirica* (summer-fall)
*Anomiopsyllus amphibilus* (a small nest-flea)
*Atyphloceras echis*
*Atyphloceras multidentatus*
*Callistopsyllus deuterus*
*Callistopsyllus terinus* (spring-summer)
*Catallagia calisheri* (esp. alpine)
*Catallagia decipiens* (year round)
*Cediopsylla inaequalis* (year round) (rabbit flea)
*DIAMANUS MONTANUS* (*Oropsylla montana*)
*Epitedia stanfordi* (spring)
*Epitedia wenmanni* (year round)
*Foxella ignota* (spring summer-fall)
*HOPLOPSYLLUS ANOMALUS*
*Hystrichopsylla dippiei* (fall)
*Hystrichopsylla gigas dippiei* (=*Hystrichopsylla dippiei*)?
*Hystrichopsylla lindsdalei*
*Hystrichopsylla occidentalis* (summer-fall)
*Megarthroglossus procus*
*Malareus euphorbia* (*Amaradix euphorbi*) (fall-winter-spring) (tundra and other zones)
*Malareus sinomus*
*Malaraeus telchinus* (winter-spring-summer)
*Megarthroglossus spp.*
*Megarthroglossus smiti*
*Megabothris abantis*
*Meringis dipodomys* (kangaroo-mouse flea)
*Meringis hubbardii* (spring-summer-fall) (kangaroo-mouse flea)
*Meringis parkeri* (year round) (kangaroo-mouse flea)
*Micropsylla sectilis* (*Rhadinopsylla sectilis*)
*MONOPSYLLUS EUOMOLPI EUOMOLPI* (*Eumolpianus eumolpi eumolpi*) (year round)
*MONOPSYLLUS exilis* (spring-summer-fall)
*NOSOPSYLLUS FASCIATUS*
*Opisocracis labis* (summer)
*Opisodasys keeni* (summer-fall)
*Orchopeas leucopus*
*Orchopeas sexdentatus agilis* (summer-fall-winter)
*Oropsylla IDAHOENSIS*
*Peromyscosylla hesperomys* (summer) (alpine)
*Peromyscosylla selenis* (“strays from heather vole”)
Phalacropsylla paradisea (spring)
Rhadinopsylla sectilis (fall-winter-spring)
Stenistomera alpina
Stenistomera macrodactyla (fall-winter)
Thrassis francisi (spring-summer)
Thrassis pandoras

Further research on factors shaping the flea community on Pm may prove of interest.

Literature


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Additional references


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**Fleas in Art and History**

Hans Christian Andersen
(b. April 2, 1805, Odense, Denmark, d. August 4, 1875, Copenhagen, Denmark)

**THE LEAPING MATCH**

from Hans Andersen's Fairy Tales
Ed. J. H. STICKNEY

THE Flea, the Grasshopper, and the Frog once wanted to see which of them could jump the highest. They made a festival, and invited the whole world and every one else besides who liked to come and see the grand sight. Three famous jumpers they were, as all should say, when they met together in the room.

"I will give my daughter to him who shall jump highest," said the King; "it would be too bad for you to have the jumping, and for us to offer no prize."
The Flea was the first to come forward. He had most exquisite manners, and bowed to the company on every side; for he was of noble blood, and, besides, was accustomed to the society of man, and that, of course, had been an advantage to him.

Next came the Grasshopper. He was not quite so elegantly formed as the Flea, but he knew perfectly well how to conduct himself, and he wore the green uniform which belonged to him by right of birth. He said, moreover, that he came of a very ancient Egyptian family, and that in the house where he then lived he was much thought of.

The fact was that he had been just brought out of the fields and put in a card-house three stories high, and built on purpose for him, with the colored sides inwards, and doors and windows cut out of the Queen of Hearts. "And I sing so well," said he, "that sixteen parlor-bred crickets, who have chirped from infancy and yet got no one to build them card-houses to live in, have fretted themselves thinner even than before, from sheer vexation on hearing me."

It was thus that the Flea and the Grasshopper made the most of themselves, each thinking himself quite an equal match for the princess.

The Leapfrog said not a word; but people said that perhaps he thought the more; and the housedog who snuffed at him with his nose allowed that he was of good family. The old councilor, who had had three orders given him in vain for keeping quiet, asserted that the Leapfrog was a prophet, for that one could see on his back whether the coming winter was to be severe or mild, which is more than one can see on the back of the man who writes the almanac.

"I say nothing for the present," exclaimed the King; "yet I have my own opinion, for I observe everything."

And now the match began. The Flea jumped so high that no one could see what had become of him; and so they insisted that he had not jumped at all—which was disgraceful after all the fuss he had made.

The Grasshopper jumped only half as high; but he leaped into the King's face, who was disgusted by his rudeness.

The Leapfrog stood for a long time, as if lost in thought; people began to think he would not jump at all.

"I'm afraid he is ill!" said the dog and he went to snuff at him again; when lo! he suddenly made a sideways jump into the lap of the princess, who sat close by on a little golden stool.

"There is nothing higher than my daughter," said the King; "therefore to bound into her lap is the highest jump that can be made. Only one of
good understanding would ever have thought of that. Thus the Frog has shown that he has sense. He has brains in his head, that he has."

And so he won the princess.

"I jumped the highest, for all that," said the Flea; "but it's all the same to me. The princess may have the stiff-legged, slimy creature, if she likes. In this world merit seldom meets its reward. Dullness and heaviness win the day. I am too light and airy for a stupid world."

And so the Flea went into foreign service.

The Grasshopper sat without on a green bank and reflected on the world and its ways; and he too said, "Yes, dullness and heaviness win the day; a fine exterior is what people care for nowadays." And then he began to sing in his own peculiar way--and it is from his song that we have taken this little piece of history, which may very possibly be all untrue, although it does stand printed here in black and white.

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On the next page

Rendimento di Grazie dopo la peste (Thanksgiving after the plague), Cardinal Ascanio Filomarino and San Martino, Naples monks.

1657, by Domencio Gargiulo detto Micco Spadaro (b. 1609–1610, Naples, Italy, d. ca. 1675, Naples). Oil on canvas, Museo di San Martino. This painting follows his painting of during the plague (Flea News 79, December 2016).
Directory of Siphonapterists (updated)

Dra. Roxana Acosta-Gutierrez
Museo de Zoologia
Departamento de Biologia Evolutiva
Facultad de Ciencias, UNAM
Apo. Postal 70-399,
C.P. 04510, Mexico. D.F.
roxana_a2003@yahoo.com.mx
Flea biogeography, systematics, and taxonomy.

Dr. J.C. Beaucournu
Parasitologie medicale
Faculte de Medecine de Rennes
2, avenue du Professeur Leon Bernard
F 35043 Rennes cedex
France
jc.beaucournu@gmail.com

Dr. Marian Blaski
Silesian University, Department of Zoology
ul. Bankowa 9
40-007 Katowice
Poland
marian.blaski@us.edu.pl

Dr. R.L. Bossard
Bossard Consulting
Salt Lake City, UT
bossardtech@gmail.com
Ecology of host-parasite relationships.

Dra. Cristina Cutillas
Departamento de Microbiología y Parasitología
Facultad de Farmacia
Universidad de Sevilla
C/ PROFESOR GARCÍA GONZÁLEZ, Nº 2
41012 Sevilla. Spain
cutillas@us.es
Molecular biology of fleas

Dr. Anne Darries-Vallier
Bio Espace – Laboratoire d’Entomologie
Mas des 4 Pilas - Route de Bel-Air
34570 Murvel les Montpellier
France
bioespace.labo@gmail.com
Ecology, biology, behavior, mass rearing, disease vectors.
Bill Donahue, Ph.D.
Sierra Research Laboratories
5100 Parker Road
Modesto, CA 95357
www.sierraresearchlaboratories.com
bill@sierraresearchlaboratories.com

Dr. Michael Dryden
E.J. Frick Professor of Veterinary Medicine
Department of Diagnostic Medicine/Pathobiology
Coles Hall
Manhattan, KS 66506
Dryden@vet.ksu.edu
Veterinary parasitology.

Thomas M. Dykstra, Ph.D.
Dykstra Laboratories, Inc.
3499 NW 97th Blvd., Suite 6
Gainesville, FL 32606
www.dykstralabs.com
dykstralabs@yahoo.com
Sensory perception of fleas, especially larvae.

Lance A. Durden, Ph.D.
Department of Biology
Georgia Southern University
69 Georgia Avenue
P. O. Box 8042
Statesboro, Georgia 30460, USA
ldurden@georgiasouthern.edu
Flea taxonomy and host associations, especially in eastern North America and the Indo-Australian region.

Laura Fielden (Ph.D.)
Associate Professor, Department of Biology
Truman State University, Kirksville, MO 63501
lfielden@truman.edu
Host specificity of fleas.

Manuel Fabio Flechoso del Cueto
C/ Heroes de la Independencia no 1 - 2oA
42200 Almazan (Soria), SPAIN
fabioflechoso@hotmail.com
Dr. Patrick Foley  
Department of Biological Sciences  
California State University  
Sacramento, CA 95819  
patfoley@csus.edu  
Epidemiology, extinction, metapopulations, identification of fleas, plague.

Dr. Terry Galloway  
Professor of Entomology and Associate Curator  
J.B. Wallis Museum of Department of Entomology  
Winnipeg, Manitoba  
Canada R3T 2N2  
Terry_Galloway@umanitoba.ca  
Ecology and taxonomy, especially of the larvae.

Dr. N. C. Hinkle  
Professor  
Dept. of Entomology  
Univ. of Georgia  
Athens, GA 30602-2603  
NHinkle@uga.edu  
Flea biology and control.

Simon Horsnall  
UK Flea Recorder  
simon.horsnall@googlemail.com

Kerv Hyland  
5 Timber Lane, Unit 314  
Exeter, N.H. 03833  
khyland@etal.uri.edu  
All groups of ectoparasites on vertebrates.

James (Jim) R. Kucera, M.S.  
5930 Sultan Circle  
Murray, UT 84107-6930  
jameskucera@aol.com  
Flea systematics & taxonomy, host relationships, distribution & biogeography.

Dra. Marcela Lareschi  
Centro de Estudios Parasit. Vectores  
CEPAVE (CONICET-UNLP)  
Calle 2 # 584  
La Plata (1900)  
Argentina  
mlareschi@cepave.edu.ar
Dr. Pedro Marcos Linardi  
Professor of Parasitology and Medical Entomology  
Departamento de Parasitologia  
Instituto de Ciencias Biologicas  
Universidade Federal de Minas Gerais  
31.270-901 Belo Horizonte, Minas Gerais  
Brasil  
linardi@icb.ufmg.br  
Taxonomy of fleas, host-parasite relationships, fleas as vectors of parasites.

Dr. Erica McAlister  
Department of Life Sciences  
The Natural History Museum  
cromwell Road LONDON SW7 5BD UK  
Fleas at the NHM.

Christine M. McCoy, M.S.  
Asst. Sr. Scientist, Acquisitions / Antiparasitics  
2500 Innovation Way  
Greenfield, IN 46140  
mccoycm@lilly.com

Sergei G. Medvedev, Doctor of Biology  
Chief of the Department of Parasitology  
Zoological Institute of Russian Academy of Sciences  
Universitetskaya Embankment 1  
St. Petersburg, 199034 Russia  
http://www.zin.ru/Animalia/Siphonaptera/index.htm  
fleas@zin.ru  
Flea taxonomy and phylogenetics.

Dr. Norbert Mencke  
Bayer Animal Health GmbH  
Policies & Stakeholder Affairs  
Kaiser-Wilhelm-Allee 50  
51373 Leverkusen  
Germany  
https://www.bayer.com/  
Norbert.Mencke@bayer.com  
Veterinary specialist for parasitology.

Ettore Napoli  
Department of Veterinary Science unit Parasitology  
University of Messina  
Messina, Italy  
enapoli@unime.it  
Ectoparasitic arthropods and their vectorial role.  
MDV PhD student - Public Health
Dr. Barry M. O'Connor  
Curator & Professor  
Museum of Zoology  
University of Michigan  
1109 Geddes Ave  
Ann Arbor, MI 48109-1079  
bmoc@umich.edu  
Ectoparasites of vertebrates, particularly mites.

Dra. Juliana P. Sanchez  
Centro de Investigaciones y Transferencia del Noroeste de la Provincia de Buenos Aires (CITNOBA-CONICET)  
Ruta Provincial 32 Km 3.5  
2700 Pergamino  
Buenos Aires, Argentina.  
julianasanchez@unnoba.edu.ar  
Ectoparasite (especially flea) systematics, taxonomy, and ecology.

Jeff Shryock, M.S.  
Sr. Research Biologist  
Merial, Ltd., Missouri Research Center  
6498 Jade Rd.  
Fulton, MO 65251  
Jeffrey.shryock@merial.com

Dr. Andrew Smith  
Vet and Biomedical Sciences  
Murdoch University  
Murdoch 6150  
West Australia  
Andrew.Smith@murdoch.edu.au  
Ecology; fleas as vectors of parasites and associated diseases.

Dr. Amoret P. Whitaker BSc MSc DIC DipFMS  
Scientific Associate – Forensic Entomology  
Department of Life Sciences  
Natural History Museum  
Cromwell Road London  SW5 7BD  
a.whitaker@nhm.ac.uk  
Forensic entomology.

Bill Wills  
Adj. Professor  
142 Heritage Village Lane  
Columbia, South Carolina 29212  
pb.wills@att.net  
Flea ecology.

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Siphonaptera Literature (2017)


Neglected Tropical Diseases 11 (1). doi:10.1371/journal.pntd.0005276.


Erica L. Mize and Hugh B. Britten. 2016. Detections of Yersinia pestis East of the Known Distribution of Active Plague in the United States. VECTOR-BORNE AND ZOONOTIC DISEASES Volume 16, Number 2, 88-95. DOI: 10.1089/vbz.2015.1825


Obituary

Robert Earl Lewis
1 December 1929 – 18 January 2017

Bob Lewis was born in Richmond, Indiana to Robert D. and Anna Lewis. He attended Earlham College in Richmond and received the Bachelor’s degree with Departmental Honors (A.B., Biology) in 1952. Shortly after graduation he married Joanne Hauschild, then spent two years as an enlisted man in the United States Army. He served as the Post Entomologist and Game Warden in the Preventive Medicine Office at Fort Leonard Wood, Missouri. Bob was discharged from the military with the rank of Sergeant in 1954.

He entered the graduate program in Entomology at the University of Illinois at Urbana, Illinois in 1954 earning the M.S. degree in 1956 and the Ph.D. in 1959. His dissertation was entitled “The thoracic musculature of the Indian rat flea, Xenopsylla cheopis (Rothschild, 1903), its function and implications in the phylogeny of the order Siphonaptera” (1). That autumn Bob and Joanne took a freighter to Beirut, Lebanon, where they remained until 1967.

In Lebanon, Bob taught at the American University of Beirut starting as an Assistant Professor of Biology, then promoted to Associate Professor in 1964. At various times there he taught General Biology, Entomology, Invertebrate Zoology, Introductory Genetics, Evolution, and Vertebrate Natural History. In the Middle East he conducted faunistic surveys concentrating on fleas in Lebanon, Syria, Jordan, Egypt, Saudi Arabia, and Turkey. He participated in the Street Expedition to Afghanistan of the Field Museum in 1965 (2), wrote and illustrated a monograph of the fleas collected, and studied at the British Museum at Tring, Hertfordshire. He directed a faunistic survey of ectoparasitic arthropods in Nepal from 1966-1971. Mites from that survey were deposited into the Bernice P. Bishop Museum, ticks to the U.S. National Tick Collection, and fleas to the Field Museum. Bob also served as the Director of the Natural History Museum at the American University of Beirut. When the political situation in Lebanon became unstable, Bob and Joanne returned to the United States, to Ames, Iowa, where Bob joined the faculty at Iowa State University.

At Iowa State University, Bob taught courses mainly in Entomology. He taught Insect Morphology, Aquatic Insects, Insect Systematics, Immature Insects, and Biogeography from July 1967 to 1 January 1997, when he retired (Associate Professor, 1967-1971, Professor, 1971-1996, Professor Emeritus, 1996). In addition to ectoparasites, he had professional interests in zoography (3) and Pleistocene geology. A total of 16 students received M.S degrees under his tutelage, 10 in Lebanon and 6 in Iowa (4). While at Iowa State these students earned the Ph.D. under Dr. Lewis: Fatimah Abang (5), James Amrine (6), Thomas Cheetham (7), Keith Mbata (8), Silverio Medina Gaude, Raymond Miller, Richard Mitchell, Beth Schramm (9), and W. Bryan Stoltzfus (10).

Bob and Joanne worked together to produce a prodigious amount of work on the fleas of the world. They decided early in their marriage not to have children so that they could travel freely. They traveled several times to London, England to work in the flea collection at the Natural History Museum. On one occasion, Frans Smit casually mentioned that he had translated the monograph on the fleas of Siberia (Ioff and Scalon, 1954) from the Russian to English (11). In the few days that the Lewises visited, Joanne typed out a copy of the handwritten translation!

With Joanne’s help as co-editor, Bob produced the semiannual newsletter Flea News from 1980

After retirement, Bob focused his studies on the taxonomy, systematics, and phylogeny of the North American flea fauna. Bob started to review and illustrate the fleas of a genus or a small family in individual publications. He then decided to put all the information together between the covers of a book.

Bob received the Faculty Citation from the Iowa State University Alumni Association in 1995. He was a member of numerous professional societies (including American Entomological Society, American Society of Parasitologists, Biological Society of Washington, Iowa Academy of Science, Kansas Entomological Society, and Zoological Society of London), and was particularly proud that he was made a Fellow of the Royal Entomological Society of London. Late in life Bob remarried to Nancy Bailie who also pre-deceased him in June 2015.

The Lewis flea collection has been deposited into the collections of the Field Museum in Chicago, Illinois, and his more than 6,000 flea reprints are now in the Carnegie Museum of Natural History in Pittsburgh, Pennsylvania. His papers including correspondence are archived at the University Archives, Special Collections Department, Iowa State University.

Bob Lewis was a complex person. He listed his hobbies as bird watching, butterfly collecting, orchid culture, classical music, and reading. He was well informed about local and national news. He was strongly opinionated about politics and politicians. You always knew where he stood on an issue. Yet, Bob was a very hospitable and social individual. Numerous scientists who visited Ames stayed in the Lewis home. Bob shared reprints with flea workers all over the world. In the assisted-living facility where Bob spent his final years he had many friends.

Not many flea taxonomists are left who have the global view and competence that Bob had with the Siphonaptera. His illustrations of flea anatomy are works of art. One hangs on my office wall! His final work, a book, The Siphonaptera of North America, will be published by the Carnegie Museum of Natural History in the Annals of Carnegie Museum series.

Ralph Eckerlin
Northern Virginia Community College

A complete list of Dr. Lewis’s publications follows.

Editorial notes:

1. “The thoracic musculature of the Indian rat flea, *Xenopsylla cheopis* (Rothschild, 1903), its function and implications in the phylogeny of the order Siphonaptera”.

"The thoracic muscles and their functions are described in supplement to studies by previous workers on the muscles of the siphonapteran head and legs. *X. cheopis* has many fewer thoracic muscles than less specialized insects. The trochanteral depressors, which are the principal extensors of the legs, are relatively of great size. The other surviving muscles act mainly to hold the various parts of the body firmly together. The flea is highly adapted not only to strenuous jumping but also to sinuous creeping among the hairs of its host. The muscular pattern of the flea, though much reduced from the
primitive condition, is such as to render a derivation of the fleas from the Coleoptera or Diptera most unlikely. Considering also other structural, physiological, and ecological factors, the bulk of the evidence leans heavily toward the view of Tillyard (1935) that the order Siphonaptera is the offshoot of some primitive mecopteran stock."


The topography of the exoskeleton of the thorax, abdomen and appendages of Cediopsylla simplex (Baker, 1895) was studied by scanning electron microscopy. The location and function of the cuticular sensory receptors are discussed. It is postulated that the sensilla of the thorax and abdomen are mainly tactile mechanoreceptors, with the exception of the basiconic pegs on the tibiae and tarsi, which are thought to be olfactory chemoreceptors. The structure of the sensillum is described and its function as a receptor of ultrasonic vibrations is proposed.

[Editor's note: the hypotheses that ultrasonic frequencies involving the sensillum are important for intra-flea communication (Amrine & Jerabek 1983), or that ultrasonics can control fleas, have not received convincing experimental support (Bonge 1990; Dryden, Long, & Gaafar 1989; Hinkle, Koehler, & Patterson 1990; Rust & Parker 1988). An alternative hypothesis is that the sensillum contains mechano-receptors that detect air currents and is involved with mating (Greenwood & Holdich 1979).]

Literature Cited


Figure 1 – Bob and Joanne (Mike) Lewis flanking Kuei Chen Li center. The Chinese flea taxonomist was visiting the Lewis home in Ames, Iowa.
Figure 2 – Bob and Nancy Lewis on their wedding day.

Publications of Robert E. Lewis


Lewis, Robert E. 1973. Siphonaptera collected during the 1965 Street Expedition to


Whitaker, John O., Jr., Chris Maser and Robert E. Lewis. 1985. Ectoparasitic mites (excluding


Lewis, Robert E. and Joanne H. Lewis. 1994. The Siphonaptera of North America north of


