Urban Spider Diversity in Los Angeles Assessed Using a Community Science Approach

Janet K. Kempf, Benjamin J. Adams, and Brian V. Brown
Board of Editors
Myla Aronson, Rutgers University, New Brunswick, NJ, USA
Joscha Beninde, University of California at Los Angeles, CA, USA ... Co-Editor
Sabina Cauła, Universidad de Carabobo, Naguanagua, Venezuela
Sylvio Codella, Kean University, Union New Jersey, USA
Julie Craves, University of Michigan-Dearborn, Dearborn, MI, USA
Ana Faggi, Universidad de Flores/CONICET, Buenos Aires, Argentina
Leonie Fischer, Technical University of Berlin, Berlin, Germany
Chad Johnson, Arizona State University, Glendale, AZ, USA
Kirsten Jung, University of Ulm, Ulm, Germany
Erik Kiviat, Hudsonia, Bard College, Annandale-on-Hudson, NY, USA
Sonja Knapp, Helmholtz Centre for Environmental Research–UFZ, Halle (Saale), Germany
David Krauss, City University of New York, New York, NY, USA
Mark Laska, Great Ecology, consulting, La Jolla, CA, USA
Zdenka Lososova, Masaryk University, Brno, Czechia
Joerg-Henner Lotze, Eagle Hill Institute, Steuben, ME ... Publisher
Kristi MacDonald, Hudsonia, Bard College, Annandale-on-Hudson, NY, USA
Ian MacGregor-Fors, Instituto de Ecología Mexico, Veracruz, Mexico ... Co-Editor
Tibor Magura, University of Debrecen, Debrecen, Hungary
Brooke Maslo, Rutgers University, New Brunswick, NJ, USA
Mark McDonnell, Royal Botanic Gardens Victoria and University of Melbourne, Melbourne, Australia
Mike McKinney, University of Tennessee, Knoxville, TN, USA
Desirée Narango, City University of New York, New York, NY, USA
Mitchell Pavao-Zuckerman, University of Arizona, Tucson, Arizona, USA
Joseph Rachlin, Lehman College, City University of New York, New York, NY, USA
Travis Ryan, Center for Urban Ecology, Butler University, Indianapolis, IN, USA
Michael Stroehbach, Technische Universität Braunschweig, Institute of Geocology, Braunschweig, Germany
Katalin Szlavecz, Johns Hopkins University, Baltimore, MD, USA
Paige Warren, University of Massachusetts, Amherst, MA, USA
Alan Yeakley, Portland State University, Portland, OR, USA
Iriana Zuria, Universidad Autónoma del Estado de Hidalgo, Hidalgo, Mexico

♦ The Urban Naturalist is a peer-reviewed and edited interdisciplinary natural history journal with a global focus on urban areas (ISSN 2328-8965 [online]).
♦ The journal features research articles, notes, and research summaries on terrestrial, freshwater, and marine organisms and their habitats.
♦ It offers article-by-article online publication for prompt distribution to a global audience.
♦ It offers authors the option of publishing large files such as data tables, and audio and video clips as online supplemental files.
♦ Special issues - The Urban Naturalist welcomes proposals for special issues that are based on conference proceedings or on a series of invitational articles. Special issue editors can rely on the publisher’s years of experiences in efficiently handling most details relating to the publication of special issues.
♦ Indexing - The Urban Naturalist is a young journal whose indexing at this time is by way of author entries in Google Scholar and ResearchGate. Its indexing coverage is expected to become comparable to that of the Institute’s first 3 journals (Northeastern Naturalist, Southeastern Naturalist, and Journal of the North Atlantic). These 3 journals are included in full-text in BioOne.org and JSTOR.org and are indexed in Web of Science (clarivate.com) and EBSCO.com.
♦ The journal’s staff is pleased to discuss ideas for manuscripts and to assist during all stages of manuscript preparation. The journal has a page charge to help defray a portion of the costs of publishing manuscripts. Instructions for Authors are available online on the journal’s website (http://www.eaglehill.us/urna).
♦ It is co-published with the Northeastern Naturalist, Southeastern Naturalist, Caribbean Naturalist, Eastern Paleontologist, Eastern Biologist, and Journal of the North Atlantic.
♦ It is available online in full-text version on the journal’s website (http://www.eaglehill.us/urna). Arrangements for inclusion in other databases are being pursued.

Cover Photograph: A dish of spiders in ethanol from among the thousands submitted to the Los Angeles Spider Survey. Photograph © Kelsey Bailey.

The Urban Naturalist (ISSN # 2328-8965) is published by the Eagle Hill Institute, PO Box 9, 59 Eagle Hill Road, Steuben, ME 04680-0009. Phone 207-546-2821 Ext. 4, FAX 207-546-3042. E-mail: office@eaglehill.us. Webpage: http://www.eaglehill.us/urna. Copyright © 2021, all rights reserved. Published on an article by article basis. Special issue proposals are welcome. The Urban Naturalist is an open access journal. Authors: Submission guidelines are available at http://www.eaglehill.us/urna. Co-published journals: The Northeastern Naturalist, Southeastern Naturalist, Caribbean Naturalist, and Eastern Paleontologist, each with a separate Board of Editors. The Eagle Hill Institute is a tax exempt 501(c)(3) nonprofit corporation of the State of Maine (Federal ID # 010379899).
Urban Spider Diversity in Los Angeles
Assessed Using a Community Science Approach

Janet K. Kempf¹, Benjamin J. Adams¹,², and Brian V. Brown¹*  

Abstract - Spiders are ubiquitous organisms in all but the most hostile terrestrial environments and are frequently encountered in urban areas. Assessing spider diversity in cities can require a significant investment of time and resources because the majority of the land is privately owned and fragmented into thousands of difficult-to-access properties. To overcome these challenges, the Natural History Museum of Los Angeles County began the Los Angeles Spider Survey in May 2002. This project, using a community (= citizen) science collecting approach, attempts to inventory the fauna and assess the prevalence of introduced spiders in the greater Los Angeles area. Through 2016, a total of 6,896 spiders have been collected, representing 241 species or morphospecies in 39 families. Nine species, including some of medical importance, represented new records for the area at the time of collection. A comparison to a survey performed in 1904 shows larger changes in the spider fauna.

Introduction

Spiders are an important part of terrestrial ecosystems. They exist in vast numbers in virtually any habitat and are the primary predators of equally common insects. Their small size and ecological flexibility allow them to exist in urban areas at high population levels, even inside buildings and homes (Bertone et al. 2016). Some are highly synanthropic, rarely occurring outside of close association with humans. These factors make spider introductions into new areas a frequent, worldwide phenomenon.

In spite of their importance and abundance, there have been few large-scale surveys of urban spiders (Fraser and Frankie 1986; Shochat et al. 2004; but see Lowe et al. 2014, 2018; Varet et al. 2014). As one of the largest international port cities in the USA, as well as a city with high levels of human immigration and exotic tropical landscaping, Los Angeles represents a prime candidate for documenting urban spider diversity and exploring accidental introduction of new species from other parts of the world. In fact, several of the most common spiders in Los Angeles probably have been introduced over the last hundred years because of these factors. During this same period, urbanization has extended throughout the city and county of Los Angeles and into surrounding counties, replacing many natural areas and former agricultural areas and their spider faunas.

Previously, there were no truly large collections of urban spiders from the Los Angeles urban area, as most collectors concentrated on studying natural areas, nor are there any ongoing studies to monitor the spider populations in Los Angeles (other than ours). Los Angeles area spiders in the NHM collections tend to be from natural areas, collected in small numbers as part of entomological surveys for other organisms.

Because of the venom they use to subdue their prey, spiders provoke a level of concern above that raised by most small arthropods. Often, the public attribute almost any unexplained lesions, bumps, or other irregularities of the skin to “spider bites”, even though no

¹Urban Nature Research Center and Department of Entomology, Natural History Museum of Los Angeles County, 900 Exposition Boulevard, Los Angeles, CA 90007 USA. ²Department of Biological Sciences, George Washington University, Science and Engineering Hall, 800 22nd St. NW, Suite 6000, Washington, DC 20052 USA. *Corresponding author: bbrown@nhm.org

Manuscript Editor: Julie Craves
spider was seen or captured. As a result, spiders are the most common subjects of inquiry to
the Natural History Museum of Los Angeles County’s (NHM) entomology staff, principally
through concerns about Brown Recluse spiders (*Loxosceles reclusa* Gertsch & Mulaik),
Black Widows (*Latrodectus hesperus* Chamberlin & Ivie), and Brown Widows (*Latrodectus
geometricus* Koch). These inquiries have the potential to reveal important information about
spider occurrences throughout the greater Los Angeles urban area if documented, but they
have mostly been overlooked.

In this paper, we discuss past and ongoing efforts to improve the understanding of spider
species composition in Los Angeles. We show that the urban spider community is diverse
and composed of both native and introduced species; however, the most commonly encoun-
tered spiders in urban environments are often introduced species. Also, we compare our
current efforts to historical surveys to consider how urbanization is continuing to impact
and change the Los Angeles metropolitan area spider community. Finally, we demonstrate
that involving community scientists can greatly increase the reach of museum efforts.

**Methods**

Most of the spiders from our study were collected for the NHM Los Angeles Spider
Survey (LASS), the first large-scale, ongoing study of urban spiders in Los Angeles. The
public were invited to participate as community scientists by collecting spiders in their
houses and gardens and bringing them to the museum, along with their recorded collection
data. The goal of the LASS is to determine the makeup of the current spider fauna of the
greater Los Angeles area, to evaluate the incidence of introduced spiders, and to determine
how widespread introduced species are in the urban landscape.

The LASS (also called “the survey”) was begun during the NHM’s annual Bug Fair
in May 2002. The survey was publicized in local newspapers, on radio and television, in
museum publications, on the museum’s website, and at museum events. Detailed informa-
tion about the survey, how to participate, and how to safely catch spiders was included on
the museum’s website together with a form for recording collection data. The spiders in
the study were collected by members of the general public in their houses, gardens, and
other urban areas, and in survey-led collecting events. Although the survey was originally
designed to cover only Los Angeles County, public interest and participation have resulted
in submissions of spiders from throughout the greater Los Angeles area, including northern
Orange, western Ventura, Riverside, and San Bernardino counties.

Geographically, the greater Los Angeles area is a hilly coastal plain bounded by the
Santa Monica Mountains to the north, the San Gabriel Mountains to the east, and the
Pacific Ocean on the south and west. Most of the area within the basin is now urban and
suburban housing or commercial zones. The Los Angeles River and its tributaries wander
from the mountains to the ocean. Many areas along its banks have returned to semi-natural
landscapes. The mountain ranges, as well as several areas within the urban landscape, are
relatively undeveloped.

In addition to the urban collections, data from several surveys of natural areas have been
included. These additional data include collections made during surveys conducted for the Santa
Monica Mountains Recreation Area (SMMNRA), for a National Geographic BioBlitz in 2008
(also in the SMMRA), at the Nature Gardens of the NHM, at Griffith Park, and along the Los
Angeles River. Spiders collected as part of surveys done by other agencies and submitted to
NHM’s Department of Entomology for identification and archiving have also been included in
this survey report. These data include spiders collected during surveys at the James San Jacinto
Mountains Reserve, the Burns Piñon Ridge Reserve in the Mojave Desert, Placerita Canyon Nature Area, and the Santa Rosa Plateau in southern Riverside County as well as a survey of tortoise burrows at Fort Irwin and collections from field entomology classes at Santa Monica College.

Given the community science approach, the LASS is not intended to be a comprehensive, structured survey of spider diversity. Collection methods were described on the museum’s website, but no attempt was made to standardize the public’s collection techniques. There are inherent biases in the collection methods since spiders collected by the public have tended to be those most often encountered in houses and gardens and those that are larger in size. Less common spiders, smaller species, and those occupying cryptic habitats, such as within leaf litter or under rocks, are probably underrepresented but were specifically targeted by LASS staff during any group collections. Formal surveys conducted in the SMMNRA and during a National Geographic BioBlitz are more representative of actual populations since standard collecting procedures were followed, including hand collecting, sweeping, beating, pitfall trapping, and leaf litter sifting. However, these collections represent a much smaller portion of the total number of spiders collected and were in no way collected strategically to function as a comparison to the ongoing LASS survey. Collections from the Santa Rosa Plateau and Placerita Canyon were submitted to the museum without any further data. Spiders from various field entomology classes were collected as bycatch in general insect surveys, similar to collection methods of LASS participants.

When received, each specimen was assigned an original spider survey number and identified, and the collection data were entered into the survey database. The spiders are stored in 75% ethanol in the collections of the NHM Entomology Department. Data are stored in the NHM KEmu database.

Results

The public reaction to the announcement of the LASS was overwhelming and heartening. On the first weekend of sample collection, ~1,000 spiders were contributed. Over 500 individuals or families have participated. In terms of geographic inclusion, a much larger coverage of the city was attained than could have been done by the few staff in the NHM Department of Entomology. From May 2002 to January 2016, a total of 6,896 individual spiders were collected. As expected, the majority of spiders were collected outdoors, largely around gardens, garages, and fences. However, 1,360 spiders were collected indoors. Female spiders were collected slightly more frequently than male spiders, with females representing about 60% of individuals that could be sexed. To our knowledge, no spider bites or other injuries took place in the collection of these specimens.

We identified a total of 4,861 individual spiders to 241 species or morphospecies representing 125 genera in 39 families collected in the greater Los Angeles area (Supplemental Table 1, available online at https://eaglehill.us/URNAonline2/suppl-files/urna-180-Brown-s1.pdf). The 10 most common families accounted for 50% of all the spiders collected, and the 10 most commonly collected species (Table 1) accounted for 52% of all spiders identified. The 10 most commonly collected spiders were almost exclusively urban and were in 7 families and 9 genera. Eight of the 10 are introduced species and were collected mostly in urban areas, but Parasteatoda tepidariorum was also collected in the SMMNRA. The 2 native species, Hololena curta and Latrodectus hesperus, were both widespread and found in all areas. Approximately 14% of all species recorded during the LASS were classified as introduced.
Many of the submitted specimens were immature \((n = 2,028)\), and those specimens have been identified only to family level. A small number of specimens remain unidentified \((n = 7)\). We were able to determine the sex of many of the spiders we examined, even if we could not always identify them to species. The survey recorded 2,286 females and 1,555 males, which includes adult spiders identified to species and immature spiders that were identified to genus.

The following 10 families were the most commonly collected and identified during the survey:

**Theridiidae:** With 1,427 spiders collected in 8 genera and 34 species or morphospecies, this family is the most common found in the survey. The various species are widespread in urban areas and/or natural areas. Three species, *Euryopis californica*, *Euryopis formosa*, and *Steatoda fulva*, were only collected in desert areas. Three of the most common (*Latrodectus geometricus*, *P. tepidariorum*, and *Steatoda grossa*) are introduced species. *Latrodectus hesperus*, a native species, was one of the most common spiders collected, but most of these specimens were collected during the first years of the survey. By 2005, they were not collected except in natural areas. The introduced *L. geometricus*, which was first collected by NHM staff in 2003, was found in increasing numbers throughout the area (Fig. 1).

**Pholcidae:** Six species or morphospecies are represented in the survey. *Psilochorus utahensis*, a native species, was collected in the SMMNRA and the desert. Both *Pholcus phalangioides* and *Holocnemus pluchei* are introduced, cosmopolitan, synanthropic species and found only in urban areas.

**Gnaphosidae:** Twenty-nine species or morphospecies in 12 genera were collected. Members of this family are widespread throughout the survey area. Gnaphosids found only in the desert include *Gnaphosa dentata*, *Haplodrassus eunis*, *Haplodrassus maculatus*, and *Nodocion utus*. Three species are introduced and synanthropic: *Urozelotes rusticus*, *Trachyzelotes lyonneti*, and *Scotophaeus blackwalli*. Of these, *S. blackwalli* is one of the most commonly collected spiders in the survey.

**Agelenidae:** Ten species or morphospecies in 4 genera are represented in the survey. *Hololena curta* was by far the most numerous and was widespread throughout the area. All Agelenids are native except for the *Tegenaria* species.

**Table 1.** The ten most commonly collected spiders during the Los Angeles Spider Survey.

<table>
<thead>
<tr>
<th>Family</th>
<th>Species</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theridiidae</td>
<td><em>Steatoda grossa</em> (C. L. Koch)</td>
<td>594</td>
<td>12.2</td>
</tr>
<tr>
<td>Pholcidae</td>
<td><em>Pholcus phalangioides</em> (Fuesslin)</td>
<td>373</td>
<td>7.7</td>
</tr>
<tr>
<td>Agelenidae</td>
<td><em>Hololena curta</em> (McCook)</td>
<td>284</td>
<td>5.8</td>
</tr>
<tr>
<td>Theridiidae</td>
<td><em>Parasteatoda tepidariorum</em> (C. L. Koch)</td>
<td>213</td>
<td>4.4</td>
</tr>
<tr>
<td>Gnaphosidae</td>
<td><em>Scotophaeus blackwalli</em> (Thorell)</td>
<td>209</td>
<td>4.3</td>
</tr>
<tr>
<td>Theridiidae</td>
<td><em>Latrodectus hesperus</em> Chamberlin and Ivie</td>
<td>195</td>
<td>4.0</td>
</tr>
<tr>
<td>Eutichuridae</td>
<td><em>Cheiracanthium mildei</em> L. Koch</td>
<td>193</td>
<td>4.0</td>
</tr>
<tr>
<td>Oecobiidae</td>
<td><em>Oecobius navus</em> Blackwall</td>
<td>162</td>
<td>3.3</td>
</tr>
<tr>
<td>Theridiidae</td>
<td><em>Latrodectus geometricus</em> C. L. Koch</td>
<td>159</td>
<td>3.3</td>
</tr>
<tr>
<td>Amphinectidae</td>
<td><em>Metalteilla simoni</em> (Keyserling)</td>
<td>155</td>
<td>3.2</td>
</tr>
</tbody>
</table>
Araneidae: These spiders are among the most noticeable because of their orb webs. They are represented by 12 genera and 35 species or morphospecies. Most are native species; exceptions are *Neoscona crucifera* and *Zygiella x-notata* as well as the recently introduced *Larinioides sclopetarius* and *Metazygia zilloides*. Most species are widespread. Several species were found only in natural areas.

Salticidae: Thirty-four species or morphospecies in 17 genera were collected, primarily in urban areas. Nine species were found in natural areas, and 4 of these species were found only in the desert. With 3 exceptions, these widespread spiders are native to the area. The exceptions are *Menemerus bivittatus*, *Plexippus paykulli*, and *Mexigonus minutus*. Of these, *M. minutus* is a new record for Los Angeles.

Lycosidae: Eight genera and 18 species or morphospecies of lycosid were collected. These spiders are widespread throughout the area of the survey.

Eutichuridae: Both species in this family collected in the survey, *Cheiracanthium mildei* and *Cheiracanthium inclusum*, are introduced. Although *C. inclusum* has previously been recorded as common in the area (Edwards 1958), only 1 specimen was collected in the survey, in Griffith Park. *Cheiracanthium mildei* is one of the most common spiders collected and is found exclusively in urban areas.

Oecobiidae: One genus, *Oecobius*, was represented by one described species (*O. navus*) and one further morphospecies. Found only in urban areas, both were probably introduced from elsewhere. They were remarkably commonly collected (n = 162), given their small size.

Amphinectidae: One introduced species, *Metallescina simoni*, was first collected in the mid-1990s in urban Riverside County and is now widespread in the area.

**Significant Single Site Collections**

Excluding collections made by the authors, several participating community scientists, dubbed “super spider collectors”, collected in their homes and gardens over several months, submitting hundreds of spiders to the survey. Some sent individual spiders to the museum as they were collected, while others submitted their accumulated collection at the end of several months. The top 6 collectors, based on number of spiders submitted and length of time they each collected, each submitted over 100 individual spiders (mean ± SD = 180 ± 50;
range = 138–260 spiders) and collectively submitted a total of 1,077 spiders representing 112 species or morphospecies from 72 genera in 34 families. These super spider collectors on average submitted 31 ± 11 (mean ± SD) species from their homes.

Four species were collected in all super spider collector homes and gardens: *C. mildei*, *P. phalangioides*, *P. tepidariorum*, and *S. grossa*. All are introduced species and among the most common collected in the survey. Four additional spiders were represented in 5 of the 6 large collections: *H. curta*, *Dysdera crocata*, *S. blackwalli*, and *M. bivittatus*. Another 2 were present in 4 collections: *Anyphaena pacifica* and *L. hesperus*.

**Faunal Changes During the Survey (2002–2016)**

One notable change has taken place in the fauna during the survey: the southern African Brown Widow, *L. geometricus*, was encountered in the southern part of Los Angeles County (in Torrance) in 2003 and later in other nearby cities. It was then recorded across the entire Los Angeles area in 2007, being found in Encino and San Gabriel, both in the northern part of the county. Today, it is ubiquitous in Los Angeles (Vetter et al. 2012, Vincent et al. 2009).

Announcements of other, less spectacular, introductions were also reported as a result of the LASS (Martinez et al. 2014, Vetter et al. 2008). Several species were new records for the Los Angeles area (Table 2). Significantly, most of these spiders were collected in the Long Beach area near the Port of Los Angeles.

**Faunal Changes Since 1904**

Banks (1904) reviewed existing collections in California and published a list of 74 species found in southern California. His review is not as representative as our survey of the modern spider fauna in southern California, since it was limited in both area surveyed and duration of collection effort, while the LASS represents several years of collecting over a much greater area. In the Banks’s review, most of the spiders collected were from Claremont (eastern Los Angeles County) or “just” Los Angeles with no further locality description. Banks reported 74 species in 23 families and 62 genera. Many records represent just a single genus and 1 or 2 individual spiders.

Five families collected in large numbers in our survey were not represented in Banks’s review. Of these, Anyphaenidae and Tengellidae are native to the area; Dysderidae, Desidae, and Amphinectidae have been introduced. Of the 74 species reported by Banks to occur in southern California, 47 have been collected in the survey and 28 have not (Table 3).

<table>
<thead>
<tr>
<th>Table 2. New records of spiders for the Los Angeles area.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Family</strong></td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td>Araneida</td>
</tr>
<tr>
<td>Araneida</td>
</tr>
<tr>
<td>Araneida</td>
</tr>
<tr>
<td>Linyphiida</td>
</tr>
<tr>
<td>Salticida</td>
</tr>
<tr>
<td>Salticida</td>
</tr>
<tr>
<td>Theridiidae</td>
</tr>
<tr>
<td>Theridiidae</td>
</tr>
<tr>
<td>Zodariidae</td>
</tr>
</tbody>
</table>

6
Additionally, Saylor (in Chamberlin and Ivie) reported on spiders collected mostly in California (Chamberlin and Ivie 1941), likely representing the areas where professional arachnologists were actively collecting. Seventeen species in 9 families and 17 genera were reported as collected in southern California, in Pomona and Santa Ana. Of these, 1 species, *Schizocosa avida* (Walckenaer), was not collected in the LASS.

Of the combined 86 species reported by Banks and Saylor, 60 were collected in our survey and 26 were not. Three of the spiders reported by Banks were among the most common collected in the present survey: *P. phalangioides*, *S. blackwalli*, and *P. tepidariorum*. Two of the 10 most common spiders in the current survey (*S. grossa* and *C. mildei*) were not reported by Banks. However, a different species of *Cheiracanthium*, *C. inclusum*, was not reported by Banks.

Table 3. List of all spiders collected by Banks (1904) that were not collected in the current survey.

<table>
<thead>
<tr>
<th>Family</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agelenidae</td>
<td><em>Hololena pacifica</em> Banks</td>
</tr>
<tr>
<td>Araneidae</td>
<td><em>Araneus angulatus</em> Clerck</td>
</tr>
<tr>
<td>Araneidae</td>
<td><em>Araniella displicata</em> (Hentz)</td>
</tr>
<tr>
<td>Corinnidae</td>
<td><em>Castianeira crocata</em> (Hentz)</td>
</tr>
<tr>
<td>Cybaeidae</td>
<td><em>Cybaeus minor</em> Chyzer</td>
</tr>
<tr>
<td>Dictynidae</td>
<td><em>Emblyna sublata</em> (Hentz)</td>
</tr>
<tr>
<td>Dictynidae</td>
<td><em>Dictyna volucripes</em> Keyserling</td>
</tr>
<tr>
<td>Diguetidae</td>
<td><em>Diguetia canities</em> (McCook)</td>
</tr>
<tr>
<td>Gnaphosidae</td>
<td><em>Herpyllus hesperolus</em> Chamberlin*</td>
</tr>
<tr>
<td>Gnaphosidae</td>
<td><em>Micaria palliditarsa</em> Banks</td>
</tr>
<tr>
<td>Linyphiidae</td>
<td><em>Oaphantes pallidulus</em> (Banks)</td>
</tr>
<tr>
<td>Linyphiidae</td>
<td><em>Spirembolus fasciatus</em> (Banks)</td>
</tr>
<tr>
<td>Lycosidae</td>
<td><em>Pardosa atromedia</em> Banks</td>
</tr>
<tr>
<td>Lycosidae</td>
<td><em>Schizocosa avida</em> (Walckenaer)</td>
</tr>
<tr>
<td>Lycosidae</td>
<td><em>Sosippus californicus</em> Simon</td>
</tr>
<tr>
<td>Pholcidae</td>
<td><em>Psilochorus apicalis</em> Banks</td>
</tr>
<tr>
<td>Salticidae</td>
<td><em>Habronattus elegans</em> (Peckham and Peckham)</td>
</tr>
<tr>
<td>Salticidae</td>
<td><em>Habronattus signatus</em> (Banks)</td>
</tr>
<tr>
<td>Salticidae</td>
<td><em>Habronattus tarsalis</em> (Banks)</td>
</tr>
<tr>
<td>Salticidae</td>
<td><em>Phanias harfordi</em> (Peckham and Peckham)</td>
</tr>
<tr>
<td>Salticidae</td>
<td><em>Phidippus octopunctatus</em> (Peckham and Peckham)</td>
</tr>
<tr>
<td>Salticidae</td>
<td><em>Platycryptus californicus</em> (Peckham and Peckham)</td>
</tr>
<tr>
<td>Segestriidae</td>
<td><em>Segestria pacifica</em> Banks</td>
</tr>
<tr>
<td>Tetragnathidae</td>
<td><em>Leucage venesta</em> (Walckenaer)</td>
</tr>
<tr>
<td>Tetragnathidae</td>
<td><em>Tetragnatha laboriosa</em> Hentz</td>
</tr>
<tr>
<td>Theridiidae</td>
<td><em>Steatoda grandis</em> Banks</td>
</tr>
<tr>
<td>Thomisidae</td>
<td><em>Mecaphesa schlingeri</em> (Schick)**</td>
</tr>
<tr>
<td>Philodromidae</td>
<td><em>Thanatus coloradensis</em> Keyserling</td>
</tr>
</tbody>
</table>

* Listed as *Herpyllus validus* (Banks). ** Listed as *Runcinia californica* Banks.
common in the Banks survey. Only 1 specimen of *C. inclusum* has been collected in our survey, from Griffith Park. None of the most common species collected in our survey were reported by Saylor.

**Discussion**

Enthusiastic participation in the LASS by community scientists has resulted in over 6,500 spiders collected for the survey from the greater Los Angeles area as of January 2016. The most common spiders that were collected are introduced, cosmopolitan species. Some species were found exclusively in urban areas, other species just in natural areas or only in the desert. Many were collected in both urban and natural areas. Several new records were recorded for the Los Angeles area. Some common species appear to have been introduced in the last 100 years, based on their absence from historical surveys; conversely, some species from previous surveys are not reported in our survey.

Our data show that the spiders most frequently encountered by the general public in Los Angeles have changed markedly over 100 years. The most commonly encountered spider in Los Angeles today, *S. grossa*, was not recorded 100 years ago. Also not known at that time were *C. mildei*, a common indoor house spider, and *L. geometricus*, the Brown Widow. Only in the latter case, however, do we have an indication of the changes wrought by the introduced species. The near disappearance of Black Widows in Los Angeles is strongly associated with the colonization of the entire city by Brown Widows (Vetter et al. 2012).

The pattern of introductions observed in our survey differs from the findings of studies on other urban animals. For example, studies of birds worldwide have found that the majority of urban species are native to the area in which the city is located (Aronson et al. 2014). Smaller creatures, like spiders, however, are easily transported via natural (Decae 1987) and human-mediated dispersal events (Luo and Li 2015) and often remain undetected until specialized and more targeted studies are done. Additionally, the mild Mediterranean climate and high levels of international commerce might make Southern California more conducive to hosting exotic animal species than are other cities that have been studied. It is important to note that, globally, urban plant communities tend to host a higher percentage of exotic species (averaging 21%) compared to the percentage of introduced spider species we detected here (Aronson et al. 2014). However, unlike spiders, urban plants are often intentionally introduced and managed as part of urban landscaping.

Community science programs have many benefits but can also suffer from various issues, in terms of both data collections and representation, depending on how they are structured. In general, broad unstructured community science programs can provide much-needed data on populations of species, including potential changes in distribution over time. This benefit is especially true for otherwise inaccessible areas, such as private property, which is common in heavily urbanized and industrialized areas (MacPhail and Colla 2020). The LASS succeeded in documenting a broad sample of the current spider population over the large metropolitan area of Los Angeles and attracted participation from over 500 individuals, groups, and families. This success is in part due to publicizing the event to museum members and at the museum’s annual Bug Fair, which is one of the most heavily-attended events held by the museum. Museum members and Bug Fair attendees are both groups that are likely to already be engaged in science and interested in topics like spider diversity. It is important to note that, although spiders were received from all over Los Angeles County and beyond, there were areas that were underrepresented, mostly in South and East Los Angeles, which tend to be minority neighborhoods. This survey was one of the first by the
museum to actively engage the public as community scientists and has been followed by several other community science projects (Brown et al. 2014).

The level of experience and ability to provide accurate data by participants have also been cited as limitations in community science projects (MacPhail and Colla 2020); however, almost anyone can catch a spider. In fact, the number of people willing to collect live Black Widows was astounding. In our survey, the only major requirement was interest since identification was handled entirely by museum experts and collection data were minimized. In some cases, location or collection dates were incomplete or missing, but this situation was rare.

The data in this survey suggest several areas for future research. Since the goal of the LASS was to assess the current spider population in the Los Angeles area using citizen scientists, there was no attempt to standardize collection techniques. The survey succeeded in documenting much of the current spider population, but participants from the general public are likely to oversample large, conspicuous spiders, leaving the smaller, more cryptic species undersampled. Future structured surveys conducted by museum scientists throughout the same study area would complement LASS data. Special efforts also could be made, such as engaging the participation of the super collectors or providing training to participants on how to capture the species expected to be less well-represented. Undersampled areas also need to be surveyed through more targeted recruitment of community scientists, by surveys conducted by museum scientists, or both.

Finally, monitoring the dynamics of urban spiders in Los Angeles remains a key role for the survey. We know that further species introductions are coming, and given this inevitability, it will be important to carefully document their introduction points, mode of spread, and effects on other species in the Los Angeles Basin.

Acknowledgements

We thank several arachnologists for their help in collecting and/or identifying spiders. Vygandis Relys was an early collaborator on the LASS. Rick Vetter identified many of the most difficult species, especially the Linyphiidae. Mike Martinez collected many of the spiders that are new records for Los Angeles from areas near the port of Los Angeles; Darryl Ubick confirmed the identifications. Brian Patrick confirmed the new record for Tenuiphantes tenuis, and G.B. Edwards confirmed the new record for M. minutus. We also thank the many participants from across the Los Angeles metro area who contributed to this project by bringing spiders to the museum. Comments by 2 anonymous reviewers, as well as the members of the Urban Nature Research Center of the Natural History Museum of Los Angeles County, greatly improved this manuscript.

Literature Cited


