ELSEVIER

Toxicon 42 (2003) 413–418

TOXICON

www.elsevier.com/locate/toxicon

Diagnoses of brown recluse spider bites (loxoscelism) greatly outnumber actual verifications of the spider in four western American states

Richard S. Vetter[a,b,*], Paula E. Cushing[c], Rodney L. Crawford[d], Lynn A. Royce[e]

[a]*Department of Entomology, University of California, Riverside, CA 92521, USA*
[b]*Biology Division, San Bernardino County Museum, 2024 Orange Tree Lane, Redlands, CA 92374, USA*
[c]*Department of Zoology, Denver Museum of Nature and Science, 2001 Colorado Boulevard, Denver, CO 80205, USA*
[d]*Burke Museum of Natural History (DB-10), University of Washington, Seattle, WA 98195, USA*
[e]*Department of Entomology, Oregon State University, 2046 Cordley Hall, Corvallis, OR 97331-2907, USA*

Received 6 January 2003; accepted 19 June 2003

Abstract

We attempt to demonstrate that physicians overdiagnose loxoscelism (colloquially known as 'brown recluse spider bites') by comparing the numbers of such diagnoses to the historically known numbers of *Loxosceles* spiders from the same areas in four western American states. The medical community from non-endemic *Loxosceles* areas often makes loxoscelism diagnoses solely on the basis of dermonecrotic lesions where *Loxosceles* spiders are rare or non-existent. If these diagnoses were correct then *Loxosceles* populations should be evident, specimens should readily be collected over the years and there should be a reasonable correlation between diagnoses and spider specimens. In 41 months of data collection, we were informed of 216 loxoscelism diagnoses from California, Oregon, Washington and Colorado. In contrast, from these four states, we can only find historical evidence of 35 brown recluse or Mediterranean recluse spiders. There is no consistency between localities of known *Loxosceles* populations and loxoscelism diagnoses. There are many conditions of diverse etiology that manifest in dermonecrosis. In the western United States, physician familiarity with these conditions will lead to more accurate diagnoses and subsequent proper remedy.

Keywords: Overdiagnosis; Misdiagnosis; *Loxosceles reclusa*; Spider bite; Arachnidism

1. Introduction

The mythology associated with spider bite diagnoses occurs worldwide causing many dermatologic afflictions to be ascribed to arachnid envenomation (Isbister, 2001, 2002). However, this aspect of clinical toxinology has been hampered by circumstantial evidence, poor reporting, inference and hyperbole (Anderson, 1982, 1998; Isbister, 2001, 2002; Vetter and Bush, 2002a). In a recent report, not one case of 750 verified spider bites with accurate taxonomic identification manifested in necrosis (Isbister and Gray, 2002). This supports the notion that generic spider bite is rarely the etiologic agent of dermonecrosis, contradicting the medical community which frequently diagnoses such.

Although the brown recluse spider, *Loxosceles reclusa*, is a source of occasional dermonecrotic injury (loxoscelism) in its native area, it is frequently blamed for causing idiopathic necrotic lesions throughout North America (Vetter, 2000a; Vetter and Bush, 2002a). Many members of the general public and the medical community perceive it to be a common constituent of their local arachnid fauna (Vetter and Bush, 2002a). Quoting Anderson (a Missouri

* Corresponding author. Address: Department of Entomology, University of California, Riverside, Riverside, CA 92521, USA. Tel.: +1-909-787-3550; fax: +1-909-787-3086.
E-mail address: vetter@citrus.ucr.edu (R.S. Vetter).

0041-0101/03/$ - see front matter © 2003 Elsevier Ltd. All rights reserved.
doi:10.1016/S0041-0101(03)00173-9

physician who researched clinical loxoscelism for 30 + years), "a presumption seemed to take hold that all focal necrosis in skin always must be due to envenomation and always by loxosceles" (Anderson, 1990). In contrast, the biological evidence solidly contradicts brown recluse presence in non-endemic regions where the spiders cannot be reliably found when purposely sought. American arachnologists are often contacted after physician diagnoses or media coverage of alleged loxoscelism. Although *Loxosceles* spiders are exceedingly rare or non-existent in heavily populated portions of California, Colorado, Washington or Oregon (Gertsch and Ennik, 1983; Vetter, 2000a,b), loxoscelism has been widely diagnosed for decades in these states. If even a small portion of these diagnoses were correct, brown recluse spiders would be routinely found by arachnologists, home owners, public health officials, etc. in non-envenomation scenarios, abundant numbers of preserved specimens would be deposited in local museums and *Loxosceles* spiders would be submitted to authorities by patients with dermonecrotic lesions.

Brown recluses are found from southeastern Nebraska to Texas east to southernmost Ohio and Georgia (Gertsch and Ennik, 1983; Vetter, 2000a,b), are both common and abundant in homes and can be collected in great number. For example, 2055 brown recluses (400 + of bite-capable size with no apparent loxoscelism) were collected in a Kansas home (Vetter and Barger, 2002) and 2000 brown recluses were collected for a venom study in Missouri (Kurpiewski et al., 1981), both within 6 months time. In California's southeastern deserts and southern Central Valley, the desert recluse, *L. deserta*, is a common native species, found where human population is sparse. In small pockets of urban Los Angeles County, a South American recluse, *L. laeta*, thrives in subterranean commercial areas and steam tunnels where encounters with humans are minimal. A tramp species, the Mediterranean recluse, *L. rufescens*, is found sporadically worldwide but is rarely collected in our four states.

Because of the numerous contacts we receive, we recorded all loxoscelism diagnoses referred to us that were made by medical personnel in our four states. We compare this to the historical number of *Loxosceles* spiders known from the same areas, to show through indirect evidence, that the statistical probability of these bite diagnoses being correct is very low. If these diagnoses were correct, *Loxosceles* spiders would be abundant and their existence would be well established.

2. Materials and methods

Via referrals and contacts, loxoscelism diagnoses were tallied for a 41-month period starting January 2000. The other authors forwarded similar cases from their states to RSV. Most cases originated from people seeking arachnological information after physician diagnosis of loxoscelism (in order to prevent subsequent 'bites' or to identify suspect spiders from their homes), correspondences with medical personnel who treated or provided care for alleged bite victims and contacts at pesticide applicator continuing-education seminars in California, Oregon and Washington (pest control agencies are often hired by home owners after medical diagnoses of loxoscelism). A few additional cases came from a study on the misdiagnoses of lymphomatoid papulosis (R.S. Vetter et al., MS in preparation), casual contacts with the general public volunteering loxoscelism diagnosis incidents when they learned of our professions, and recent newspaper reportings if a physician or hospital was documented by name. Most accounts were recent diagnoses, however, some had occurred years prior. Only first- or second-hand accounts with verifiable physician diagnoses were tallied. Most contacts came from the 'bite' victim or an immediate relative or co-worker of the afflicted person.

The first three authors are curators of spiders at their respective institutes, collectively curating approximately 175,000 spiders amassed from a wide spectrum of sources. RSV (23 years of California experience) has been investigating *Loxosceles* spiders and the mis- and over-diagnoses of their bites for over a decade. PEC and RLC are the most prominent arachnological authorities for their respective states with PEC (5 years of Colorado experience) conducting an extensive Colorado spider survey since 1999 and RLC (32 years of Washington experience) having published an annotated Washington spider checklist (Crawford, 1988). LAR (7 years of Oregon experience) is the arthropod identification expert for Oregon, having access to a database started in 1986 with the majority of submissions being spiders.

We compared the number of these diagnoses to the number of verified specimens of non-native *Loxosceles* spiders historically found in these four states as well as the location of known populations of other *Loxosceles* species. This information came from a variety of sources including: the definitive taxonomic revision of North American *Loxosceles* spiders (Gertsch and Ennik, 1983), published records (Waldron and Russell, 1967; USDA, 1969), spiders from our museums and from the California Academy of Sciences (100,000 + specimens) in San Francisco, submissions from state agencies and the public, local arachnologists, county agricultural commissioner offices, county entomologists, cooperative extension agents, vector and pest control personnel, the Los Angeles County Museum of Natural History which is performing an urban southern California spider survey, the California Department of Food and Agriculture which handles exotic animal identifications for the state. In short, we sought out many likely sources which would have spider knowledge or receive specimens for identification, many with experience, specimens and databases accumulated over decades.

3. Results

In 41 months, we were informed of 216 loxoscelism diagnoses in California (146), Oregon (35), Washington (22) (Fig. 1) with 13 Colorado diagnoses originating from Denver (8), Durango (2), and 1 each from Golden, Boulder, and Colorado Springs. For the Pacific coast states, bite diagnoses are spread throughout wide geographic areas from large, metropolitan cities to small, rural towns in habitats that range from desert to prairie to mountains varying from moist coastal regions to inland deserts or high elevation grasslands. In California, 138 (94.5%) diagnoses came from cities from which no populations of *Loxosceles* have ever been verified. The remaining eight California diagnoses originated from areas where desert recluses could have been the culprits yet no spider was associated with the incident. No bite diagnoses emanated from Los Angeles County cities known to have the South American recluse spider. Amongst the outcomes attributed to loxoscelism was a single amputation (California), double amputation (Colorado) and one death (California). Of these 216 brown recluse bite diagnoses reported to us, nine were eventually determined to be: Lyme disease (four cases in California), lymphomatoid papulosis (California, Washington), *Staphylococcus* infection (Oregon, Colorado), chemical burn from oven cleaner (California).

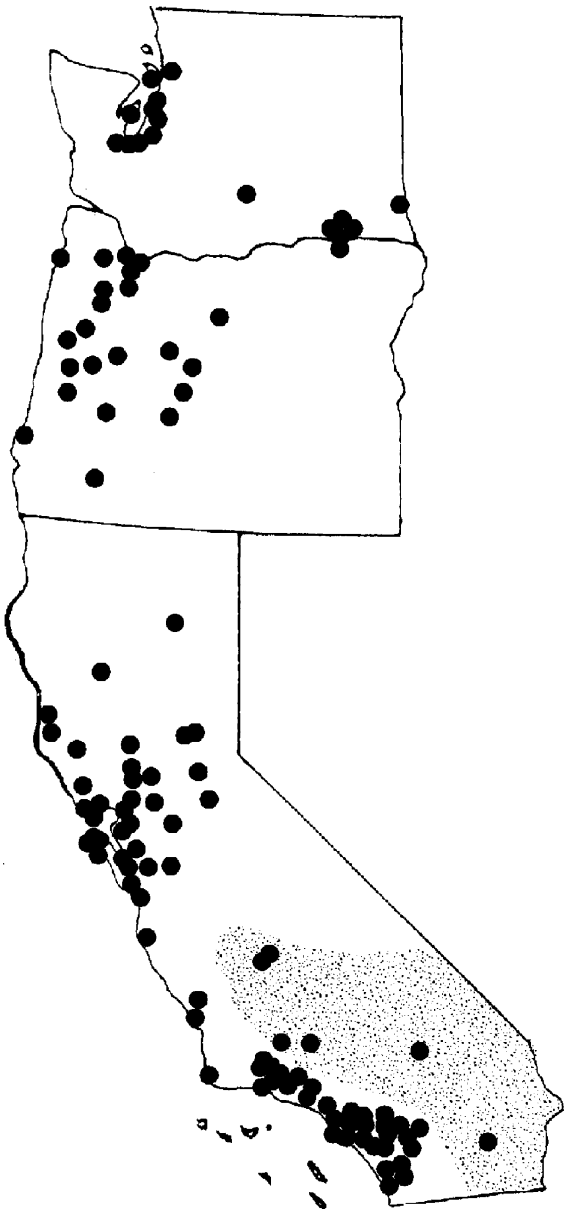

Fig. 1. Localities where loxoscelism diagnoses were made (dots) in California, Oregon and Washington in comparison to the known distribution (shaded area) of the native California desert recluse. Some dots represent a city with more than one diagnoses. The few localities for Colorado are presented in the results section.

In contrast, we can find historical verification of only 17 bonafide brown recluse specimens in the four states listed above: California (8), Colorado (6), Washington (2), Oregon (1) with one verified population in a Colorado bank. In Gertsch and Ennik (1983), only one verified brown recluse is listed from each of Colorado and California. In addition, 18 specimens of the Mediterranean recluse have been historically collected in California (8), Colorado (5), and Washington (5) with one population in a Washington building; three of these records were listed in Gertsch and Ennik (1983). Most specimens listed above originated from facilities which receive interstate goods or from recent household relocations.

Of 26,000 spiders recently identified in the Colorado spider survey, only two were *Loxosceles*. Of 2500 spiders recently submitted in the Los Angeles spider survey, none were *Loxosceles* (J. Kempf, Los Angeles Museum of Natural History, personal communication). None of the 35 historically verified brown or Mediterranean recluse spiders listed above were known to be involved in an envenomation and none of the spiders submitted to us in our careers by western American ‘bite victims’ have ever been *Loxosceles* spiders.

4. Discussion

Loxoscelism diagnoses were made over widespread areas in the western United States and greatly outnumber the *Loxosceles* spiders historically collected from the same areas. This inconsistency indicates that loxoscelism is overdiagnosed in the western United States. In this study, 70 diagnoses originated from Washington, Colorado and Oregon despite supporting no native populations of *Loxosceles* spiders with only extremely rare, sporadic, circumscribed finds. Although it might appear logical in

California that the desert or South American recluse could be a causative agent, almost all diagnoses originated from coastal and central Californian cities where no *Loxosceles* spiders have ever been found. The desert recluse is non-existent outside its endemic area and *L. laeta* is not found in homes and has not dispersed far from known localities (which are not foci of epidemic dermonecrosis), therefore neither species is the likely etiologic agent. *L. laeta* is considered to be an insignificant health risk in Los Angeles (G. Van Gordon, Los Angeles County Department of Health Services, written communication).

Physicians diagnose loxoscelism throughout North America including incredulously improbable *Loxosceles* habitats such as Canada and Alaska (Vetter and Bush, 2002a; R.S. Vetter, unpublished data). The scenario of many loxoscelism diagnoses in juxtaposition to no or few proven *Loxosceles* specimens is not restricted to the western US. In Florida, 95 loxoscelism diagnoses were reported from 21 counties under the jurisdiction of the Tampa poison control center in the year 2000 yet no brown recluses have ever been collected in these counties (Edwards, 2001). Surveying 940 South Carolina physicians revealed 478 loxoscelism reports made in 1990 (Schuman and Caldwell, 1991) yet only one authentic brown recluse spider is listed for the state (Gertsch and Ennik, 1983) and an arachnologist working extensively in South Carolina never collected a *Loxosceles* spider nor had one submitted to him for identification (M. Draney, Univ. Wisconsin-Green Bay, personal communication). Loxoscelism is considered to be a common, annual affliction in Colorado (Mara and Myers, 1977), however, the Colorado spider survey demonstrates the fallacy of this conviction. Considering that individual homes in endemic areas can harbor dozens to thousands of *Loxosceles* spiders with no envenomations (Schenone et al., 1970; Vetter and Barger, 2002), the virtual lack of *Loxosceles* spiders in non-endemic *Loxosceles* areas in juxtaposition to the common diagnosis of loxoscelism points to the conclusion that physicians are over- and misdiagnosing the affliction.

Convincing the western US medical community that they are overdiagnosing loxoscelism is challenging. Although both medical and popular literature repeatedly state a logical argument that brown recluses get transported from endemic areas (Vetter and Bush, 2002a), the erroneous, uncorroborated extrapolation is then made that this occurs frequently, initiating rampant breeding populations and widespread infestations in non-native areas. In reality, translocated spiders die without reproducing otherwise *Loxosceles* spiders would have often established populations in western states, would be routinely found in non-envenomation scenarios and finds would be more numerous than one spider every several years or so. This is more striking when it is realized that one Kansas home without envenomations produced many fold more brown recluses spiders per week (Vetter and Barger, 2002) than our four states produced in history. The actual numbers of *Loxosceles* spiders are not as critical as is the comparative order of magnitude; *annual* loxoscelism diagnoses reported to us are always many times greater than the *historical* verified number of *Loxosceles* specimens found in our states. (As mentioned above, the native desert recluse in California is common in sparsely populated desert but loxoscelism is not rampant there.)

Physicians throughout North America attribute necrotic lesions to spider bites irrespective of the known distribution of medically important spiders (Vetter, 2000a; Vetter and Bush, 2002a,b; this study). The etiologic agents of dermatologic lesions that have been misdiagnosed as loxoscelism are numerous and diverse, many being non-arthropod in nature (Table 1) (Russell

Table 1
Conditions that can be confused with or have been misdiagnosed as brown recluse spider bite as reported in the literature

Bacterial	*Reaction to drugs*
Staphylococcus infection	Warfarin poisoning
Streptococcus infection	*Arthropod-induced*
Gonococcal arthritis dermatitis	Lyme disease
Cutaneous anthrax	Rocky Mountain spotted fever
Viral	*Ornithodoros coriaceus* bite (soft tick)
Infected herpes simplex	Insect bites (flea, mite, biting fly)
Chronic herpes simplex	*Topical*
Varicella zoster (shingles)	Poison ivy/poison oak
Fungal	Chemical burn
Sporotrichosis	*Underlying disease states*
Keratin cell mediated response to fungus	Diabetic ulcer
Lymphoproliferative disorders	*Misc./multiple causative agents*
Lymphoma	Pyoderma gangrenosum
Lymphomatoid papulosis	Pressure ulcers
Vascular disorders	Stevens-Johnson syndrome
Focal vasculitis	Erythema multiforme
Purpura fulminans	Erythema nodosum
Thromboembolic phenomena	Toxic epidermal necrolysis (Lyell's syndrome)
Polyarteritis nodosa	

and Waldron, 1967; Russell and Gertsch, 1983; Kunkel, 1985; Russell, 1986; Rosenstein and Kramer, 1987; Erickson et al., 1990; Roche et al., 2001; Osterhoudt et al., 2002; Vetter and Bush, 2002c; Weenig et al., 2002). Delayed detection or delayed treatment for some conditions (e.g. Lyme disease, lymphoma, cutaneous anthrax, necrotizing bacteria, pyoderma gangrenosum) could have grave consequences. In addition to the obvious detriment to public health, an incorrect diagnosis of loxoscelism can cause unnecessary anxiety in the patient and relatives (Vetter, 1998), improper remedy (Bryant and Pittman, 2003; Vetter and Bush, 2004) and increased risk of litigation (Kunkel, 1985).

5. Conclusions

Corroborating the scenarios in other non-endemic *Loxosceles* areas in the United States, the evidence presented in this study strongly supports the argument that populations of brown recluses do not exist in the western United States and that the number of bites attributed to them is logically impossible. Western American physicians should give greater consideration to many other causative agents before attributing a necrotic lesion to a spider bite. The diagnosis of loxoscelism for dermonecrotic lesions should be considered a regional affliction and, other than the southwestern deserts, in the western United States, loxoscelism should be considered an extremely unlikely event.

Acknowledgements

The authors thank an anonymous reviewer for comments which improved the manuscript especially regarding the clinical information in Table 1.

References

Anderson, P.C., 1982. Letter to the editor. Toxicon 20, 533.

Anderson, P.C., 1990. Loxoscelism and the history of the Missouri brown spider: a recollection of Dr. Joseph Flynn. Missouri Med. 87, 747–752.

Anderson, P.C., 1998. Missouri brown recluse spider: a review and update. Missouri Med. 95, 318–322.

Bryant, S.M., Pittman, L.M., 2003. Dapsone use in *Loxosceles reclusa* envenomation: is there an indication? Am. J. Emerg. Med. 21, 89–90.

Crawford, R.L., 1988. An annotated checklist of the spiders of Washington. Burke Mus. Contrib. Anthropol. Nat. Hist. 5, 1–48.

Edwards, G.B., 2001. The present status and a review of the brown recluse and related spiders *Loxosceles* spp. (Araneae: Sicariidae), in Florida. Florida Dept Agric. Consumer Serv., Div. Plant Industry, Entomol. Circ. 406, 1–6.

Erickson, T., Hryhorczuk, D.O., Lipscomb, J., Burda, A., Greenberg, B., 1990. Brown recluse spider bites in an urban wilderness. J. Wilderness Med. 1, 258–264.

Gertsch, W.J., Ennik, F., 1983. The spider genus *Loxosceles* in North America, Central America, and the West Indies (Araneae, Loxoscelidae). Bull. Am. Mus. Nat. Hist. 175, 264–360.

Isbister, G.K., 2001. Spider mythology across the world. West. J. Med. 175, 86–87.

Isbister, G.K., 2002. Data collection in clinical toxicology: debunking myths and developing diagnostic algorithms. Clin. Toxicol. 40, 231–237.

Isbister, G.K., Gray, M.R., 2002. A prospective study of 750 definite spider bites with expert identification. Q. J. Med. 93, 723–731.

Kunkel, D.B., 1985. The myth of the brown recluse spider. Emerg. Med. 17 (5), 124–128.

Kurpiewski, G.L., Forrester, J., Barrett, J.T., Campbell, B.J., 1981. Platelet aggregation and sphingomyelinase D activity of a purified toxin from the venom of *Loxosceles reclusa*. Biochim. Biophys. Acta 678, 467–476.

Mara, J.E., Myers, B.S., 1977. Brown spider bite. Rocky Mountain Med. J. 74, 257–258.

Osterhoudt, K.C., Zaoutis, T., Zorc, J.J., 2002. Lyme disease masquerading as brown recluse spider bite. Ann. Emerg. Med. 39, 558–561.

Roche, K.J., Chang, M.W., Lazarus, H., 2001. Cutaneous anthrax infection. New Engl. J. Med. 345, 1611.

Rosenstein, E.D., Kramer, N., 1987. Lyme disease misdiagnosed as a brown recluse bite. Ann. Int. Med. 107, 782.

Russell, F.E., 1986. A confusion of spiders. Emerg. Med. 18 (11), 8,9,13.

Russell, F.E., Gertsch, W.J., 1983. For those who treat spider or suspected spider bites [letter]. Toxicon 21, 337–339.

Russell, F.E., Waldron, W.G., 1967. Spider bites, tick bites. Calif. Med. 106, 248–249.

Schenone, H., Rojas, A., Reyes, H., Villarroel, F., Suarez, G., 1970. Prevalence of *Loxosceles laeta* in houses in Central Chile. Am. J. Trop. Med. Hyg. 19, 564–567.

Schuman, S.H., Caldwell, S.T., 1991. 1990 South Carolina physician survey of tick, spider and fire ant morbidity. J. So. Carolina Med. Assoc. 87, 429–432.

United States Department Agriculture, 1969. Coop. Econ. Insect Rep. 19, 847.

Vetter, R.S., 1998. Envenomation by an agelenid spider, *Agelenopsis aperta*, previously considered harmless. Ann. Emerg. Med. 32, 739–741.

Vetter, R.S., 2000a. Myth: idiopathic wounds are often due to brown recluse or other spider bites throughout the United States. West. J. Med. 173, 357–358.

Vetter, R.S., 2000. Brown recluse and other recluse spiders: integrated pest management in and around the home. University of California Pest Notes #7468, 1-4. http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn7468.html

Vetter, R.S., Barger, D.K., 2002. An infestation of 2,055 brown recluse spiders (Araneae: Sicariidae) and no envenomations in a Kansas home: implications for bite diagnoses in nonendemic areas. J. Med. Entomol. 39, 948–951.

Vetter, R.S., Bush, S.P., 2002a. Reports of presumptive brown recluse spider bites reinforce improbable diagnosis in regions of

North America where the spider is not endemic. Clin. Infect. Dis. 35, 442–445.

Vetter, R.S., Bush, S.P., 2002b. The diagnosis of brown recluse spider bite is overused for dermonecrotic wounds of uncertain etiology. Ann. Emerg. Med. 39, 544–546.

Vetter, R.S., Bush, S.P., 2002c. Chemical burn misdiagnosed as brown recluse spider bite. Am. J. Emerg. Med. 20, 68–69.

Vetter, R.S., Bush, S.P., 2004. Additional considerations in presumptive brown recluse spider bites and dapsone therapy. Am. J. Emerg. Med. 22 in press.

Waldron, W.G., Russell, F.E., 1967. *Loxosceles reclusa* in southern California. Toxicon 5, 57.

Weenig, R.H., Davis, M.D.P., Dahl, P.R., Su, W.P.D., 2002. Skin ulcers misdiagnosed as pyoderma gangrenosum. New Engl. J. Med. 347, 1412–1418.