

## An unidentified harvestman *Leiobunum* sp. alarmingly invading Europe (Arachnida: Opiliones)

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**Abstract:** Since about the year 2000 a hitherto unidentified species of the genus *Leiobunum* C. L. Koch, 1839, has rapidly invaded central and western Europe. Records are known from The Netherlands (probably the country of first occurrence in Europe), Germany, Austria and Switzerland. This introduced species, until now, mainly inhabits walls of buildings and rocky environments. Adults characteristically aggregate during daytime into groups of up to 1.000 individuals. The species is described and details on its present distribution, habitat preference, phenology and behaviour are presented.

**Keywords:** aggregation, alien species, behaviour, central Europe, introduced species, invasion strategies, taxonomy

It is not at all common practice to publish on a species that has not yet been identified to species level. In view of the fact that an unknown harvestman of the genus *Leiobunum* C. L. Koch, 1839 has recently not only been found for the first time in the Netherlands, but also in Germany, Austria and Switzerland – regularly occurring in astonishingly large numbers – it seemed useful to publish on this matter as soon as possible. Undoubtedly this introduced species has the ability to become a threat to our indigenous opilionid fauna.

Some blackish specimens of the genus *Leiobunum* (Fig. 1) were found in October 2004 near Nijmegen, The Netherlands. With the key provided by MARTENS (1978) these specimens could not be identified as a north-western or central European species, nor were we able to assign it to any European representative of the genus known to date. During the following years, 2005 and 2006, many more records were obtained from several localities near the river Waal, in the vicinity of Nijmegen. At two industrial sites this mysterious harvestman occurred in extremely large numbers, making it all the more urgent to identify it to the species level. In 2007 this *Leiobunum* species was found near Amsterdam. Simultaneously photos

of similarly sized and coloured specimens turned up on a German Spider Website (<http://spinnen-forum.de/forum>). Some specimens from a town in Saarland, Germany, were collected and they perfectly matched the Dutch species. More sightings were published through this website, one of which originated from Austria.

The fact that an apparently introduced harvestman species has already succeeded in colonizing parts of Western and Central-Europe, combined with the sightings of huge aggregations, gave rise to our concern. In the near future this invasive species could very well become a threat to numerous indigenous harvestman taxa.

From 2004 onward, attempts were made to get this *Leiobunum* identified, by studying the available literature and by contacting several specialists (see Acknowledgements). One of the difficulties one meets with is the worldwide distribution of the current genus *Leiobunum*. About 125 species have been described until now from Asia (especially Japan), Europe, Northern Africa, North and Central America (CRAWFORD 1992, TOURINHO 2007). Moreover, many of the original descriptions are inadequate compared to modern standards. Until now only the central European (MARTENS 1978), the Japanese (SUZUKI 1953, 1976) and partly the North American species (BISHOP 1949, DAVIS 1923) have been revised and can be recognized from the descriptions and figures alone. A worldwide revision of the genus has not yet been undertaken. We started our research on the possible origin of this species in Spain and Northern Africa, and then shifted attention to Mexico and the southern

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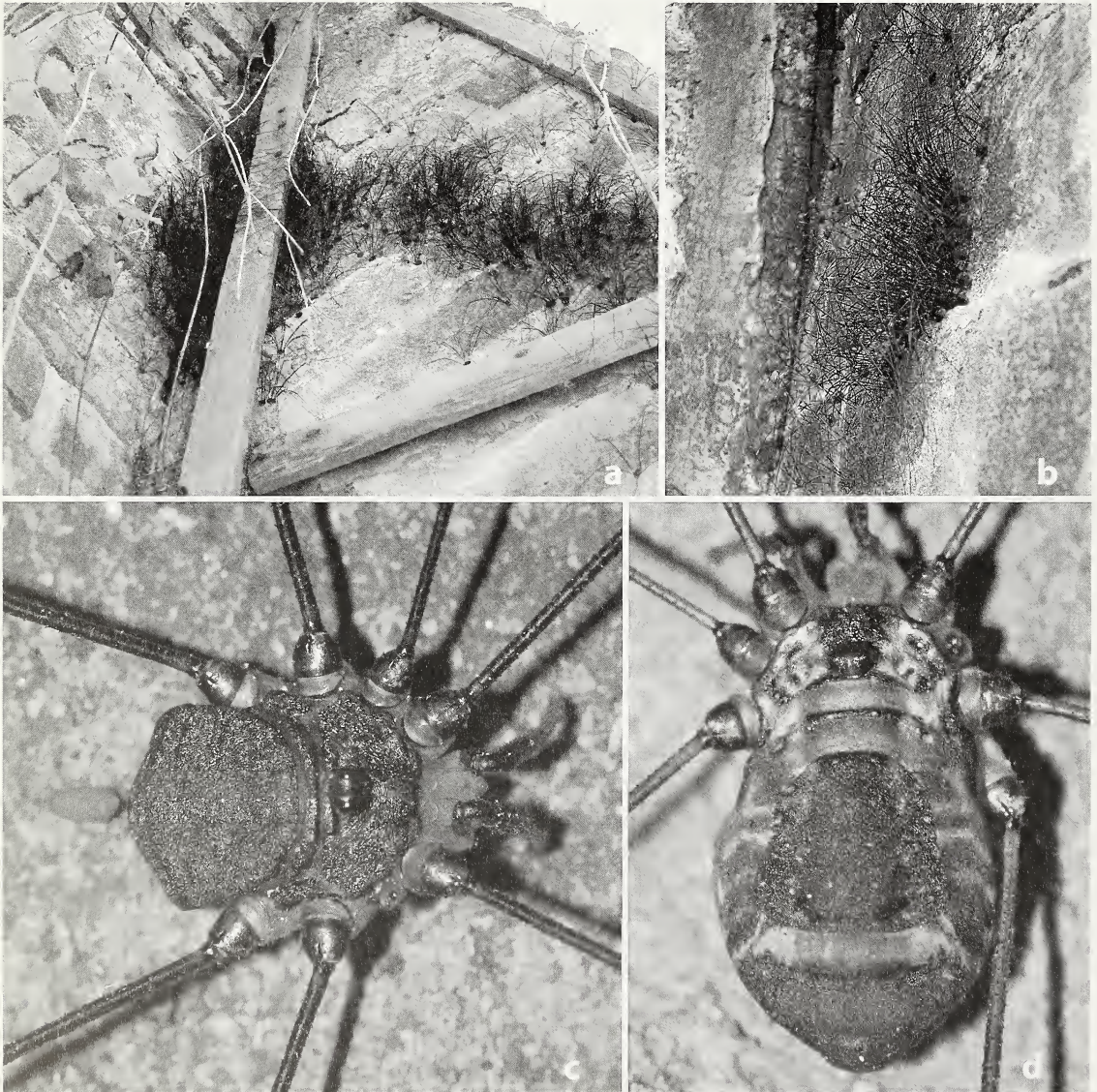
parts of the United States. Still the efforts of many persons proved fruitless. Also type series of various *Leiobunum* species deposited in the Senckenberg Museum were investigated (see Appendix). A first short notice referring to this species was published by WIJNHOFEN (2005).

In this contribution we describe the morphology of this invasive species of the Leiobuninae, which we will name here provisionally as *Leiobunum* sp., summarize the currently known records, and give some information on the habitat, phenology, behaviour and accompanying harvestman species.

## Description of *Leiobunum* sp.

### Field identification

*Leiobunum* sp. is a large species, similar in size to *Leiobunum limbatum* L. Koch, 1861, long-legged, robust, body almost blackish with only a few light markings and with a slightly green metallic shimmering dorsum (Figs. 1c-d). There is only minor sexual dimorphism in coloration and dorsal pattern. Ventrums and coxae of the legs are warm pale yellowish to pale light brown, strongly contrasting with the dark trochanters, legs and dorsum. The legs are conspicuously long and slender, dark brown to black (Figs. 1a-b). In



**Fig. 1:** *Leiobunum* sp.; **a-b:** aggregations of adult individuals, The Netherlands; **a:** on a brickstone wall, Ooij; **b:** on the ceiling of an old building, Beuningen; **c-d:** adults, Witten/Ruhr, Germany; **c:** ♂; **d:** ♀; 2<sup>nd</sup> record in Germany. – Photos: **a, b:** H.W., **c, d:** A. Steiner.



females the tibiae of the legs have conspicuous white tips, reduced in older specimens (Fig. 1b). Large aggregations numbering dozens up to many hundreds of long-legged harvestmen on house walls undoubtedly point to *Leiobunum* sp. This characteristic species cannot be confused with any of the central European *Leiobunum* species.

### Description

We use the following abbreviations (for singular and plural): Ceph cephalothorax, Cx coxa Mt metatarsus, Pt patella, Ta tarsus, Ti tibia, Tr trochanter, ve ventral, ventrally.

**Venter and coxae** (Fig. 2f): armed with hairs, light yellow to pale orange, contrasting strongly with Tr and dorsum; anal operculum white, similar to the joint membranes between Cx and Tr (Fig. 2n).

All Cx with a well developed frontal and posterior row of tubercles (Figs. 2f-g), posterior row of leg three missing, resulting in coxal denticle formula: FB FB F- FB (F=front row, B=back row). Genital operculum armed with scattered hairs; a row of eight to ten denticles on its lateral margins (Figs. 2h-i).

**Pedipalpus** (Figs. 3a-c): Fe armed ve with a row of 5 to 7 large, blunt tubercles and meso-ve with a row

**Tab. 1:** Lengths of legs I-IV (in mm), ♂, in parentheses ♀ (after specimens from Ooij, The Netherlands)

	Tr	Fe	Pt	Ti	Mt	Ta
I	0,4 (0,4)	11,8 (10,5)	1,6 (1,7)	9,4 (8,5)	12,1 (11,0)	15,6 (15,4)
II	0,4 (0,4)	18,0 (17,0)	1,7 (1,6)	17,1 (16,3)	17,2 (20,0)	35,3 (22,8)
III	0,4 (0,4)	12,0 (10,4)	1,9 (1,6)	9,3 (9,4)	13,3 (11,9)	17,4 (16,0)
IV	0,4 (0,4)	15,5 (14,0)	1,9 (1,8)	12,2 (11,0)	18,5 (16,0)	24,3 (21,2)

**Male:** Length of body: 4.0–4.9 mm (n=5); maximum spread of legs: about 180 mm.

**External morphology:** The scutum is of the type 'scutum parvum' (compare MARTENS 1978, Fig. 5), with a finely granulated dorsum. Complex microsculpture, consisting of star shaped granulations and finely sculpted ripples (Fig. 1c). At the anterior part of the Ceph, in front of the eye tubercle, the granulations are somewhat irregular, partly faded, partly arranged in ripples. At the lateral sides of the dorsum the granulations are faded.

**Coloration of dorsum:** dark brown to partly black, in life with a metallic green shimmer, as if covered with a thin oily coating (Fig. 1c). This gloss is lost in alcohol, unless the specimen is left to dry. Some ♂♂ are lighter (much more obvious in alcohol than in live specimens, partially due to the absence of the overlaying gloss), with golden brown patches at the sides of Ceph, occasionally extending on the distal part of abdomen, showing an indistinct central marking. Sometimes the abdominal segments have regularly positioned brown spots laterally and pairs of brown spots on the central marking.

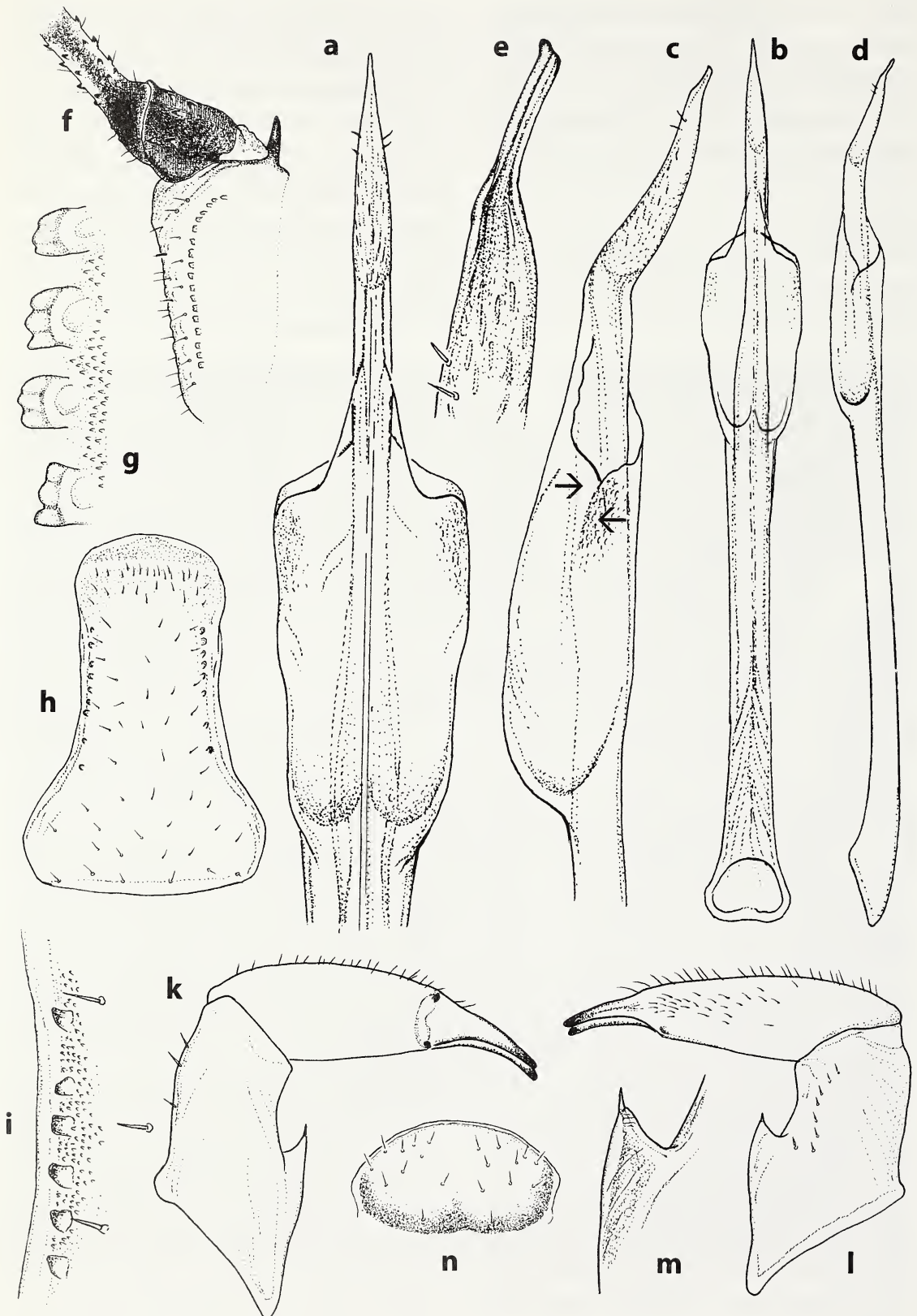
**Eye tubercle:** high, constricted basally, canaliculate, slightly tilted backwards, and armed only with a few very small hairs. The eye tubercle is glossy black, brownish at the anterior base. In some ♂♂ it has a slightly lighter, more or less distinct brown central midline.

of black-tipped denticles; distally at the median as well as the lateral side with some denticles; on the inner proximal side with 1 to 3 black tubercles. Pt with small tubercles dorsally and laterally; Ti ve with scattered tubercles; Ta quite short, only slightly curved inward, ve with a row of 1 to 8 black-tipped, short spines. Pedipalpus pale, yellowish, the apical dorsal portion of the Fe clouded with brown, Pt dark brown, lighter ve, Ti dorsally clouded with brown.

**Chelicerae** (Figs. 2k-m): smooth and glossy, no tubercles present, only armed with small setae, uniformly yellow to pale orange.

**Legs** (Figs. 1a-c, Tab. 1): conspicuously long and slender, dark brown to black, in some ♂♂ with lighter tips at the joints, especially at the tips of the second and fourth leg, its extent often depending on age after maturation. Tr dark brown with some lighter mottling.

**Penis** (Figs. 2a-e): long and slender, seen dorsally the truncus tapering from base to the glans, slightly broadening again below the pockets of the alate part; alate part markedly longer than broad, somewhat broadening from the middle section to the top; distal part almost rectangular. Extreme tip of the stylus with a characteristic small bulbous projection dorsally (Fig. 2e). When seen exactly from the front, the transparent membranes at the top of the alate part intersect. Alate part strongly



flattened in lateral view. Seen laterally the pockets of the alate part appear bulbous-shaped at their base, narrowing to the top, forming a distal opening with a separate dorsal and a ventral membrane (Fig. 2c, arrows).

**Female:** Length of body (in mm): 5.4–6.4 mm (n=5); maximum spread of legs: about 170 mm.

**External morphology** (Fig. 1d): scutum of the type 'scutum parvum', expressed as a stiff, granulated 'shield' once the eggs have started to develop and the body is somewhat enlarged and inflated. Coloration as in the ♂, but with more distinct light markings at the Ceph and abdomen, revealing a dark brown central marking with small regularly spaced light brown to yellow spots on each abdominal segment confined to the lateral margins; central marking frequently terminates in two black, non-shiny, sideways pointed, triangular spots. Dorsum in live specimens with a metallic green shimmer (Fig. 1d) similar to that of the ♂; membranes between and at the sides of the tergites greyish; coloration of the venter strongly contrasting with the dorsum, being pale yellow to pale orange brown, in general slightly more orange than in ♂ ♂.

Legs long and slender, generally slightly shorter than in ♂; the second leg measuring about 80 mm. Legs with conspicuous white tips at the joints, most distinct at the Ti tips of legs II and IV but often reduced in older specimens.

### Taxonomy

In general the penis shape of *Leiobunum* sp. is similar to that of *Leiobunum rotundum* (Latreille, 1798), *L. defectivum* Rambla, 1959 (according to figures in PRIETO & FERNÁNDEZ 2007), the North American species *L. nigripes* Weed, 1892 and *L. ventricosum* (Wood, 1870) according to the drawings in BISHOP (1949). But this similarity may not necessarily indicate close relationships. A shimmering dorsum, even more intense than that of *Leiobunum* sp. is also present in the Mexican species *L. metallicum* Roewer, 1932, but its penis shape is very different. Until now we were unable to trace a valid name for this species. We checked the type series of 26 *Leiobunum* species housed in the Forschungsinstitut Senckenberg, Frankfurt am Main; we conclude none matches the present species (see Appendix).

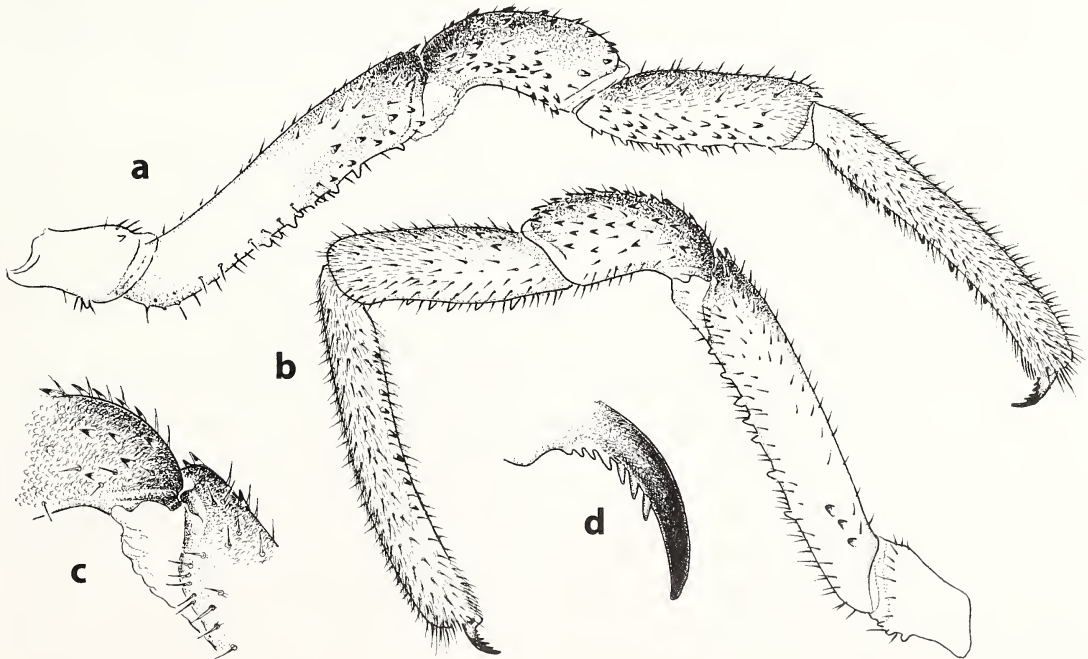


Fig. 3: *Leiobunum* sp.; ♂, pedipalpus; a: lateral view, b: median view, c: joint between Fe and Pt, d: claw of Ta. – © H.W.

◀ Fig. 2: *Leiobunum* sp.; ♂; a-e: genitalia; a-b: penis, dorsal view, c-d: penis lateral view; e: distal part of glans and stylus, lateral view; f-g: first right leg, frontal view of Cx, Tr and Fe and detail of denticles of Cx; h-i: genital operculum and detail of denticles; k-m: chelicera, k: left, lateral view, l: right, median view, m: enlarged ventral spur; n: anal operculum. – © H.W.



### Present distribution in Europe

About 130 specimens were collected; voucher specimens are deposited in Coll. J. Martens (CJM) No. 5315, 5469, 5978–5985, 5988, 6003, 6009, 6038: 39 ♂♂, 23 ♀♀; 3 ♂♂ and 3 ♀♀ in Coll. Naturalis, Natural History Museum, Leiden, The Netherlands; 1 ♂ 1 ♀ in Coll. C. Komposch, Graz, Austria; 2 ♂♂ 1 ♀ in Coll. C. Prieto, Bilbao, Spain; 2 ♂♂, 1 ♀ in Coll. J. Shultz, College Park, USA. The following account lists the confirmed records up to October 2007 (Fig. 4).

### The Netherlands

The first record of *Leiobunum* sp. is from October 19, 2004. A ♂ and ♀ were collected on a concrete construction on a dike in Ooij, east of Nijmegen, province of Gelderland, the Netherlands (N: 51°51' E: 5°56', UTM GT 0249). It is located between the river Waal and a large industrial site. On October 20 a ♂ and ♀ specimen were collected from the same spot, on November 3 another ♂ (HW leg.).

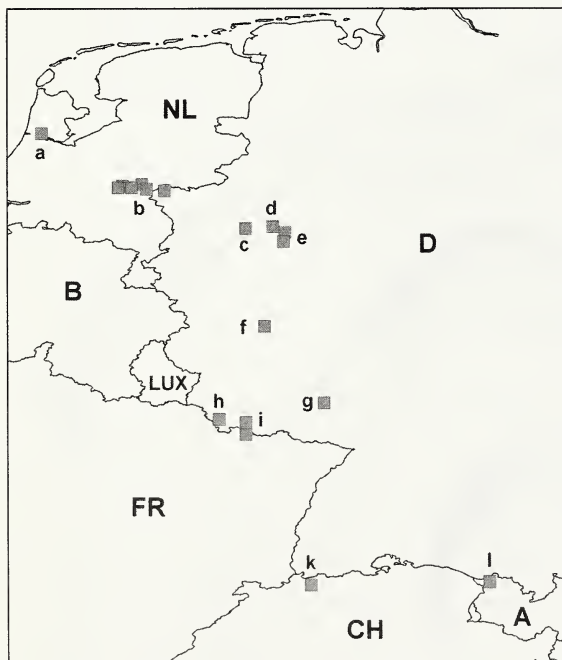
In 2005 permission was granted to visit a nearby industrial site. An old disused brickstone oven functions as a storage building. Hundreds of dark

*Leiobunum* were recorded from its walls between August 4 and October 7, 2005 (Fig. 1d).

In 2006 the species was found in the vicinity of a brickstone factory north of the river Waal, and at several similar locations west of Nijmegen as well. At one particular site the species also occurred in huge numbers (Figs. 1a–b). The owner of this company said this had been going on for four to five years now. At the white walls of his adjacent house one could observe many dense aggregations each containing hundreds of these dark harvestmen.

Additional records in 2007 confirmed this *Leiobunum* has by now colonized large parts of the region in the direct vicinity of the river Waal. Until October 2007 it was found in the villages: Spijk (near Lobith, N: 51°50' E: 6°8'), Ooij, Bommel (N: 51°54' E: 5°53'), Beuningen (N: 50°52' E: 5°46'), Deest (N: 51°53' E: 5°40') and Druten (N: 51°52' E: 5°37', all leg. or vid. HW). The maximum distance between the recording sites in the vicinity of Nijmegen is 40 km.

The first evidence that this species already had to be more widespread in The Netherlands was a record in 2007 in Westzaan (N: 52°28' E: 4°46'), not far from Amsterdam, where some dozens occurred on the walls of a house. Matty Berg collected 3 subadult specimens on June 2, 2007, one adult ♀ on August 13, 2007 (all Coll. HW).



**Fig. 4:** Present distribution of *Leiobunum* sp. in central Europe up to December 2007.

NL: a: Westzaan, b: vicinity of Nijmegen; D: c: Essen, d: Witten, e: vicinity of Hagen, f: Mayen, g: Enkenbach-Alsenborn, h: Saarlouis, i: vicinity of Saarbrücken CH: k: Lausen; A: l: Lauterach.

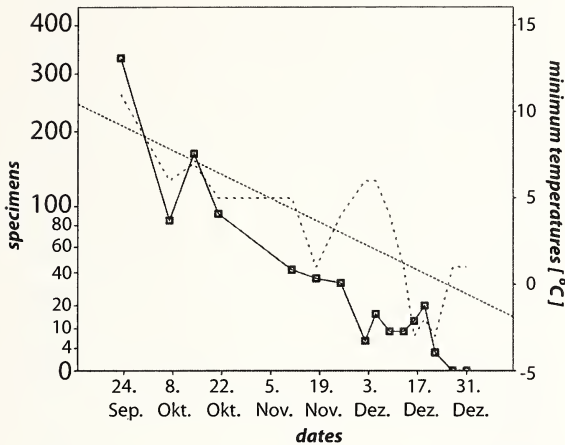
### Germany

**Nordrhein-Westfalen, Witten/Ruhr** (N: 51°26' E: 7°20', TK 4510), one ♀ resting on a shaded wall surrounding a garden area, was noticed by Axel Steiner on September 21, 2006. Based on photographic evidence of a single ♀ this observation represents the first record in Germany.

**Hagen**, near Breckerfeld (N: 51°16' E: 7°27', TK 4710), on November 8, 2006 the second record in Germany was noticed by Axel Steiner, based on photographic evidence. He found one ♂ on the wall of an old historical building in a small forested valley with a creek. On October 13, 2007 he noticed 15–20 specimens on the wall of a closed down factory in Hagen (CJM 6038: 3 ♂♂, 2 ♀♀).

**Essen** (N: 51°24'37" E: 7°1'52", TK 4508), remnants of castle Isenburg situated within the extended city forest protected area; first recorded July 19, 2007 by Jörg Ramsauer, then visited several times from September to December 2007 by Karola Winzer. On one occasion several groups of in

total about 570 specimens were counted via digital photographs on the walls of the old massive gateway (CJM 5978: 5 ♂♂). The population trend at this locality is shown in Fig 5. Continuous decline in the number of specimens associated with decreasing minimum temperatures is obvious. After a severe frost lasting several days (16–22 Dec.) all specimens had disappeared.



**Fig. 5:** *Leiobunum* sp., Isenburg population, Essen, Germany. Population trend from Sep. 24 to Dec. 31, 2007. Bold line and squares: number of recorded specimens; loosely dashed line: minimum temperatures recorded in Essen city; densely dashed line: regression line of minimum temperatures (Data kindly provided by Karola Winzer).

**Rheinland-Pfalz, Mayen** (N: 50°19'50,8" E: 7°14'19,7" TK 5609), industrial area. A pair was found resting at the side of an isolated rock near the road in grassland. At night about 20 specimens were resting or walking on walls of an old house, partly overgrown by ivy (*Hedera helix*) (CJM 6003: 10 ♂♂ 3 ♀♀, ALS leg. 1.10.2007.).

**Enkenbach-Alsenborn**, 15 km east of Kaiserslautern (N: 49°29' E: 7°54', TK 6513). In September 2007 Heike Maurer sent two electronic images of *Leiobunum* spec, one of them showing an aggregation of 17 adult specimens at the northern roofed part above the entrance of a residential building (CJM 5988: 4 ♂♂ 1 ♀).

**Saarland, Kleinblittersdorf-Auersmacher** (N: 49°8' E: 7°2', TK 6808), several small aggregations of about 53 individuals in total were observed by Eva Bolz on the walls of her house (CJM 5979: 2 ♂♂ 3 ♀♀, A. Staudt leg. 12.8.2007).

**Saarlouis** (N: 49°18' E: 6°44', TK 6606), mayor's office, city center, on August 25 and September 1,

2007 two ♀♀ specimens of *Leiobunum* sp. were recorded and collected by Aloysius Staudt. No further specimens were present; no aggregations at the walls of this house or adjacent buildings were found (CJM 5980).

**Dudweiler** bei Saarbrücken (N: 49°16' E: 7°2', TK 6708), Lidl shopping center, September 28, 2007, an aggregation of 40 specimens was detected by Steffen Potel (CJM 5981: 1 ♂, Aloysius Staudt leg.).

## Switzerland

**Kanton Basel-Landschaft**, community of Lausen (N: 47°28' E: 7°45'), about 13 km south of Basel. In September 2007 on the mentioned website Sabrina S. noted an unusual aggregation (several dozens) of large blackish harvestmen in a darkish stable. We could not obtain further information, but this undoubtedly concerned *Leiobunum* sp.

## Austria

**Vorarlberg**, community of Lauterach near Bregenz (N: 47°30' E: 9°44', TK 8424): Günther Muesburger made notice of this opilionid on the mentioned website and added a digital image of a group of four ♂♂ and ten ♀♀ clumped in the corner of a white wall and ceiling. Two ♂♂ and one ♀ were collected (CJM 6009).

## Habitat and behaviour

*Leiobunum* sp. has mainly been found in man-made environments, like buildings and industrial sites. The two localities near Nijmegen with the largest populations hitherto recorded were both situated in the direct vicinity of an old disused brickstone factory. A very striking behavioural feature of this *Leiobunum* is its strong tendency to group together. Large aggregations of harvestmen were found on walls, under roof gutters and window ledges and also at the walls inside an old brickstone oven. It was observed that a negative phototaxis must play a part in the choice of these daytime shelters, most of which were protected from wind and direct sunlight. As a consequence the north-facing walls of buildings were preferred. In Germany it occupied similar habitats. Single individuals or smaller aggregations of up to 20 individuals were resting on the walls of houses as well as sheltered places under roof gutters and in shaded corners of buildings. Yet *Leiobunum* sp. did not seem to be confined to man-

made habitats. The large colony in Essen lived at the ruined walls of an old castle within the Essen city forest, which is a large deciduous forest, with only a single inhabited building in the neighbourhood.

Aggregations of *Leiobunum* sp. maintained their roosting places, once established, for longer periods of time, probably many weeks. At night these predators swarm out on the walls to hunt individually on other invertebrates, returning to their favoured daytime shelters during early morning. In the Essen city forest the colony of more than 500 individuals consisted of several sub-colonies, which more or less remained stable over a period of days. The number of individuals and the exact locations of these aggregations changed only slightly over longer intervals of several weeks (K. Winzer, personal comm.). Observations in The Netherlands indicated these favoured shelters were used year after year by the successive generations. The stability of these local aggregations and their long-term use could simply be demonstrated by the presence of faeces which were deposited on the wall. Several images placed on web sites clearly pointed out the daytime shelters as concentrations of numerous small black droppings. On white painted walls of houses these droppings could be quite annoying to the residents. On two occasions the inhabitants stated for this reason they had removed and destroyed all harvestmen from their house walls (HW).

Aggregations of *Leiobunum* sp. were very easily disturbed, especially by sudden changes in light conditions. If, for example, one moved too close by, the animals suddenly started to move their bodies up and down in a fast rhythmic motion. This abrupt 'bobbing' behaviour would swiftly spread through a whole group, with individuals moving away from the disturbance. Eventually the group would break up.

### Phenology

Until now we have no detailed information on the life cycle of *Leiobunum* sp. In Europe it is mature in summer and autumn. Most records of single individuals and mass aggregations only consisted of adult specimens. They dated from the beginning of August to the end of December. Maximum numbers were observed in September. In October the aggregations started to disintegrate. Egg deposition apparently occurs during that timespan and eggs probably overwinter. The end of the

individual life time may be limited by the scarcity of (arthropod) food sources in late autumn and by the onset of frost in November/December. This type of life cycle is common among European harvestmen, including all *Leiobunum* species of the mentioned region (MARTENS 1978). Numerous juveniles of a *Leiobunum* species were found under stones, rubble and pieces of wood on April 20. Later at this site large groups of *Leiobunum* sp. were observed. Close to Amsterdam some subadults were collected from the walls of a house early June. So probably the first juvenile stages live at ground level, while the subadults may move to the higher strata of walls and rocks. Thus, like all *Leiobunum* species, the life cycle of single individuals is confined to one year.

In total approximately about 6,240 adult *Leiobunum* sp. were recorded in The Netherlands. One large group of 770 specimens was counted with the help of digital images. Also a few other groups were counted in this manner. Based on this experience for most other aggregations the numbers could be estimated. Aggregations observed on exactly the same spot were recorded only once. The sex ratio for ♂♂ is 46.6 % (n=653: 304 ♂♂, 349 ♀♀).

### Accompanying harvestman species

Time and again it was observed that in The Netherlands on walls with large aggregations of *Leiobunum* sp. almost no other harvestman species were to be found. This *Leiobunum* seemed to absolutely dominate these habitats. On some rare occasions single individuals of *Leiobunum rotundum* (Latreille, 1798), *Leiobunum blackwalli* Meade, 1861, *Dicranopalpus ramosus* (Simon, 1909), *Opilio canestrinii* (Thorell, 1876), *Opilio parietinus* (De Geer, 1778) and *Phalangium opilio* Linnaeus, 1758 were observed at the margins of such *Leiobunum* aggregations. Most frequently *Leiobunum rotundum* also was found inside these groups. Furthermore in the surrounding areas remarkably few harvestmen were recorded. Especially very common species like *Paroligolophus agrestis* (Meade, 1855) and *Oligolophus tridens* (C.L. Koch, 1836) which, at least at night, penetrate the herb and bush strata seemed almost completely absent.

### Predators

A few observations were made of other invertebrates preying on *Leiobunum* sp. Frequently spider webs of *Nuctenea umbratica* (Clerck, 1757), *Araneus*



*diadematus* Clerck, 1757 and species of the family Agelenidae contained bodies and/or separate legs of this opilionid. A salticid spider *Marpissa muscosa* (Clerck, 1757) was observed on a wall with a body of this *Leiobunum* in its jaws, with the legs being removed.

## Discussion

### Behaviour

A prime feature of *Leiobunum* sp., otherwise only rarely observed in European Opiliones, is its tendency to aggregate into massive numbers. Their daytime shelters may contain over one thousand individuals. In Europe, similar behaviour is known from *Amilenus aurantiacus* (Simon, 1881), a long legged species not closely related to *Leiobunum*, when the subadults wander into cave systems, where they moult to adulthood and stay there in groups of hundreds and even thousands over the winter (MARTENS 1978). Sightings of groups of *L. rotundum*, numbering a few dozens up to a hundred individuals, have been observed in The Netherlands (HW personal obs.). In general, European *Leiobunum* species never aggregate to numbers presently observed for *Leiobunum* sp. HOLMBERG et al. (1984) classified such aggregations into two types: 'loose' and 'dense'. In loose aggregations the bodies of the opilionids were oriented in different directions with the legs flexed or outstretched on the ground. The animals' bodies could still be distinguished separately, although in most cases the opilionids' bodies were oriented in the same direction, with their 'heads' down. In dense aggregations the opilionids clung together so tightly, the individual animals were barely recognizable. These aggregations may consist of several layers of opilionids. They attached themselves to the substrate and to those opilionids underneath by the claws of their pedipalps or chelicerae. The legs were hanging straight down motionless, which would look like "a mass of black horsehair" (HILLYARD 1999 citing an observation of uncertain species affiliation in Great Britain mentioned by WOOD 1863: 677). This type of dense aggregation was occasionally observed in *Leiobunum* sp. within the larger groups of at least 140 animals. However, all sorts of intermediate types of aggregations were often seen, with harvestmen densely packed in the centre of the aggregation and the 'loose type' at the periphery of such clusters. In other regions rich in *Leiobunum* species, like Japan (SUZUKI 1953, 1976),

none tends to aggregate to comparable numbers of individuals (Tsurusaki, personal comm.).

Observations on overwintering mass aggregations of *Leiobunum paessleri* Roewer, 1910 in caves in British Columbia suggested that the combined action of many opilionids' scent glands was more effective as a repellent against predators than one individual's effort (HOLMBERG et al. 1984). In this respect the formation of aggregations may be regarded a defensive strategy. Also, in our opinion, the white tibia tips of *Leiobunum* sp. could have a defensive function. These white tips were most distinct on the longest legs II and IV (Figs. 1a-b). In aggregations slight movements of the legs may provide for a 'floating' sheet of 'light flashes', distracting the attention of predators (like birds) away from the lower layer of vulnerable bodies. So perhaps all *Leiobunum* species with white tibia tips will have the tendency towards forming groups. More hypotheses as to why harvestmen aggregate are presented by MACHADO & MACÍAS-ORDÓÑEZ (2007). According to a list in this contribution it is obvious that the size of *Leiobunum* sp. aggregations ranks among the seven or eight species with the largest aggregations ever observed in Opiliones.

### Habitat

Until now in Europe *Leiobunum* sp. is more or less confined to human environments, mainly walls of houses. However the large colony of more than 500 individuals living at the ruined walls of a castle in the Essen city forest indicates *Leiobunum* sp. primarily may be regarded a rock-dwelling species. The preference for sheltered rocky habitats coincides with several Dutch records of *Leiobunum* sp. at isolated places far away from buildings, e.g. piles of concrete rubble at the banks of the river Waal.

### Invasion strategies and influence on indigenous species

The European harvestman fauna always has been subject to considerable changes in species composition. Some of the recent changes have been documented in detail, showing that several species adapt to new territories without notably influencing the indigenous opilionid fauna. Of *Opilio ruzickai* Šilhavý, 1938, originating from the Balkan region, on one occasion only two specimens were found in Innsbruck, Austria (CJM 3521, 1 ♂ ♀, Innsbruck, Stadtgebiet, Weiherburggasse, an Hauswänden, 730-800m, JM leg. 27.9.-1.10.1986). In the Vienna

region, Austria, a population of this species has persisted for at least 45 years. Once established, it enlarged its territory for several decades (GRUBER 1996, KOMPOSCH & GRUBER 2004) but within a couple of years remained more or less stable in range and numbers and did not much influence the local species set (GRUBER 1996).

Other recent invasions, like the one of *Dicranopalpus ramosus*, originating from the western Mediterranean region, turned out to be more influential. In the beginning it expanded its range only slowly to southern Spain and further on to Great Britain (RAMBLA 1986, SANKEY & SAVORY 1974), but since around 1990 it has been rapidly moving northeast (NOORDIJK et al. 2007). The species reached Germany (SCHMIDT 2004), but until now the populations are patchily distributed and locally only small numbers of individuals are concerned. In the Netherlands and parts of France it is locally quite common nowadays not only on walls of houses in urban habitats. It has already adapted to natural habitats as well. Although it was suggested it may compete with indigenous species like *Leiobunum rotundum* and *Paroligolophus agrestis* (WIJNHOFEN 2006) ALS found both species syntopically with *D. ramosus* in France (Bretagne, Dép. Morbihan, West of Lorient, Guidel-Plages, Le Pointic, in September 2005). The population density of the indigenous species did not seem to be influenced markedly. *Paroligolophus agrestis* was numerous and *Leiobunum rotundum* occurred regularly. Wall-dwelling specimens of *D. ramosus* were found side by side with *Phalangium opilio* in nearby settlements. It appears that this species will rather supplement the European species community of harvestmen than disturb it.

Other faunal changes were much more dramatic. The large-scale invasion of *Opilio canestrinii*, probably from trans-alpine Italy, starting around 1970 considerably influenced the central European fauna. Within a few decades *O. canestrinii* invaded all of central Europe and beyond and became an ubiquitous species. During this process wall-dwelling species like *Leiobunum rotundum* and *Opilio parietinus* became rare or disappeared completely, especially the latter species. The same happened with *Leiobunum tisciae* Avram, 1971 which is (or at least was until recently) widely distributed in northern Germany around the Baltic coast and southern Scandinavia (MARTENS 1978, ENGHOF 1988, TOFT 2004). It is an immigrant species

itself, probably originating from the Carpathians (MARTENS & SCHÖNHOFER in preparation). With the advance of *Opilio canestrinii*, *Leiobunum tisciae* more or less completely disappeared from the western countries of its area (TOFT 2004, personal comm.).

These invasive harvestmen all have in common that they are long-legged species, colonizing man made environments. Also some of these species, after having been naturalized, succeeded in colonizing more or less natural habitats, like forests. In Germany, *O. canestrinii* is presently found in broad-leaved forest habitats, e.g., in the Taunus Mountains in the Frankfurt am Main area. It was recorded in high numbers on tree trunks with smooth bark (e.g., *Acer*) in the Oder inundation forests (Brandenburg; Losow, near Frankfurt a.d. Oder, CJM 4779, ALS leg. 16.10.2005). *Opilio canestrinii* is now the dominant long-legged species there. In this habitat *Leiobunum rotundum* and *L. blackwalli*, formerly the predominant species in the herb layer and on tree bark are nowadays represented only by a minor fraction of the total population of long legged harvestmen in summer and autumn. In the Netherlands, too, *O. canestrinii* is now one of the most abundant species in a wide range of habitats.

The invasion of *Leiobunum* sp. into Europe may, however, exceed our experience with alien harvestmen. This newly-arrived, long-legged species is capable of rapidly spreading into man-made habitats. It obviously has a high reproduction rate, resulting in large populations within a few years. If, as some observations already suggest, this species will be able to adapt to central European climatic conditions and invade natural habitats as well, its offensive character could become a real threat. Many endemic species including those of the Alpine region could be at risk.

Large numbers of opilionids need large amounts of food. Among other arthropods, many syntopic (and synanthropic) harvestmen species may be part of their menu, especially juveniles. Since *Leiobunum* sp. seems to reach maturity quite early (end of July, beginning of August) this may act as a powerful competitive weapon. Not to mention the direct effects of disturbing other opilionids, simply by their large numbers.

We conclude that *Leiobunum* sp. has been introduced into Europe around the year 2000, the country of introduction probably being the



Netherlands. Regarding the generally low interest of Central European arachnologists in harvestmen, the accumulation of recent records within the last two years may indicate this new species by now has already colonized large areas.

In our opinion the invasion of *Leiobunum* sp. and its effects on the local fauna require detailed attention – a specific monitoring-program should be established. Also solid data on its life cycle, biology and ecology are needed: food, mating period, egg deposition, duration of embryonic development, the period of occurrence of juvenile instars and of adults, frost and heat resistance, migratory behaviour of juveniles and adults. Hopefully our concerns regarding the damaging effects of the invasion of this new species will not come true.

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### Zusammenfassung

Etwa seit dem Jahr 2000 breitet sich eine bisher nicht identifizierte Art der Gattung *Leiobunum* C. L. Koch, 1839 schnell in Mitteleuropa aus. Nachweise ab dem Jahr 2004 sind aus den Niederlanden (wahrscheinlich dem Land des ersten Auftretens in Europa), Deutschland, Österreich und der Schweiz bekannt. Die wahrscheinlich eingeschleppte Art besiedelt bisher lediglich Wände von Gebäuden und seltener felsähnliche Biotope in Wäldern. Adulte Individuen ruhen tagsüber selten einzeln oder in eng geklumpten Gruppen aus Dutzenden bis Hunderten von Individuen an leicht abgedunkelten Stellen in Mauerwinkeln, an glatten Hauswänden und überhängenden Dachtraufen. Jungtiere leben am Boden. Diese Art verfügt über ein großes Vermehrungspotential mit früher Reifezeit und ist in der Lage, schnell große Populationen aufzubauen und sich rasch über große Distanzen auszubreiten. Heimische Weberknechtarten scheinen durch sie verdrängt zu werden. Die Herkunft dieses *Leiobunum* ist bislang unbekannt. Genitalmorphologisch bestehen Ähnlichkeiten zu europäischen und nordamerikanischen Arten.

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**Note:** For further documentation the authors would like to encourage all fellow arachnologists to look for this novelty. We would like to receive any additional recording of this *Leiobunum*, whenever possible accompanied by electronic images. Also preserved specimens are welcome at any time.

## Appendix

Type series of *Leiobunum* checked in the collections of the Forschungsinstitut Senckenberg, Frankfurt am Main:

*L. anatolicum* Roewer, 1957, Holotype SMF 9906444, Turkey; – *L. bifrons* Roewer, 1957, Holotype SMF 9902870, Japan; – *L. bimaculatum* Banks, 1893, Paratype SMF 9800038, USA, Alabama; – *L. biserialatum* Roewer, 1910, Syntype SMF 9800005, Afrika; – *L. caporiacci* Roewer, 1957, Holotype SMF 9906235, Greece; – *L. cavernarum* Roewer, 1952, Holotype SMF 9911046, USA, North Carolina; – *L. coccineum* Simon, 1878, Syntype SMF 9800004, Algeria, Algier; – *L. consimile* Banks, 1900, Paratype SMF 9800037; Paratype SMF 9800052, Mexico; – *L. cupreum* Simon, 1878, Syntype SMF 9800021, Morocco; – *L. curvipalpi* Roewer, 1910, Holotype SMF 9800006, Japan; – *L. hedini* Roewer, 1936, Syntype SMF 9904748, China; – *L. heinrichi* Roewer, 1957, Holotype SMF 9906234, Paratype SMF 9909008, Myanmar; – *L. hongkongium* Roewer, 1957, Holotype SMF 9910256, China; – *L. insignitum* Roewer, 1910, Syntype SMF 9800053, Mexico; – *L. insulare* Roewer, 1957, Holotype SMF 9900381, Greece; – *L. ischionotatum luteovittatum* Roewer, 1912, Syntype SMF 9800058, Mexico; – *L. japonicum* Müller, 1914, Syntypes SMF 2047, 2120, Japan; – *L. lusitanicum* Roewer, 1923, Holotype SMF 9900382, Portugal; – *L. metallicum*, Syntype SMF 9903692, Mexico; – *L. mirum* Roewer, 1957, Holotype SMF 9902871, Nepal; – *L. nycticorpus* Goodnight & Goodnight, 1942, Paratype SMF 9909060, Mexico; – *L. seriatum* Simon, 1878, Syntype SMF 9800017, Syria, Latakia; – *L. socialissimum* C. L. Koch, 1848, Syntype SMF 2057, 9800014, 9800025, Morocco; – *L. speciosum* Banks, 1900, Syntype SMF 9800038, USA, Alabama; – *L. suzukii* Roewer, 1957, Holotype SMF 9911217, Japan; – *L. townsendi* Weed, 1893, Syntype SMF 9800044, USA.



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