

## Sexual behaviour in *Loxosceles gaucho* Gertsch (Araneae, Sicariidae)

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### Summary

Sexual behaviour in the brown spider, *Loxosceles gaucho*, is described by a flow diagram on the basis of laboratory observations of 28 monogamous couples performing a total of 41 copulations. In courtship, both males and females showed foreleg vibration, palpal drumming and abdominal pulsation, in accordance with the general pattern in haplogyne spiders. However, they used the web in the copulatory process and had a similar mating posture to that shown by some other web-spinning spiders. The sexual behaviours of another 19 virgin pairs in 19 copulations were quantified, and showed that the females were as active as the males. The frequencies of these behaviours in courtship and precopulation were estimated, revealing a remarkable increase in sexual behaviours during precopulation. The sexual behaviour in *L. gaucho* follows the same general pattern as that described for *Loxosceles laeta* and *L. reclusa*, but with some differences in both courtship and copulation, suggesting that reproductive isolation in these species depends on the vibratory pattern of palpal drumming and abdominal pulsation.

### Introduction

Little is known about the biology, ecology and behaviour of *Loxosceles* spp. The spiders of this genus constitute an important group in veterinary and human medicine, therefore the study of their reproductive behaviour contributes to the understanding of the factors that may influence their population growth. Comparison with other species is relevant to discover the behaviour mechanisms which are general to all the group. Galiano (1967) described courtship and mating behaviour for *L. laeta* (Nicolet) using five phases: precourtship, courtship, precopulation, copulation and postcopulation.

Despite being abundant in south-eastern Brazil, *L. gaucho* Gertsch is one of the least studied species. It can be found in house yards, being sedentary in irregular webs which cover the substrate like a sheet (Gertsch, 1967).

In the current study, the frequency of the sexual behaviours of pairs of *L. gaucho* was recorded and described in a flow diagram, and its sexual behaviour is compared with that of *L. laeta* and *L. reclusa* Gertsch & Mulaik, according to the data available in the literature.

### Methods

Pairs of *L. gaucho* were reared individually in the laboratory from the moment of hatching onwards. The spiders were kept in diet tubes until their subadult phase (4th instar), and then transferred to acrylic boxes (17 × 8 × 7 cm).

The spiderlings were fed, first with *Drosophila* sp., and then *Musca domestica*, *Gryllus* sp. and other insects collected by sweeping.

Random pairs of adult females and males of *L. gaucho*, from different mothers, were used in trials. In each case, the male was placed on the female's web, always keeping a certain distance from her. Two experiments were developed: (1) 28 trials, by placing the male on the female's web, and recording 41 copulations on cassette tapes. The behaviours were grouped and quantified by analysing the playback of each copulation and transforming them into percentages (Fig. 5). This allowed us to assess the receptivity of the pairs for copulation, since they were left to mate until receptiveness ceased. (2) To quantify the time spent in each sexual behaviour phase and analyse their more conspicuous behaviours, we used a VHS video recorder during 19 copulations carried out by 19 virgin pairs, different from those used in the first test. Males and females were separated just after the first copulation. To quantify the sexual phases, it was necessary to define the limits of each phase. Courtship was defined as beginning when the male emitted its first sexual signal, e.g. palpal drumming or foreleg vibration. The end of courtship and start of precopulation was when the male palps became hidden under the female's cephalothorax. Similarly, the start of the male's palpal insertion into the female's genital pores was set as the limit between the precopulation and copulation phases. Palpal drumming could not be recorded in the precopulation phase.

In order to compare behavioural patterns between males and females and between both phases (courtship and precopulation) we used the *t*-test for dependent samples on the square roots of data.

### Results

Preliminary observations indicated that both male and female *L. gaucho* perform three main sexual behaviours: foreleg vibration (Fig. 1), palpal drumming (Fig. 2) and abdominal pulsation (Fig. 3). Foreleg vibration is the simultaneous vertical movement of the forelegs, whose tarsi touch the female's web. Rhythmical vibration of the male's forelegs is very impulsive, while in the female it is more constant and slower. In palpal drumming, the spiders move their palpi alternately and vertically, this being most frequent in males and rare in females. The abdominal pulsation is a quick vertical and horizontal abdominal movement in the male, whereas in females it is a slower vertical movement. In the copulation, the *L. gaucho* male, in a single quick striking movement, lifts the female upside-down in relation to the substrate while the palps are inserted (Fig. 4).

During courtship, the males, when they first contacted the female's web, always vibrated their forelegs (Fig. 5). On dense webs, the males often cut some of the threads with their chelicerae while they approached the females. The females, which were beside or behind the males,

moved slowly into a face-to-face position in response to the male's foreleg vibration. For palpal drumming, the males vertically twisted their left palps clockwise and the right palps in the opposite direction, making a 90° angle in relation to the substrate. In the precopulation phase, when the males advanced under the female's cephalothorax, their palps gradually came to rest (horizontal, parallel to the substrate). In the copulation, at the moment of palpal insertion, the males twisted their palps in an inverse direction from the courtship, reaching an angle of 180°.

In the copulation, *L. gaucho* behaves like the primitive spiders: the male faces towards the female, the female lifts her own cephalothorax and the male inserts his palps into the female's gonopores. However, the male occupies a parallel position, like other web-spinners (Fig. 4). During the male's strike, the weight of the female and the male is supported only by the male's 4th legs and abdomen (Fig. 4). The male's striking movement was always quick, followed by palpal insertion. There was no insertion without the strike. Sometimes the females appeared non-receptive (Fig. 5), i.e. they resisted the male's stroking. During courtship, the females stretched their legs sideways (Fig. 5), ceasing their body movements.

#### Receptivity of the pairs for mating

In 28 trials with 28 males and 28 females, 17 pairs (60.7%) copulated at least once, while 11 pairs (39.3%) did not perform any copulation. Table 1 shows the distribution of numbers of copulations by the pairs. The

spiders that mated successfully had an average of  $2.41 \pm 1.42$  copulations per couple.

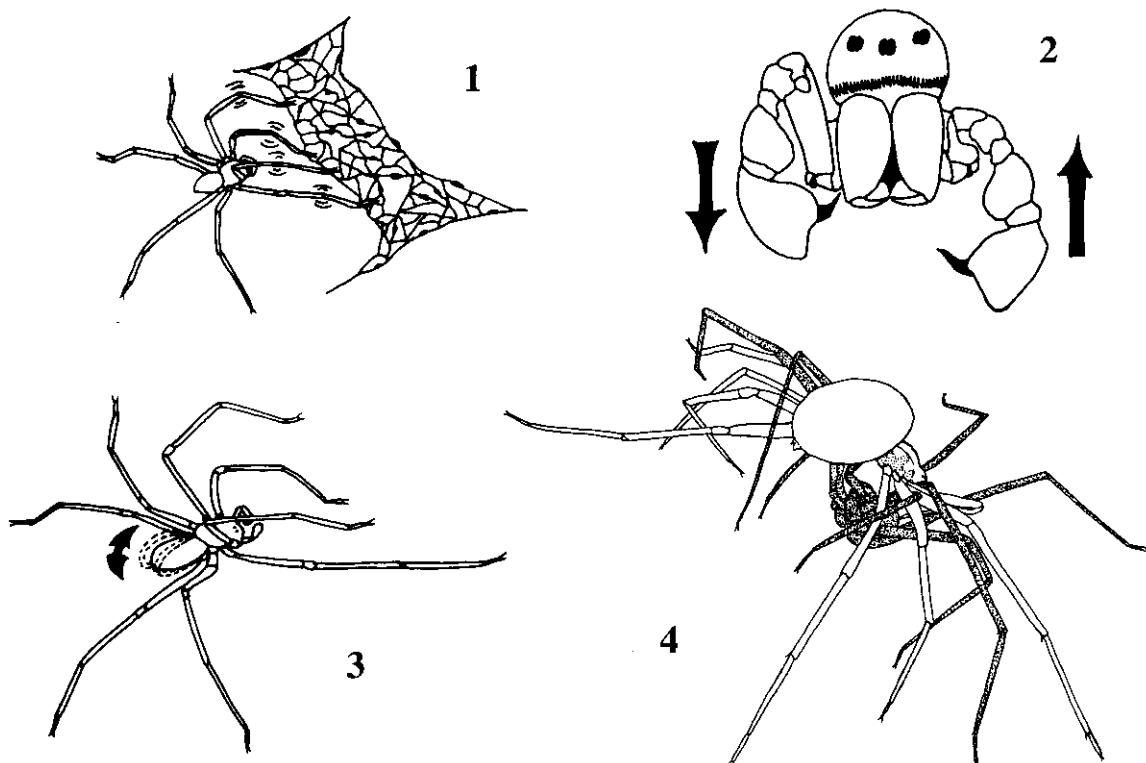
The sequence and frequency of the sexual behaviours performed in 41 copulations by the 17 receptive pairs, and by the other 11 non-receptive pairs, are shown in Fig. 5. The observed frequency of their behaviours is represented by the thickness of the arrows. The palpal drumming of females did not reach the minimum frequency needed to include it in Fig. 5.

#### Duration of the sexual behaviour phases

In the total period of courtship and mating, 19 pairs spent an average of  $17.35 \pm 8.35$  min. The courtship phase lasted for  $9.85 \pm 6.38$  min, the precopulation phase occupied  $5.02 \pm 3.02$  min, and the copulation phase  $2.48 \pm 2.55$  min.

#### Total numbers of sexual behaviours in males and females

There was a significant difference between the sexes concerning their total numbers of sexual behaviours (Table 2). During courtship, the total number of palpal drummings was higher in males than in females. On the other hand, foreleg vibration and abdominal pulsation occurred more frequently in females than in males during both courtship and precopulation (Table 2). Without taking into consideration the duration of each phase, for both sexes, the number of foreleg and abdominal movements was slightly higher in the courtship than in the precopulation phase, but not significantly different (Table 2).



Figs. 1-4: Sexual behaviour of *L. gaucho*. **1** Foreleg vibration (simultaneous vertical movement of the pairs of legs whose tarsi touch the female's web); **2** Male palpal drumming (alternate vertical palp movements); **3** Abdominal pulsation (vertical and horizontal abdomen movements); **4** Pair in mating position (male shaded).

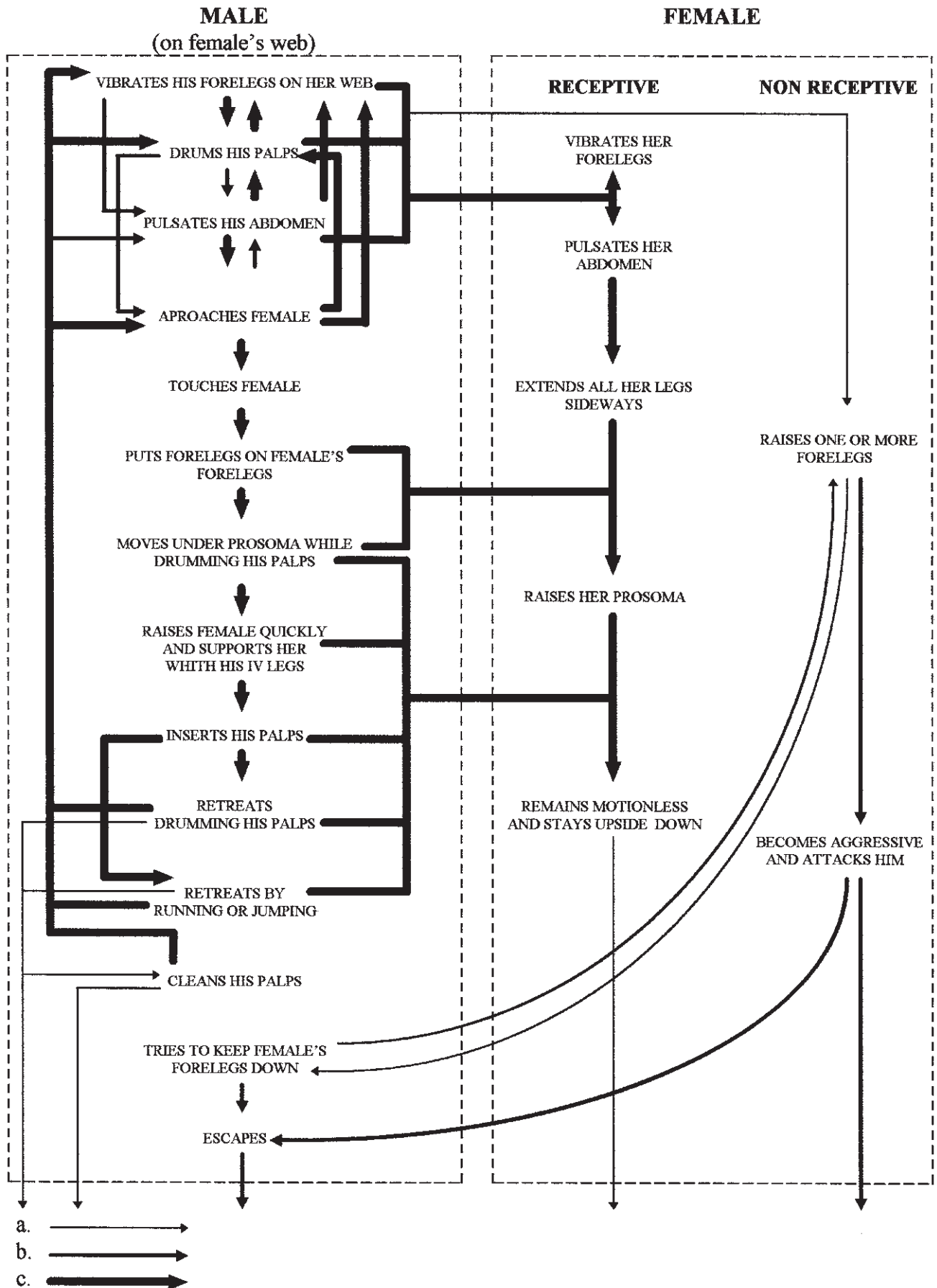


Fig. 5. Flow diagram of sexual behaviour in *L. gaucho* based on 41 copulations by 17 pairs and on 11 other pairs which did not copulate. Arrows a, b and c indicate frequency between 8.3–35.3%, 35.4–43.8%, and 93.8–100%. Dashed lines delimit sexual behaviour.

	Copulations per couple	Number of couples
	1	4
	2	8
	3	2
	4	1
	5	1
	6	1
<b>Total</b>	<b>41</b>	<b>17</b>

Table 1: Distribution of numbers of copulations by pairs of *L. gaucho*.

#### Frequency of male and female sexual behaviours in each phase

The average frequency of foreleg vibration was significantly higher in the precopulation phase than during courtship, in both males and females (Fig. 6). For the females,  $t = -2.02$  ( $p < 0.059$ ) and for males,  $t = -5.48$ ; ( $p < 0.0001$ ).

In females, the average frequency of abdominal pulsation was significantly higher in precopulation than during courtship ( $t = -3.22$ ;  $p < 0.001$ ), but in males there was no significant difference in frequency between courtship and precopulation ( $t = -1.08$ ;  $p < 0.30$ ) (Fig. 7).

#### Discussion

In two of the three sexual behaviours studied, the females exceeded the males in number and frequency of foreleg vibration and abdominal pulsation, indicating her active participation in mating. The cautious movements of the male towards the female and his frequent retreats (running, jumping) showed a tension, which is probably related to self-protection. However, aggressive acts by the females occurred infrequently and the pairs tended to be tolerant, remaining close to each other even when not in copulation. Only in a minority of trials did the female attack the male. Our interpretation of the results agrees with several studies (e.g. Jackson, 1979; Robinson & Robinson, 1980; Starr, 1988) which support the view that courtship is mainly a matter of female choice rather than derived from a need to inhibit predation.

Palpal drumming was more frequent in males, but this may simply be because males are better equipped for this behaviour. The foreleg vibration, palpal drumming, and abdominal pulsation shown by the male were sequential, never simultaneous, and usually led to the female's response and, finally, copulation. However, these three behaviours are not all essential for a successful copulation, suggesting that they may occur according to the degree of acceptance by the female. With less receptive females, the males may have to use all three. Horner & Stewart (1967) described in *L. reclusa* two of the same behaviours that we observed in *L. gaucho*, i.e. "rhythmic pulsation of the male's or female's abdomen" and "intermittent palpal vibration" which was more intensive in males than females.

When the available data for *L. laeta*, according to Galiano (1967), are compared with *L. gaucho*, both follow the same general pattern, differing specifically in the courtship phase, the receptive *L. gaucho* males being provoked into courtship by the web of the female and not only by direct contact between the pairs as in *L. laeta* (Platnick, 1971). In the copulation of *L. laeta* and *L. reclusa*, the single, quick strike was not observed. We agree with Starr (1988), who interpreted that the stroking serves to overcome the female's resistance and is therefore another good indication of mate choice. In the copulation, the performance of *L. gaucho* differed from that of *L. reclusa*, where the female was tilted backwards by a thrust, until the tip of her abdomen touched the floor (Horner & Stewart, 1967).

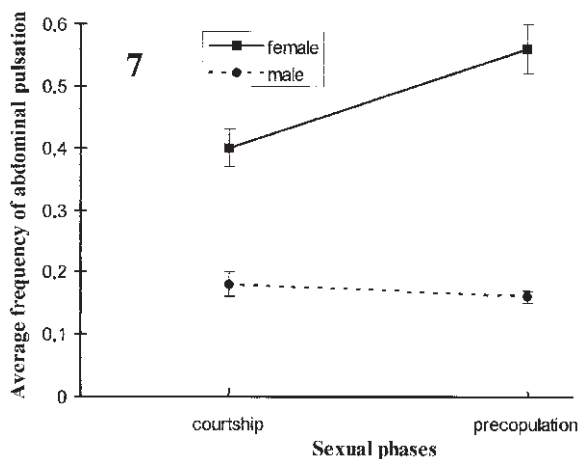
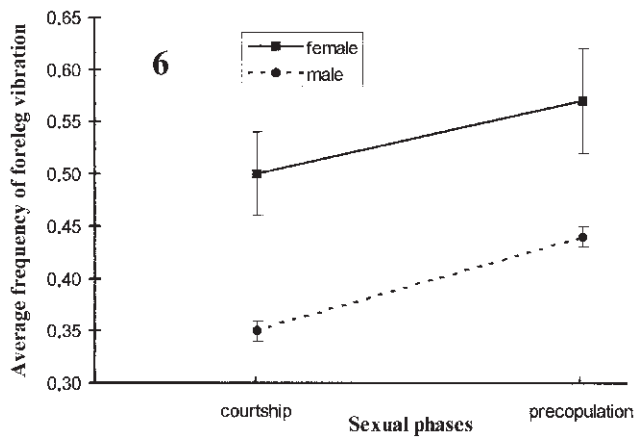
Sperm transference, in all these species, involves the simultaneous insertion of both palps, as described in the haplogynes by Foelix (1982). The act of stretching their legs sideways, while ceasing body movements, as seen in *L. gaucho* females, has also been observed in other haplogynes, as in *Pholeus phalangioides* (Fuesslin) by Uhl *et al.* (1995).

In *L. laeta*, palpal insertion is very quick, taking not more than a couple of seconds, whereas in *L. gaucho* it is much more variable, from a couple of seconds up to 11 minutes. The number of copulations may reach four in *L. laeta* and up to six in *L. gaucho*.

The frequency of foreleg vibration increased in precopulation in both males and females (Fig. 6). The frequency of abdominal pulsation, which increased in precopulation in females (Fig. 7), may signify that other non-sexual behaviours were inhibited. Maybe the

Behaviour	Courtship		Mating phases		Precopulation	
	♂	♀	<i>t</i>	♂	♀	<i>t</i>
Palpal drumming	6.07 ± 0.60	1.80 ± 0.36	6.18 $p < 0.0001$	– –	– –	– –
Foreleg vibration	8.00 ± 0.64	11.17 ± 1.16	– 3.28 $p < 0.005$	7.20 ± 0.35	9.38 ± 0.96	– 2.58 $p < 0.019$
Abdominal pulsation	3.99 ± 0.58	9.09 ± 0.79	– 5.94 $p < 0.0001$	2.58 ± 0.25	8.85 ± 0.83	– 6.86 $p < 0.0001$

Table 2: Total numbers of sexual behaviours performed by males and females of *L. gaucho* during courtship and precopulation (means ± SD and *t*-tests).



Figs. 6–7: Average frequency (acts per second) of female and male sexual behaviours during the courtship and precopulation phases in *L. gaucho*. **6** Foreleg vibration; **7** Abdominal pulsation.

increase in these behaviours is related to the vulnerability of the pairs in the precopulation phase, since they are so close together, prompting their self-protection. The slight reduction in the male's abdominal pulsation during precopulation (Fig. 7) may be related to the position of his body, in contact with the substrate, while under the female.

These differences between the species may have been partly influenced by the manner in which the pairs were introduced in the experiments. Obviously, when the

male is allowed to explore the web, his first act is to communicate his presence by vibrating his legs, the same probably occurring in natural conditions. As both species followed the same general behaviour pattern in courtship and copulation, we suspect that the mechanisms of reproductive isolation between them depend on the variations in palpal and/or abdomen movements, i.e. intensity, frequency, and duration.

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