Vibration sensitive hairs on the spider leg

J. Speck-Hergenröder and F. G. Barth [1,2]

Zoologisches Institut, Gruppe Sinnesphysiologie, Johann Wolfgang Goethe-Universität, Siesmayerstr. 70, D-6000 Frankfurt am Main (Federal Republic of Germany), 25 May 1987

Summary. Electrophysiological recordings from neurons in the spider central nervous system showed hair sensilla at the metatarsus-tarsus joint to be another, so far unknown source of sensitivity to tarsal vibration. The central neurons were most sensitive to vibration frequencies of 70 Hz and 150 Hz. Their absolute threshold sensitivity was lower than that of the most sensitive vibration receptor of spiders, the metatarsal lyriform organ, by at least two powers of ten.
Key words. Spider vibration sensitivity; central nervous system; hair sensilla.

In studies on the vibration sense of spiders [3,4] evidence has repeatedly been found for the presence of more than one source of vibration sensitivity. Although the metatarsal lyriform organ is considered the most sensitive vibration receptor in spiders [5,6], its ablation does not result in a complete failure of their orientation towards a source of vibration such as prey [7].

Electrophysiological proof is now available that in addition to the metatarsal lyriform organs (there is one on each leg) the pretarsal slits are vibration sensitive even though their thresholds are higher by about two orders of magnitude [8] (fig. 1).

While studying the vibration sensitivity of interneurons in the subesophageal ganglionic mass of the Central American hunting spider *Cupiennius salei* (Ctenidae), [9,10] an additional source of vibration sensitivity was established. These are hair receptors which we call metatarsal bridge hairs. They are found ventrally at the joint between the metatarsus and the tarsus on all legs (figs. 1 and 2a). They bridge the joint in a slightly bent fashion so that their tip touches the proximal part of the tarsus, some of them even when the tarsus is slightly (ca. 25°) bent upwards. They are stimulated by dorsoventral displacement of the tarsus (fig. 2b). There are about 16 (slightly more on leg 4 than on the other legs) such hairs at each metatarsus-tarsus joint and they reach a length of up to 3 mm.

When recording from interneurons in the ventro-median area of the subesophageal ganglionic mass of *Cupiennius*, units were repeatedly found in the ganglia of all legs onto which the output of all the metatarsal bridge hairs of the ipsilateral leg corresponding to the ganglion recorded from converge. To show this, the shafts of the various hairs were displaced individually, one after the other, under the microscope. The response of the central neuron was recorded simultaneously.

All these units did not show spontaneous activity. When the hairs were displaced by vibrating the tarsus with a feedback controlled vibrator [11] – thereby imitating their stimulation by natural substrateborne vibrations – threshold curves could be determined (fig. 3). The method allowed the measurement of absolute displacement of the tarsus tip with a sensitive displacement transducer monitoring the movement of the vibrator shaft [11]. Threshold displacement values were taken to be reached when one or two action potentials occurred in the central neuron upon stimulation of the hairs by

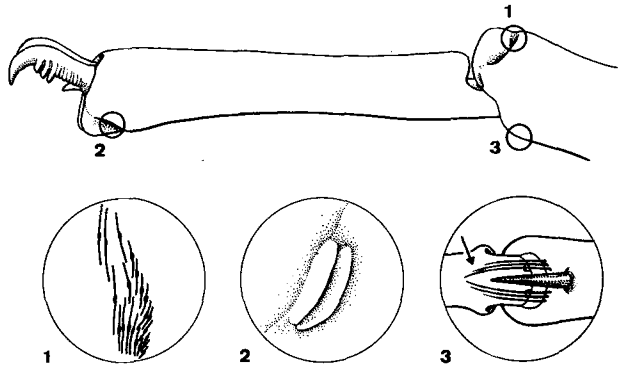

Figure 1. Three different types of mechanoreceptive sensilla located on the distal segments of the spider leg (*Cupiennius salei*) and shown to be sensitive to substrate vibration. 1. Metatarsal lyriform organ located dorsally on the distal metatarsus and consisting of an array of 21 innervated slits in the cuticle (also shown in dorsal view in inset). 2. Pretarsal single slit sensillum found on each ventrolateral side of the pretarsus behind the claws (inset: lateral view of leg). 3. Metatarsal bridge hairs ventrally at the joint between metatarsus and tarsus (inset: ventral view of joint) (see fig. 2a).

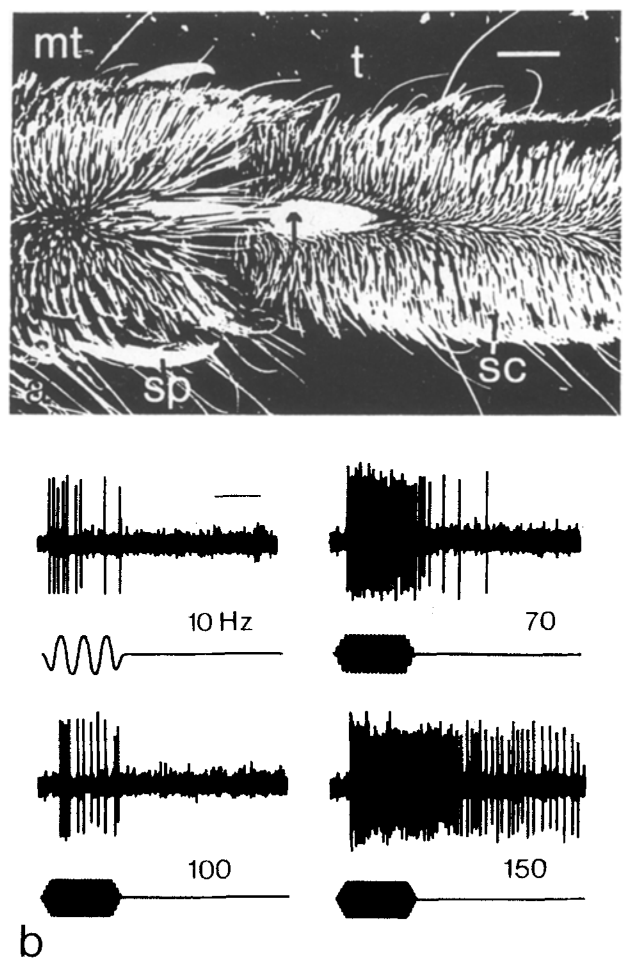

Figure 2. Substrate vibration sensitive hairs on the spider leg. *a* Ventral aspect of a metatarsus-tarsus joint of *Cupiennius salei* Keys. showing the vibration sensitive joint hairs (arrow) (photograph courtesy of E.-A. Seyfarth). mt, metatarsus; t, tarsus; sp, spine; sc, scopula hairs; bar 500 µm. *b* Responses to vibration of the tarsus at different frequencies and constant amplitude recorded extracellularly from an interneuron in the ganglion of the 1st right leg. Bar equivalent to 200 ms.

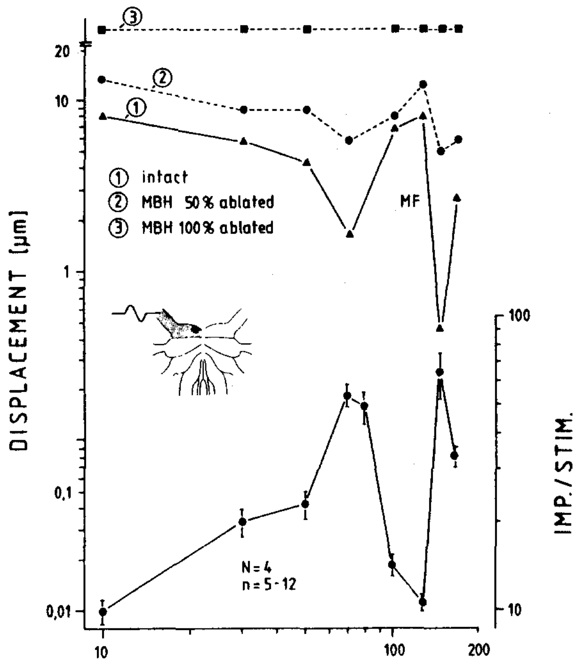

Figure 3. Top: Threshold curves of interneuron in the ganglion of the 1st right leg determined for vibratory stimulation of the tarsus with all metatarsal bridge hairs (*MBH*) intact, and 50% or 100% of them ablated. Bottom: Response of interneurons to tarsal vibration given as the number of impulses per stimulus (displacement 12 dB above threshold; duration 300 ms); note y-axis on right side. Inset: Ventral view of subesophageal ganglionic mass; site of recording.

tarsal displacement. Due to the lack of spontaneous activity the neuron's threshold response could easily be identified. The resulting threshold curves show lowest values at 70 Hz and at 150 Hz which is also reflected by corresponding maxima of the response upon stimulation by suprathreshold vibrations (fig. 3).

Ablation of half of the bridge hairs lowers threshold sensitivity of the interneuron by about 20 dB (at 150 Hz). Upon ablation of all of them the interneuron does not respond to tarsal vibration at all (fig. 3). The number of hairs stimulated may be an indication to the central nervous system of stimulus strength. It is also noteworthy that the sensitivity peaks of these interneurons coincide well with frequencies prominently contained in the male courtship vibrations of the same species and prey signals relevant to it[3,4].

A comparison of the metatarsal bridge hairs' primary sensitivity with that of the metatarsal organs and of the pretarsal slits is not possible on the basis of the interneuron responses. It will be interesting to see, whether they are tuned to specific small ranges of frequencies like the present and the other vibration sensitive interneurons known[10] or whether they show high pass characteristics in the biologically most relevant range of frequencies like the other two identified receptors for substrateborne vibrations in spiders[3].

The present finding of a third type of vibration sensitive receptor in spiders once more calls for an evaluation of the potentially different roles of these receptors in behavior as suggested by differences in absolute sensitivity and tuning. The lowest thresholds found for the slits of the metatarsal organ show a sensitivity in this organ which is higher by at least two powers of ten than that of any other primary sensory neuron or vibration sensitive central neuron so far described. Nevertheless, spider vibration sensitivity is not the result of the metatarsal organ's activity alone.

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2 To whom reprint requests should be sent. New address: Institut für Zoologie, Universität Wien, Althanstr. 14, A-1090 Wien, Austria.

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Selectivity of alterations in skeletal fibers in chronic Chagas' disease of the mouse

P. M. Cabeza Meckert and R. P. Laguens

Catedra de Patologia II, Facultad de Ciencias Medicas, Universidad Nacional de la Plata, 1900 La Plata (Argentina),
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Summary. In mice chronically infected with *Trypanosoma cruzi*, the masseter muscle (rich in type II fibers) was devoid of inflammatory infiltrates and parasites. In contrast, other muscles, composed of type I and II fibers, showed a decrease of type I fibers, parasites and lesions, suggesting that in *T. cruzi* infection type I muscle fibers are selectively damaged.
Key words. *Trypanosoma cruzi*; Chagas' disease; skeletal muscle; tissue tropism.

Trypanosoma cruzi, the ethiological agent of Chagas' disease, is an intracellular parasite that infects and multiplies selectively in macrophages, glial and nervous cells and smooth, skeletal and heart muscle[1,2]. Although this cell and tissue selectivity can be dependent on the parasite, which exists in either reticulotropic or myotropic strains[3], the reasons for this preferential tissue tropism are unknown. Recently, it has been reported that in the course of acute infection of the mouse with the Brasil strain of *T. cruzi*, the percentage of infected type I skeletal muscle fibers was nearly five-fold higher than that of type II, suggesting that the heart and muscle alterations characteristic of Chagas' disease are de-