difficult because the points of insertion of the receptors onto the shell are inaccessible.

Diffraction also has the advantage that strains in RM_1, RM_2 and, for that matter, in nearby extensor muscles can be monitored simultaneously, provided one has a sufficient number of laser beams. It can also be pointed out that unlike mechanical means, diffraction pattern can follow the structural changes in the fibres with negligible timelag and hysteresis, the only limitations thus being imposed by the system used to pick it up.

A further advantage of using diffraction to monitor strain is that it can easily be converted into electrical signals which can be automatically and rapidly measured. For instance, by passing the 2 first order fringes through a mechanical chopper and then on to two photodiodes, the time interval T between the resulting pulses measures the sarcomere length. We have set up such a system, in which the time interval T is transmitted via interfacing to a control computer, Hewlett-Packard 2100S, which can also be used to apply stretches, monitor action potentials and record force. Since a resolution time of the order of 1 msec is easily achieved, not only can slow postural adjustments be monitored but also fast flexions of the crayfish tail can be followed.

The Stimulus Transmitting Apparatus in the Trichobothria of the Bugs *Pyrrhocoris apterus* L. and *Dysdercus intermedius* (Dist.) and its Influence on the Dynamic of Excitation in these Sensilla

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Summary. Correlations exist between ultrastructural characteristics in the stimulus-transmitting apparatus of the trichobothria on the 4th abdominal segment of the bug *Pyrrhocoris apterus* (L.) and the functional characteristics of these sensilla.

In several investigations of sensory organs – work done on the crayfish receptor organ[2] and on the Pacinian corpuscle[3,4] for example – it could be proved that the properties of the structures which provide the coupling between the stimulus and the receptor cells can cause a decline of the stimulus effect with time, or can filter away certain components of the stimulus, even prior to transmission to the excitable structures.

On the ventral side of the 4th abdominal segment of the bugs *Pyrrhocoris apterus* (L.) and *Dysdercus intermedius* (Dist.), groups of 3 trichobothria are situated laterally, one at each side. In *Pyrrhocoris* these trichobothria differ in their functional properties[5]. Apart from differences in their size and the length of their hair shafts, all trichobothria display the same external construction (Figure 1).

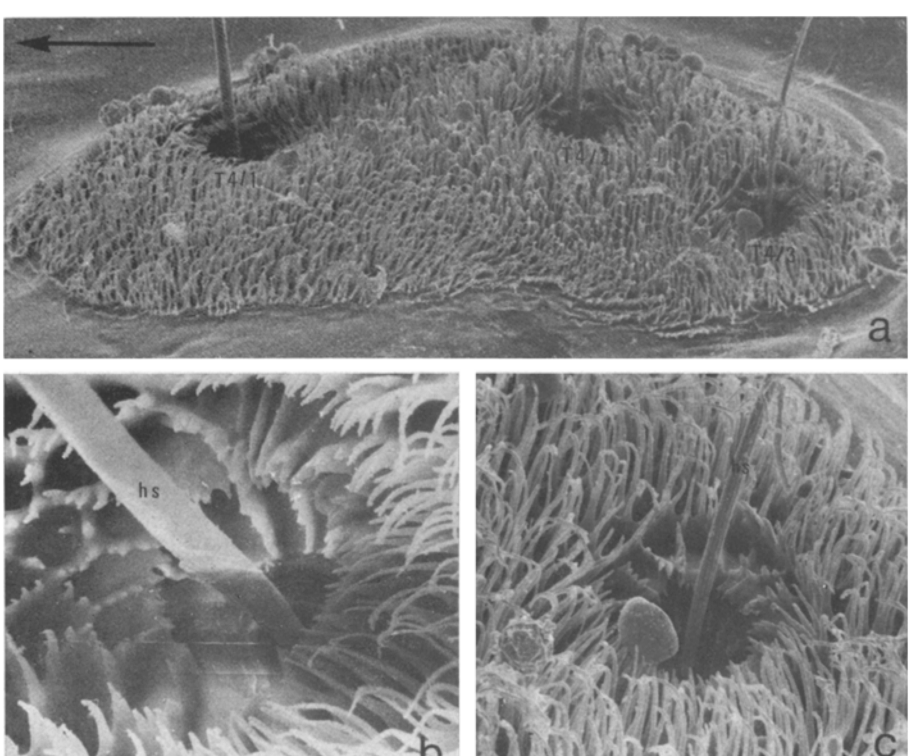

Fig. 1. a) Group of three trichobothria (T1–3/4) on the 4th abdominal segment of *Pyrrhocoris apterus*. Caudal direction is indicated by arrow. (Courtesy of B. BEY and G. THIES, Regensburg.) ×750. b) T1/4 trichobothrium. ×2900. c) T3/4 trichobothrium. ×2000.

This investigation is restricted to the trichobothria with the longest hair shafts (type T1/4)[5] and with the shortest hair shafts (type T3/4)[5] whose internal construction is identical in both animals. By sectioning them in series, attempts have been made to find ultrastructural correlations for their functional characteristics. The movable articulation of the hair shafts (hs) by a joint membrane (jm) and by suspension fibres (sf) is the same in both hair types (Figure 2). Furthermore, both are innervated by a single sensory cell, the distal process of which contains a tubular body (tb) at the tip (Figure 2). Whereas the tubular bodies have the same diameters (0.5 μm), they differ in length (T1/4 = 2.5 μm; T3/4 = 1.5 μm). The construction of these tubular bodies is similar to that described in the antennal tactile hairs of *Dysdercus*[6].

The socket septa (ss) which connect the socket (s) and the tubular body show considerable differences in these two types of trichobothria. The flat socket septum in type T1/4, which has the form of a 90° sector (Figure 2c), extends horizontally (thickness: 600–1000 Å). A stick-like cuticular structure (cs, basal diameter: ca. 0.2 μm), which usually tapers distally, inserts perpendicularly at the tip of this quadrant (Figures 2a and b). The cuticular stick is closely attached to the dendritic sheath (ds), but terminates before the dendritic sheath enters the hair shaft. The construction of the socket septum in type T3/4 varies considerably. One time it was seen as a network of poorly contrasted elements which included cavities

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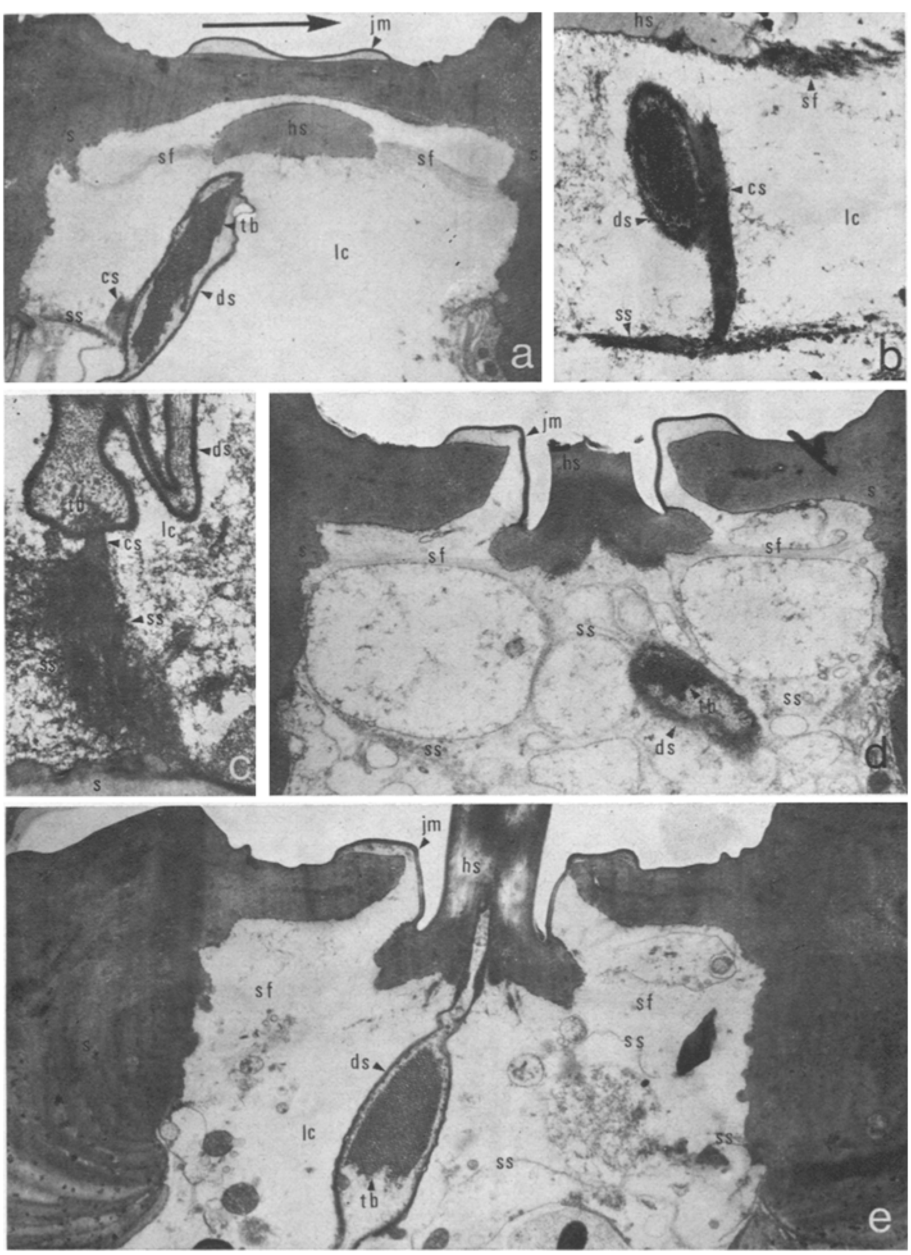

Fig. 2. Except (lc) = lymph cavity abbreviations are explained in the text. a) Oblique longitudinal section of type T1/4 trichobothrium of *Pyrrhocoris apterus*. Caudal direction is indicated by arrow. ×16,500. b) Longitudinal section of the cuticular stick (cs) in T1/4 trichobothrium of *Dysdercus intermedius*. ×18,000. c) Oblique cross section of type T1/4 trichobothrium of *Dysdercus* on the level of the socket septum (ss). ×18,000. d) and e) Longitudinal sections of type T3/4 trichobothria of *Pyrrhocoris*. d) ×25,500. e) × 24,000.

outlined by membrane-like structures (Figure 2d). At other times only irregularly distributed membrane-like structures were found between the socket and the tubular body (Figure 2e).

The type T1/4 trichobothria respond maximally to deflections in caudal direction[5]. They display a distinct directional sensitivity which here, as well as in some other tactile sensory hairs of insects[7], seems to be influenced among other things by the polar construction of the socket septum. Only deflections of the hair shaft, which press the tubular body against the socket septum and cuticular stick, can result in a compression of the tubular body (= adequate stimulus[8]). This hypothetical idea of stimulus transmission postulates that the socket septa belong to the stimulus transmitting apparatus which influences the transformation of the input stimulus into the effective stimulus[9]. The process of transformation depends on the physical properties of the stimulus transmitting apparatus[2-4,9]. Although it is plainly impossible to see special physical properties of the socket septa in pictures made by the electron microscope, it is possible to say, based on the observed differences in construction, that the socket septum in type T3/4 has different properties (probably less stability) than the socket septum in type T1/4. Therefore in T3/4 trichobothria a different resistance (probably a lesser one or a more rapidly declining one) will be offered to the lateral displacements (caused by the lever effect of the hair shaft) of the tubular body. Although the input stimulus (deflection of the hair shaft through a definite angle) is the same in both cases, different effective stimuli would act upon the tubular bodies. The different patterns of response (T1/4 phasic-tonic; T3/4 phasic)[5] support this assumption. Out of at least 5 fundamentally different processes which possibly cause the decay of excitation in sensory cells[9], in the T3/4 trichobothria in comparison with T1/4 trichobothria, an increased 'dynamical decay of stimulus'[9-11] should be taken into consideration.

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11 Definition of 'dynamical decay of stimulus' = dynamische Reizminderung[10]: Eine durch die dynamischen Eigenschaften des reizleitenden Apparates bedingte zeitliche Abnahme des vom reizleitenden Apparat zu den sensiblen Endstrukturen geleiteten Reizes.

Prevention of the Formation of Mycotoxins in Whole Wheat Bread by Citric Acid and Lactic Acid (Mycotoxins in Foodstuffs. IX)

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Summary. Additions of citric acid and lactic acid to whole wheat bread suppress the formation of aflatoxins by *Aspergillus parasiticus* (0.5% citric acid, 0.75% lactic acid) and that of sterigmatocystin by *A. versicolor* (0.25 and 0.5% respectively).

The biosynthesis of aflatoxins is known to be inhibited by several organic acids as carbon sources, e.g. by shikimic, pyruvic, α-ketoglutaric, succinic and citric acids[2-4]. Nothing is known whether or not these acids are also inhibitors of the formation of other mycotoxins, such as sterigmatocystin and patulin. Aflatoxins[5,6] sterigmatocystin[7] and patulin[5,8] can be formed by moulds in bread. Previous studies on the influence of preservatives in bread on the formation of mycotoxins[9] revealed that an acidifying substance for dough, containing citric and lactic acids, suppresses the formation of aflatoxins and sterigmatocystin. This study was continued with pure substances and the results are described here.

Methods. Whole wheat bread (Grahambrot) was prepared with additions of citric acid (DAB 7) and lactic acid (DAB 7) in levels of 0.25, 0.5 and 0.75% (relative to whole wheat). Packages of 3 slices were packed into a cellulose foil (GEB 300; Kalle, Wiesbaden, BRD) and sterilized in hot steam. The total acid content ('Säuregrad') was determined according to the method of Schulerud[5]. The packages were inoculated with spores of one of the following moulds: *Aspergillus parasiticus* (formerly *A. flavus*, strain 89717; Commonwealth Mycological Institute, Kew, Surrey, England), *Aspergillus versicolor* (strain 519; Dr. R. Orth, Karlsruhe, BRD) and *Penicillium expansum* (strain D 19; Institut für Spezielle Botanik, Universität Mainz, BRD). The incubation temperature was 22°C. The semiquantitative determinations of the toxins were performed as described earlier (aflatoxins[5], sterigmatocystin[7,10], patulin[8,11]). The fungal growth was determined by measuring the radius of the colonies every 24 h.

Results and discussion. a) Aflatoxins. Additions of citric and lactic acids of up to 0.5% do not markedly influence the growth of *A. parasiticus*, whereas the highest concentrations of both acids (0.75%) have a slight growth-reducing effect. The production of the aflatoxins B_1 and G_1, however, is greatly inhibited by low levels of citric acid and by higher concentrations of lactic acid (Table). A comparison of these results with the data of

1 Acknowledgment. I thank Dr. R. ORTH (Bundesforschungsanstalt für Ernährung, Karlsruhe, BRD) for the strain of *Aspergillus versicolor*.

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