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OCCURRENCE OF RESILIN IN ELASTIC STRUCTURES IN THE FOOD-PUMP OF REDUVIID BUGS

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Resilin is a naturally occurring rubber. It is extremely efficient, returning almost all the energy stored during its deformation. Resilin was first described by Weis-Fogh (1960), who with Andersen (Andersen & Weis-Fogh, 1964) produced an extensive review covering the identification, physical and chemical properties of the substance. Andersen & Weis-Fogh set out five diagnostic characters for resilin and reported five sites of resilin occurrence: the wing hinge in all insects studied, including *Schistocerca gregaria* and *Periplaneta americana*; tendons in *Aeshna cyanea* and *Calliphora erythrocephala*; the hindleg spring of various fleas; the abdominal spring of *Oryctes* sp. and *Melolontha* sp.; and the clypeolabral spring of *Schistocerca gregaria*. This communication reports the occurrence of resilin in the food-pump of Reduviid bugs and discusses its functional significance.

In two papers Bennet-Clark (1963*a*,*b*) described some of the properties of the food-pump in *Rhodnius prolixus*. In this paper I confirm Bennet-Clark's (1963*b*) observation that the piston has a staining reaction similar to the 'rubber' found in the wing hinge of locusts (Jensen & Weis-Fogh, 1962) and show that the rubber-like elements are in fact resilin. However, the distribution of rubbery elements in *Rhodnius* is shown to be somewhat different from that suggested by Bennet-Clark (1963*a*).

Fluorescence microscopy was used to locate possible resilin elements in the food-pump of *Rhodnius*.

The food-pump was dissected from the head. The pump is a boat-shaped structure held in place by two sets of ventrally placed muscles. Dorsally there is one large muscle which runs the length of the head and attaches to the diaphragm of the pump. This muscle drives the pump.

Whole pumps were put under a Zeiss fluorescence microscope, excited with light at 370 nm, and emissions at 420 nm were observed. Two laterally placed bands of fluorescence suggesting the presence of resilin were seen. In addition a weaker band was seen in the middle of the diaphragm.

Pumps were taken from larger Triatomine bugs – *Triatoma phyllosoma* (Brumeister) and *Dipetalogaster maximus* (Uhler). Although the food-pumps were essentially the same, there were changes in the distribution of the fluorescent material. This was most marked in *Dipetalogaster*, where fluorescence of the central element was much stronger while that of the lateral elements was reduced (Fig. 1).

Resilin elements were dissected from pumps in distilled water and shown to be

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springy. Transfer to absolute alcohol, a dehydrating agent, caused the elements to become stiff and brittle. Returning them to distilled water brought a return of the rubbery properties associated with resilin.

The lateral 'resilin' bars were readily dissected from the food-pump. The bars were birefringent when strained, the birefringence being positive in the direction of extension.

Paraffin sections were taken of *Rhodnius* food-pump. Some were stained with methylene blue some with toluidene blue, others were observed under the fluorescence microscope to see which part of the pump showed the fluorescence characteristic of resilin. Staining and fluorescence microscopy both showed the same distribution of putative resilin elements in the food-pump (Fig. 2). The lateral elements are 'C'-shaped in transverse section and wrap round the angle between the pump diaphragm and the pump side. The central element is roughly triangular in section. This distribution differs significantly from Bennet-Clark's suggestion that the whole diaphragm is a rubbery sheet.

The lateral resilin bars appear to have a role in a recoil mechanism, in which the bars are deformed by the muscle pulling upwards [Fig. 2(ii)] and recoil as soon as the pump is released [Fig. 2(i)]. The apparent function of the central bar is to bend the

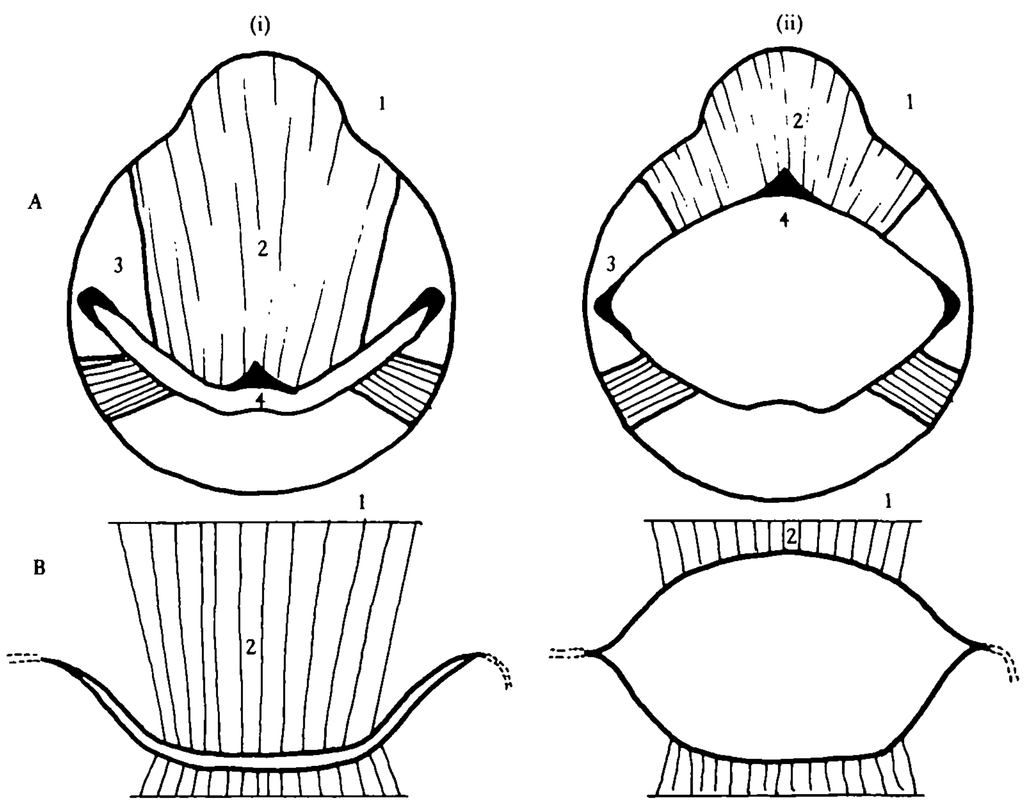

Fig. 2. (A) Diagrammatic cross sections through head of *Rhodnius prolixus* based on paraffin sections. (B) Diagrammatic sagittal sections through the head of *Rhodnius prolixus* based on observations of whole pumps. (i) Pump empty. (ii) Pump full. 1, dorsal ridge; 2, dorsal pump muscle; 3, lateral resilin bar; 4, central resilin bar.

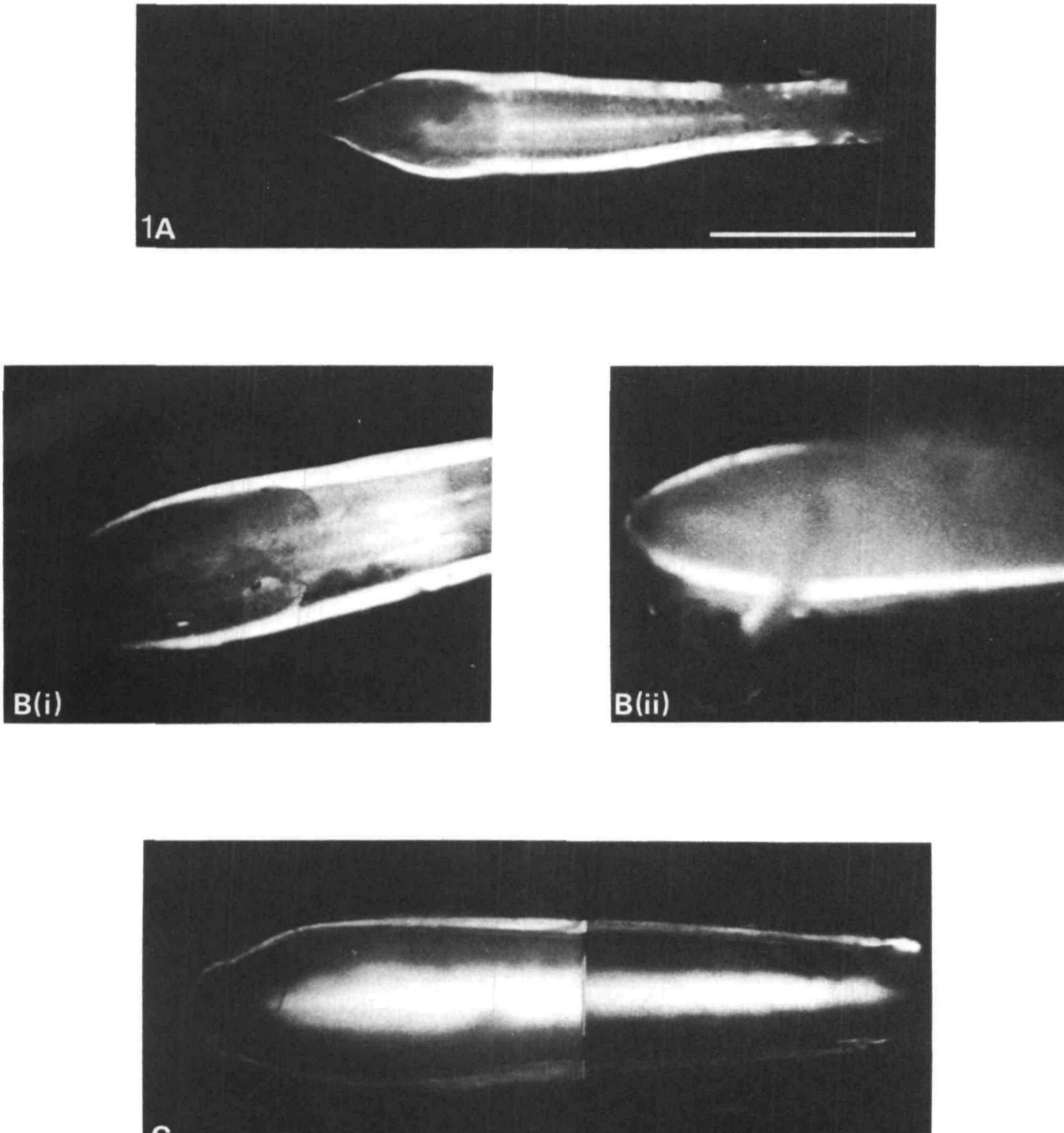

Fig. 1. Food-pumps from Reduviid bugs stimulated with light at 370 nm and photographed at 420 nm to show the distribution of resilin. (A) *Rhodnius prolixus*, (B) *Triatoma phyllosoma* (i) cleared (ii) dorsal muscle in place, (C) *Dipetalogaster maximus*, composite photograph. All at same magnification, scale bar = 1 mm.

membrane between the two lateral bars down into the boat-shaped lower half of the pump. The pump diaphragm is depressed into the lower half of the pump in dissected specimens. The role of the resilin elements in the food-pump of Reduviid bugs is likely to be in the recoil phase where blood has to be forced into the gut. The pump is 'empty' in the absence of an applied force. Bennet-Clark's (1963*a*) calculations show that a suctional force of up to 911 925 Pa is produced by the pump. It is interesting to note from this point of view how much of the volume of the head is occupied by the pump muscle (Fig. 2). The dorsal ridge on the head is semicircular in cross section, perhaps to prevent buckling of the head cuticle by decreasing its radius of curvature when large muscular forces are applied in the food-pump.

The food-pumps of three Reduviid bugs have been studied to confirm the presence of resilin elements. In the pumps three resilin elements were found. For these, four of Weis-Fogh's five criteria for characterizing resilin have been fulfilled.

The likely role of resilin in the food-pump is in the emptying phase of the pumping cycle.

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