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ON THE SUGGESTION THAT THE SECRETION FROM THE METATHORACIC SCENT GLANDS OF A SURFACE-DWELLING AQUATIC INSECT, *GERRIS NAJAS* (DE GEER), (HETEROPTERA; GERRIDAE) HAS A WATERPROOFING FUNCTION

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INTRODUCTION

The ventral surface of the pond skater, *Gerris najas*, is covered with a hair pile extremely resistant to water penetration. It is possible that the hydrofuge properties of the hair pile are maintained by an oil released from glands opening out on to the general body surface. Holdgate (1955) has reported findings indicating that many surface-dwelling and surface-breathing aquatic insects actively maintain high and constant contact angles during life.

Many bugs are provided with scent glands located ventrally in the hind part of the adult thorax. The metathoracic scent glands of *G. najas* open into a median reservoir which in turn opens to the exterior by a single median pore. The secretion, an oily fluid, has a slightly unpleasant odour reminiscent of that from *iso*-butyl alcohol.

More than one previous observer has suggested that the hydrofuge properties of the hair pile of *Gerris* are maintained by the periodic release of secretion from the metathoracic scent glands. Alone amongst these, Brinkhurst (1960) has described experiments which appear to support this suggestion. The experiments are in no way conclusive, however, and reveal little other than the possible effects of various treatments on the state of filling of the reservoir. This paper describes experiments designed to measure the effect of sealing the external opening of the metathoracic scent gland system of *G. najas* on the resistance of the hair pile to wetting by surface forces.

MATERIAL

Adult *G. najas* were collected from a canal running through the castle grounds in Cardiff. All the specimens identified belonged to this species, *Gerris* (*Aquarius*) *najas* (De Geer). Collections were made in the September of 1971. Until required the insects were kept in a running-water aquarium well stocked with food. Only the females, which are readily distinguished from the males by their much larger size, were used in the experiments to be described.

RESISTANCE TO WETTING

The resistance of the hair pile to wetting by surface forces was determined by treatment with graded solutions of pure methyl alcohol in water. The method is based

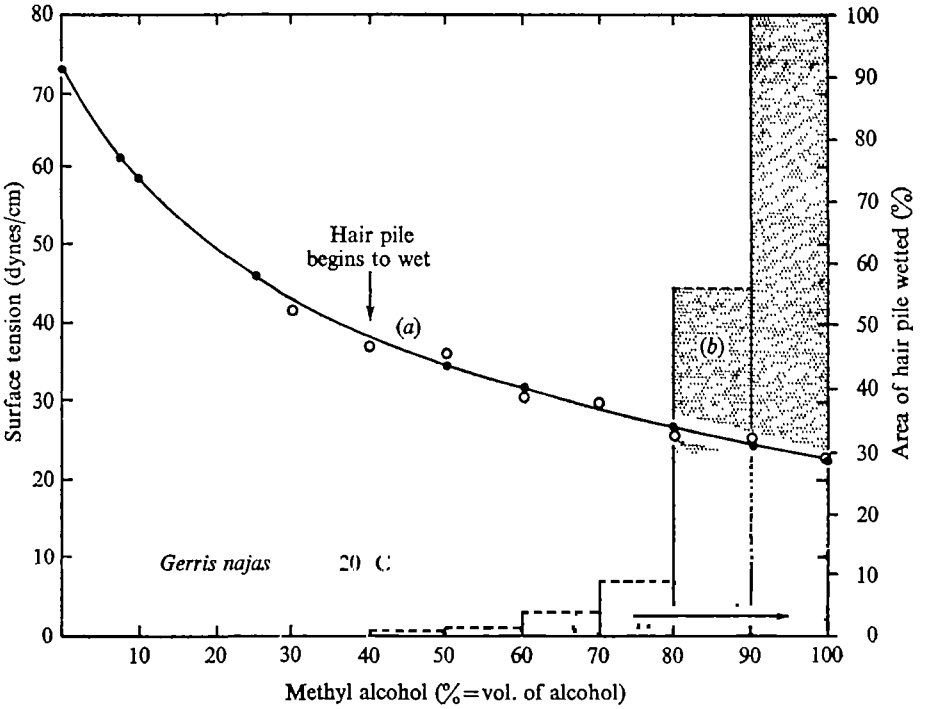

Fig. 1. (*a*) Curve showing the relationship between the surface tension and concentration of pure methyl alcohol in water. Closed circles from data supplied by Weast (1969), open circles from determinations by a simple capillary method. (*b*) Histogram showing the effect of immersion in graded solutions of methyl alcohol in water on the area of abdominal hair pile wetted. Mean values from determinations on six adults.

on that described by Thorpe & Crisp (1947), who used *iso*-butyl alcohol, in the first of their detailed papers on plastron respiration in aquatic insects. A change in the colour of the hair pile from dark grey to black was the immediate indication that wetting had taken place.

The method consisted in dipping the abdomen into each solution in turn, commencing with the most dilute (30%), the specimen remaining in any concentration for not more than about 3 sec, and recording for each concentration, on a previously drawn map of the ventral abdominal surface, the area of surface wetted. As the abdomen is strongly arched ventrally, a more precise indication of the area of hair pile wetted at each concentration was obtained by redrawing the outlines of the wetted areas on a second map drawn from a specimen whose ventral abdominal surface had been carefully flattened throughout. The values obtained from the surface area measurements were then converted each into a percentage of the total area. From data supplied by Weast (1969) a curve relating surface tension to the concentration (% = volume of alcohol) of pure methyl alcohol in water at 20 °C, at which temperature the determinations were made, was obtained. Measurements of the surface tensions of the test solutions relative to water were made by a simple capillary method, due account being taken of the differences in specific gravity between the solutions, and the results obtained were entirely consistent with the values given by Weast.

Mean values extracted from the results of determinations on six individuals are

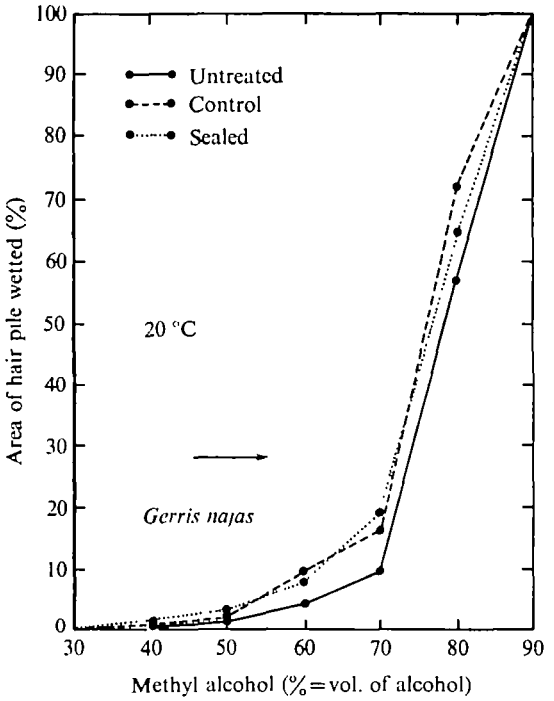

Fig. 2. The effect of sealing the external aperture of the metathoracic scent gland system on the ability of the abdominal hair pile to resist wetting by surface forces. Mean values from determinations on six entirely untreated adults, six adults with sealed openings, and five controls.

shown in Fig. 1, together with a curve relating the surface tension and concentration of methyl alcohol in water. It was found that solutions up to 30% strength had no effect whatsoever. Above this strength the appearance of a dark spot on the last abdominal segment was usually the first indication that the hair pile was no longer able to resist wetting but even in 70% wetting had not proceeded very far. In 80% (surface tension 27·3 dynes/cm), however, the area of surface wetted was greatly increased and full wetting invariably followed in 90%.

Thorpe & Crisp reported that when *Aphelocheirus* was dried after treatment with *iso*-butyl alcohol in water the resistance of the hair pile to wetting was in no way diminished. It seemed reasonable to suppose, therefore, that the treatment was unable to bring about any irreversible change in the surface properties of the hair pile. Precisely similar results were obtained during the course of the present work on *Gerris* using solutions of methyl alcohol in water.

THE EFFECT OF SEALING THE EXTERNAL OPENING OF THE METATHORACIC SCENT GLAND SYSTEM

Nail varnish was used to seal the opening. The solvent quickly evaporates to leave a small flattened plug of varnish over the opening and over the hair pile in the immediate vicinity of the opening. It was found necessary to use fresh varnish as after a period of use the wetting power of the solution is diminished. Individuals selected

to act as controls were similarly treated, the essential difference being that the varnish was deposited on the hair pile in the vicinity of the opening and not over the opening itself. Insects with sealed openings, controls, and untreated insects were kept together in a running-water aquarium supplied from a tap and were amply supplied with food. The untreated individuals provided the standard by which it could be judged whether the treatment with varnish had had any effect on the ability of the hair pile to resist wetting. There were few deaths during the experiments.

Before determinations were made on the insects with sealed openings evidence was sought indicating that the seal had been effective. First, the ability of the insects to release secretion when exposed to pure gaseous CO_2 was investigated. This treatment seems invariably to elicit a discharge from individuals with well-filled reservoirs. Secondly, the thorax was amputated, dissected open, and the degree of filling of the reservoir noted. If the reservoir was clearly tightly distended with secretion despite the previous exposure to CO_2 it was concluded that the seal had been wholly effective. If, on the other hand, the reservoir contained insufficient secretion to distend it fully the insect was discarded. Less than a half of the insects with sealed openings satisfied this requirement.

The controls and the untreated insects were treated in precisely the same way as the insects with sealed openings and tested for their ability to release secretion to the outside. Most of the controls and untreated insects were found to possess this ability.

In the first of two experiments a period of 2 weeks was allowed to elapse before determinations were made and in the second experiment a period of 7·5 weeks. As no difference was evident between the results obtained from the two experiments the experimental findings were combined. As may be seen from Fig. 2, insects with sealed openings were no less resistant to wetting than the controls. These results give no support to the suggestion that the secretion from the metathoracic scent glands has a waterproofing function. What may be noted, however, is that the untreated insects seemed to be more resistant to wetting than the treated insects which indicates that the treatment alone may have had a slightly adverse effect on the ability of the hair pile to resist wetting.

DISCUSSION

The various suggestions that have been made regarding the possible functions of the diverse secretions from the metathoracic scent glands of water bugs can be divided into three categories. First, a secretion could have a cleansing or a waterproofing function. Secondly, it could provide a chemical means of defence against predators. Thirdly, it could have a role to play in the sexual or other social activities of the adults.

The present findings give no support to the suggestion that the secretion from the metathoracic scent glands of *Gerris* has a waterproofing function, although it is possible that an effect would have been revealed in experiments of greater duration or severity. It would seem also to argue against this suggestion that, as indicated by observations on surfaces coated with lycopodium powder, the secretion, or some component of it, spreads rapidly when deposited on a water surface. According to Holdgate (1955), for a waterproofing oil to be effective it must possess few hydrophilic polar groups and show little tendency to spread on a water surface. Finally, there is

no evidence of the secretion being released and applied to the body surface when grooming takes place.

Observations of comparative interest have been made on water beetles from diverse families. Thorpe & Crisp (1949), with regard to the plastron of members of the Elmidae, incline to the view that the hydrofuge properties of the hair pile are not brought about by a glandular secretion. Indeed, they argue against the existence of a separate, specific, waterproofing wax, although they were unable to show that such does not exist. For preventing entry of water between the hairs they suggest that grooming is important by keeping the hairs tidily arranged.

Thorpe & Crisp (1949) record that *Hydrophilus* grooms itself out of water but found no evidence of any secretion being applied to the body surface during the process. Members of the family Dytiscidae, on the other hand, which also leave the water to groom themselves, have been observed to release the phenolic secretion from their pygidial glands when grooming takes place and spread it over the whole of the body surface by means of the movements of the limbs (Maschwitz, 1967). There can be little doubt that the secretion is acting as an external disinfectant and not as a means of waterproofing the body surface. The elytra of beetles prevented from leaving the water tend to become coated with a microbial slime (Schildknecht, 1970).

SUMMARY

1. Experiments have been carried out which give no support to the suggestion that the secretion from the metathoracic scent glands of the pond skater *Gerris najas* has a waterproofing function.

2. The ability of the hair pile to resist wetting by surface forces was determined by treatment with graded solutions of pure methyl alcohol in water.

3. In experiments of up to 7·5 weeks duration it was found that the hydrofuge hair pile of insects with sealed scent gland openings was no less resistant to wetting by surface forces than that of the controls.

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