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Research Article

PRELIMINARY STUDIES ON THE PYGIDIAL GLAND AND ABDOMEN OF THE BOMBARDIER BEETLE, PHEROPSOPHUS HILARIS HILAR IS (COLEOPTERA: CARABIDAE)

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ABSTRACT

The bombardier beetle has been the subject of much discussion by creationists and evolutionists alike. Recent reports demonstrate the sophistication and accuracy with these carabid beetle deliver a spray of hot quinones and steam to ward off predators. Works over the last 50 year have reported on the histology and ultrastructure of the pygidial gland and accessory components of these defensive organ. Those reports differ significantly from the present paper. Thus it appears that some distinction exists in the morphology of the abdomen, defensive gland and nozzle.

INTRODUCTION

The bombardier beetle has been a subject of interest for many years. This beetle is called a 'bombardier' because it ejects a hot, highly noxious spray of aqueous benzoquinones, oxygen and steam as a defense mechanism against would be predators (Eisner *et. al.,* 2000). This secretion is very accurately delivered via twin sets of spray nozzles located at the tip of the beetle abdomen and is most effective at stunning predators. Even mammals such as mice, thus allowing the beetle to escape (Crowson, 1981).

Bombardier beetle range in size from 2.0 mm overall length to 30 mm in length and can be found all over the world. They live under rocks or pebbles in cool, sandy soil, usually aggregating in groups during the day time, they are usually active in night (Erwin *et.al.,* 1970). These exits several different types of bombardier beetle, which employ slightly different types of defensive structures and chemistry but generally the same method of defense shooting at predators when threatened and then running away. Most noticeable, is the force of the spray, which is ejected during the reaction. The spray is ejected in explosive discharges of about 500 pulses per second, which can surprise and deter large vertebrates and can even send some attackers into seizures (Aneshansley *et.al.,* 1969). The beetle's spray is astoruishingly hot, a feature that seems to be dependent on the biochemistry of the reaction between the hydroquinines, hydrogen peroxides and the catalases and peroxidases that the beetle synthesizes and stores in separate reservoirs, (Eisner *et.al.,* 2000). The structure of the defense system of the bombardier beetle is complex, consisting of two sets of secretary lobes, collecting canals, collecting reservoirs, exit tubes, and exit nozzles (Dean *et.al.,* 1980). All known carabid 'bombardier' beetles have similar internal structures, and they all employ a similar chemical reaction (Aneshansley *et. al.,* 1983). This paper provides a detailed study of the morphology and fine structure of the pygidial gland and abdomen.

MATERIAL AND METHODS

Adult *Pheropsophus hilaris,* of both sexes, collected from the fields in the vicinity of Annamalai Nagar, were used throughout the present investigation. The adult male and female insects are collected from the field were reared in wooden cages measuring 30x33x45 cm in the laboratory at the room temperature 28 ± 2^0C as suggested by the bottom of the cages was filled up with sand of about 10-15 inches. Since these beetles are living in crevices, brick stones are kept in the cages. To keep the moisture of the soil, water was sprayed regularly at equal intervals of every 12 hours. In order to provide sufficient aeration, the sides of the cages are fabricated with meshes. To allow sufficient light, one side of the cage is covered with glass. *Pheropsophus hilaris* was fed with wet

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Prawn, Fish meat, Larvae, eggs of pest insects, organic waste matters, dead and decay materials (Nagarajan, 1995).

The abdomen of the, *pheropsophus hilaris* were dissected and dried in vacuum for getting good moisture free specimen was needed. Then the samples were coated-gold with full deposition for 3 minutes using polaron SC 500 sputter coater. Few tungsten line coating was given this coating has given primary to prevent charging samples and clarity of pictures. Then the samples were mounted in stereo scan 440-model electron microscope UK.

The ascertaining voltage given was 20kw and the beam current used was in between 18-25 p.a (pica amperes) notching distance was between 39mm to 1mm. The secondary electron images were taken for all the samples with varied magnifications from 50 x 10,000 (Kotze and Soley, 1990).

RESULTS AND DISCUSSION

Defense system of the bombardier beetle is very complex and no one has attempted to truly explain the design. The structure of the defense system of bombardier beetle, *pheropsophus hilaris* is quite complex, consistary of two sets of secretary lobes, collecting canals, collecting reservoirs, one-way valves, sphincter muscles, reaction chambers, exit tubes, and exit nozzles (Aneshansley *et. al.,* 1983) (Fig – 1).

The paired secretary Lobes connect via long tubes to collecting reservoirs, each of which are surrounded by a thin layer of muscle, (Crowson, 1981). The muscles around the reservoirs squceze the first amount of resctants through the valve into the reaction chamber, the resulting explosion causes the pressure to rise rapidly in the reaction chamber, forcing shut the one-way valve (Schnepf *et.al.,* 1989 and Schildnecht *et.al.,* 1970). The products of the reaction then exit the chamber with a pop and a puff, and the pressure inside the reaction chamber lowers against, falling below the pressure of the reservoirs, which is still being squeezed by the reservoirs muscles. The cycle then repeats it self- the valve thus oscillates passively (Eisner *et. al.,* 2000).

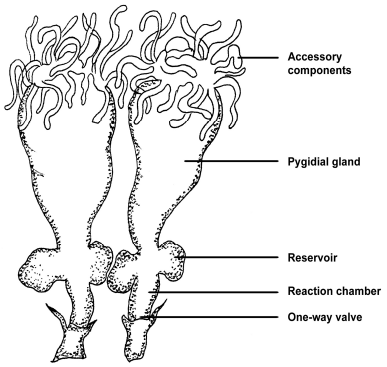

Fig – 1 General structure of Pygidial gland – *Pheropsophus hilaris*

The nozzle of *Pheropsophus hilaris* is difference from other genera in its architecture and arrangement. Extending from the abdominal tip on either side are having lounge-like projections (Fig – 2) which upon closed examinations reveal a pattern of apertures used for spray dispersal (Fig – 3) A large pace is embedded at the tip of the nozzle containing fattened hairs or papillae that extend out of the pore and above the surface of the nozzle. Additionally, five or much more similar pores run along the midline of the toughs – like nozzle, each with a small papilla extending from the center of the pore (Fig – 4 & 5).

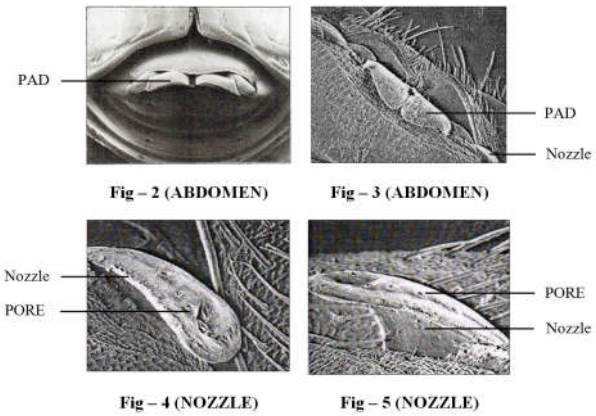

Fig – 2 (ABDOMEN) **Fig – 3 (ABDOMEN)**

Fig – 4 (NOZZLE) **Fig – 5 (NOZZLE)**

In contrast to previously reported structure studies of bombardier it is here shown that muscle surrounds all structure related to the defensive spray of the genus brachinus, including the reaction chamber (Eisner *et.al.,* 1992). Although it is a complex system, it can be relatively easily explained and stood under by many workers (Anon, 1990). Thus, it has become a much used example by creationists in their argument for creation from design.

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