Title: Eye of female *Drosicha mangiferae* in various developmental stgaes (Hemiptera:Coccoidea: Margarodidae).

Authors: Monalisa Mishra*, Snigdha Bhadani
Affiliations: Neural Developmental Biology Lab, Department of Life Science, National Institute of Technology, Rourkela, Odisha, India, 7690008. Email address: *mishramo@nitrkl.ac.in

ABSTRACT Arthropods possess various types of photoreceptors across the phylum. An adult photoreceptor comprises ocelli (simple eye), compound eye (multiple lenses) or both. In holometabolous insects, the compound eye sizes do not vary after it reaches its adult stage. However, in hemimetabolous insects, the compound eye grows throughout the life. The compound eye undergoes modification either by adding or removing functional units from the eye to provide adequate survivability to the animal. The current studies describe the eye of female mango mealy bug *Drosicha mangiferae,* which possesses only one pair of functional unit as it's photoreceptor throughout its life. The current study explains the role of eye in the behaviour of the animal.

Keywords *Drosicha mangiferae,* Compound eye, Single facet eye

Introduction Arthropods are the most successful animals on this earth. One of the reasons for its success is the sensory organ, which evolved several times to provide the best fit to the animal (Barth & Schmid, 2013; Mishra, 2013; Buschbeck & Friedrich, 2008). An adult arthropod photoreceptor includes compound eye, ocelli or both (Nilsson, 2013). In some hemimetabolous and holometabolous insects, the larval stages possess stemmata which resemble with primitive ommatidia. In hemimetabolous insects, the size of the eye increases from life either by adding extra facets as well as by increasing the diameter of the facet (Frolov, et al., 2012; Keskinen & Meyer-Rochow, 2004). Within the same species, sexual dimorphism is observed within the eye (Lau & Meyer-Rochow, 2007; Meyer-Rochow & Lau, 2008). *D. mangiferae*, commonly known as mango mealy bug possesses sexual dimorphism in terms of its wing. Males are winged whereas the females are wingless. Females are commonly found in the mango inflorescence or in the bark of mango tree which comes to the ground (to grass) during the rainy season. The vision of an animal is required to find the food and partner. The current study correlates the post embryonic change in eye size and its visual behaviour of female *D.mangiferae* not described in earlier studies.

Material and methods *D. mangiferae* (Hemiptera: Coccoidea: Margarodidae) colonies (4 different population) were collected from National Institute of Rourkela, Odisha, India (N22°14'57", E84°52'58") between June 2016 to June 2017. Walking behaviour of the animal was monitored in the field. The young ones can walk with a faster speed than the adults with long body length and breadth. We kept an obstacle to the various angle (dorsal and lateral side) of the animal to check whether the animal can see from any angle or not.

Measurements of animal of various body lengths were taken. The heads were cut and mounted on a stub having double adhesive carbon tape under a stereo microscope and imaged using an environmental scanning electron microscope (Quanta FEG250, FEI) at an operating voltage of 10 kV. A total of 70 bugs were used for the current studies. Measurements of various parameters were taken using ImageJ 1.48.

Figure 1 Overview of the *Drosicha mangiferae*. (A') Young one's walking over the grass (A) Dorsal view of a young (B) Dorsal view of an adult (C) Ventral view of the adult (D) Ventral view of the head of *Drosicha mangiferae* taken under a stereo microscope. Arrow points towards the eye of the animal.

Results and Discussion

Behaviour of the animal To check the vision of the animal various behavioural studies were carried out with animals of various body lengths (Fig. 1A', A-C). Obstacles were kept in dorsal and lateral side of the animal and its response was observed. The animal with smaller body size responded faster than the animal of larger body size. Furthermore, the obstacle present on the lateral side of the body has a better response than the one at the frontal side. The behavioural study suggests that the animal has very poor vision.

Analysis of eye: Under the stereo microscope, two black dots were found on ventral side near the antennae (Fig. 1D). Based on the location and shape it is presumed to be the eye of the animal (Fig. 2A-D). The distance between the antennae and two black-colored dots changes with body length (Fig. 2E). To show the relation between body length and the distance between eye and antennae graph was plotted (Fig. 2E). An antennae SEM is shown in figure 2F. Scanning electron micrograph reveals, only one lens at the base of the antennae. The diameter of the lens is 96.245±6.2 µm. The facet appears to be smooth at higher magnification. Corneal hair or mechanosensory bristles are not found near the eye. The white skin of the body appears like wool under scanning electron microscope (Fig. C and D). The eye size or the facet diameter increases with the body length of the animal.

Severe reduction in eye size is observed in the current studied species. Wingless females use that energy for the production of eggs at cost of flight and vision (Lau & Meyer-Rochow, 2007). Can the animals see with its eye? According to Barlow, 1952 to see the optimal size of the facet should be 8-10µm (Barlow, 1952) which the currently studied animal eye satisfies. Transition of the compound eye to

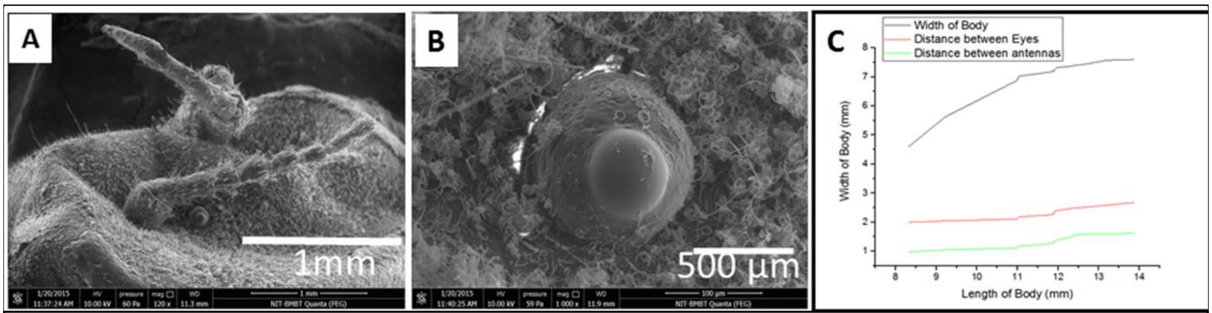

Figure 2 Scanning electron micrographs of the eye of *Drosicha mangiferae*. (A) Lower magnification of the head depicting the localisation of the eye at the base of the antennae from various angle (B) Frontal view of the eye shows its circular nature (C) Graph represents the distance between the eye and antennae with body length.

single ommatidia as observed in the current study could be resulted due to severe reduction of the eye (Nilsson & Osorio, 1997) as occurring to stemmata, the homologous organ of primitive ommatidia (Liu & Friedrich, 2004). We cannot think the single facet as stemmata since a number of stemmata is always more than one in both hemi and holometabolous animals and they are found in larval stages. Thus the single facet of *D. mangiferae* throughout its life is probably due to the severe reduction of photoreceptor during evolution.

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