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Scanning electronic microscopic study of antenna of *Tribolium Confusum* (confused floor beetle)

P R Thakare*, V R Kakde
Department of Zoology, Jijamata Mahavidyalaya, Buldana, Maharashtra, India

Abstract
Arthropods bears short appendages, jointed legs containing most of the beetle species in the biodiversity. Beetles in the form of varied families in the phylum Arthropoda shows different mouth structures with abdominal forms. Red floor beetle *(Tribolium castaneum*) and Confused floor beetle (*Tribolium confusum*) showed similar external appearance except antennal structure and smooth abdomen without any row of pits. Scanning electronic microscopic study of the dorsal and lateral view of the confused flour beetle shows varied numbers of sensilla. These sensilla types are *viz*., ST (Sensilla trichoidea), SC (sensilla chaetica), SB (Sensilla basiconica) and Amp (ampulacea). Antenna is clavate type and having 4 to 11 segments with widely separated antennal insertions, distance between them more than the length of first antennal segment. Antenna has four enlarged segments (antennal club) at the terminal end. Raw deep pits are present over the dorsal surface of the beetle. Scanning electronic microscopy is done under used the Lyzer Zoom Stereoscopic Microscopy, Trinocular model ZSM-3 Light microscope. SEM study observed specifically antennal sensilla segments with length in micrometer. Sensilla trichoidea typically innervated by one to several neurons can be solely mechanoreceptors, contact chemoreceptors, thermo sensitive, or olfactory in function. Sensilla chaetica responsible for mechanoreceptors or contact chemosenstive in function. Sensilla basiconica are short hairs (pegs) or cones that are innervated by one to several neurons. Sensilla ampullacea are positioned in deep pits with narrow openings and innervated by two to several neurons.

Keywords: scanning, electronic microscopy, *Tribolium confusum*, *Tribolium castaneum*, Lyzer, zoom stereoscopic microcopy etc

Introduction
Coleoptera is an order of class-Insecta commonly called beetles. Beetles comprises the largest group of insects with over quarter of million described species. The word 'Coleopteran' comes from the Greek word, keleos meaning "Sheath"; and petron means "wing", thus "sheathed wings". They are to be found in almost every habitat and range in size from 1-100 mm in length. The heaviest known insect is Scarab beetle. Most beetles have two pairs of wings. Front pairs are hard, leathery called "elytra" provides sheath like projections for the rear pair which is transparent, membranous and thus protect the rear part the beetle dorsal and ventral body. The spiracles open into the body cavity, an adaptation which reduces water loss during respiration and protect the abdomen from desiccation, (Watt, 1983). The order coleopteran includes more species than any other order of insects constituting almost 25% of all known life forms. About 40 % of all described insect species are beetles (about 400,000 species) and new species are discovered frequently. There are about 500 recognized families and subfamilies. One of the first proposed estimates of the total number beetles species on planet. Coleopteran are found in nearly all natural habitats including fresh water and marine habitats, everywhere there is vegetative foliage from trees and there bark to flowers, dead and decaying matter and even cow dung. (Choate, 1999) [5]. About 600 beetle species in 34 families are associated with stored grain or food materials made from grains. However, stored fruits and vegetables are also attacked. Some beetles are associated with stored food because they feed on the mold and fungi growing on these substrates or they are predators of insects or arthropods that are the primary invaders. (Campbell, 2015) [4].

Family: Tenebrionidae
This family comprises over 1200 species in North America but more than 80% of them are restricted to the South Western Unites States. Only 139 species occurs within the Canadian and Alaskan borders. Many Tenebrionidae live in semiarid areas and deserts but in Canada, most species are found in rotten wood, fungi, under logs and stones and the bark of dead trees. Tenebrionidae often commonly referred to as darkling beetles. Many Tenebrionidae species inhabit dark places. Exceptions include many species in genera such as *Stenocara* and *Onymacris* which are active by day and inactive at night. Tenebrionidae is a family of the beetles with some 20,000 described species worldwide. Of these around 8,000 species are found in the Palearctic region (Lobl and Smetana, 2008) [8]; the European fauna is represented by almost 1,800 species. They are extremely variable in shape, size and ecological requirements. Tenebrionidae beetles occupy ecological niches in mainly deserts and forests as plant scavengers.

***Tribolium confusum* (Confused Floor Beetle)**

Food and Nutrition

The confused floor beetle, *Tribolium confusum* is a common insect that attacks stored grains and foods in the pantry. This insect has a word-wide distribution and it is very abundant in the United States. It lives in almost any kind of flour, cracked grain, breakfast food or meal. A list of specific foods in which these beetles are found and includes whole wheat flour, bleached & unbleached white flour, bran, rice flour, rye flour, corn meal, barley flour and oat meal. The Confused flour beetle and the Mediterranean flour moth have long been recorded as serious pest of stored grain products. Good, 1933 [7] also reports the beetles living in chocolate, spices (red pepper) and various kinds of nuts and sometimes feeding on specimens in insect collections. Arthropods in the living environment affect the quality of life through their mere presence, or their ability to damage, food, fiber and the structure, or by threatening human health (Robbinson, 1996).

Life cycle

The life cycle of confused flour beetle takes place from 40 to 90 days and adult can live for three years. All forms of the life cycle may be found in infested grain products at the same time. Although small beetles about 1/8 of an inch long, the adults are long-lived and may live for more than three years (Walter, 1983). Female beetles of *Tribolium confusum* can lay 300-400 eggs and produces 6-7 generations in one year. Breeding takes place in a temperature range of 20^0 C and 37^0 C. Optimum developments occurs in the range of 32^0 C to 35^0C. Confused flour beetle has one of the highest rates of population growth for stored-product insects. The beetle is able to breed under cooler conditions than the red flour beetle. Both the red and confused flour beetles live in the same environment and complete for resources (Ryan *et al*, 1970). The pupae are lighter in color, being white to yellowish. The eggs white, microscopic and often have bits of flour stuck to their surface. The slender larvae are creamy yellow to light brown in color. They have two dark pointed projections on the last body segment. The red flour beetle may fly, especially before a storm but the confused flour beetle does not fly. Eggs, larvae and pupae from both species are very similar and are found in similar environments (Ryan et.al.1970).

Economic Importance

Tribolium confusum confused flour beetle is probably the most serious pest of the genus *Tribolium* and one of the most economically important beetles. It is notorious as a pest of cereal products although the adults and larvae also feed on a wide variety food stuffs including sound grain. According to Aditi Pai, Gregor Bucher 2019 [2], the storage pest of *Tribolium confusum* commonly known as flour beetles, are of great economic importance because of their cosmopolitan distribution and affinity for stored grain. More recently *T. confusum* has become an important model organism for functional genetics, used in evolutionary developmental biology.

Matrials and Methods

Tribolium confusum beetles were collected from flour mills during the month of November 2021. The adult beetles of the genus *Tribolium confusum* (confused flour beetle) stored in 70% alcohol and allowed to air dried, then put into 90% alcohol followed by xylene. This specimen allow to air dried, whole beetle mounted on specimen bronze stub. Then examined different sensilla were done under JEOL 6380 scanning electron microscope at Visvesvaraya National Institute of Technology, Nagpur. The varied patterns of sensilla were observed over dorsal and ventral surface of antenna along with the antennal length were obtained from the micrographs.

Result and Discussion

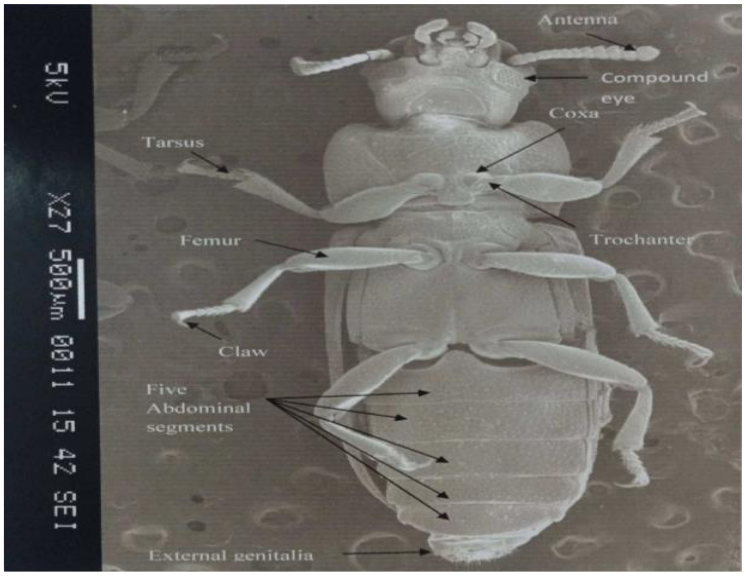

Fig 1: SEM of ventral view of *Tribolium confusum*

The confused flour beetle apparently received this name due to confusion over about its identity as it is identical so similar to the red flour beetle at first glance. Although small beetles, about 1/8 of an inch long, the adults are long-lived and more than three years (Walter).The Scanning Electron Microscopic Study of the dorsal surface of beetle *Triboilum confusum* showed variations in the types of sensilla *viz*.,trichoidea, chaetica, basiconica, coeloconica, ampullacea.

Antenna is clavate type in Confused flour beetle and having 11 segments with widely separated antennal insertions, distance between them more than length of first antennal segment. Along with this, antenna has four enlarged segments antennal club at the terminal end. Antennal segment are shiny lighter in color and terminal antennal segment vertical and horizontal length respectively 98.5 micrometers and 115 micrometer. The length of antennal segment from starting scape up to the terminal tip segment varying increased in phase. There are five major types of sensiila are observed over antennal segment of beetle *Triobolium confusum* i.e., Sensilla trichoidea 1 (ST1), Sensilla trichoidea (ST2), Sensiila chaetica (SC), Sensilla basiconica, (SB), Sensilla ampullaceal (SA).

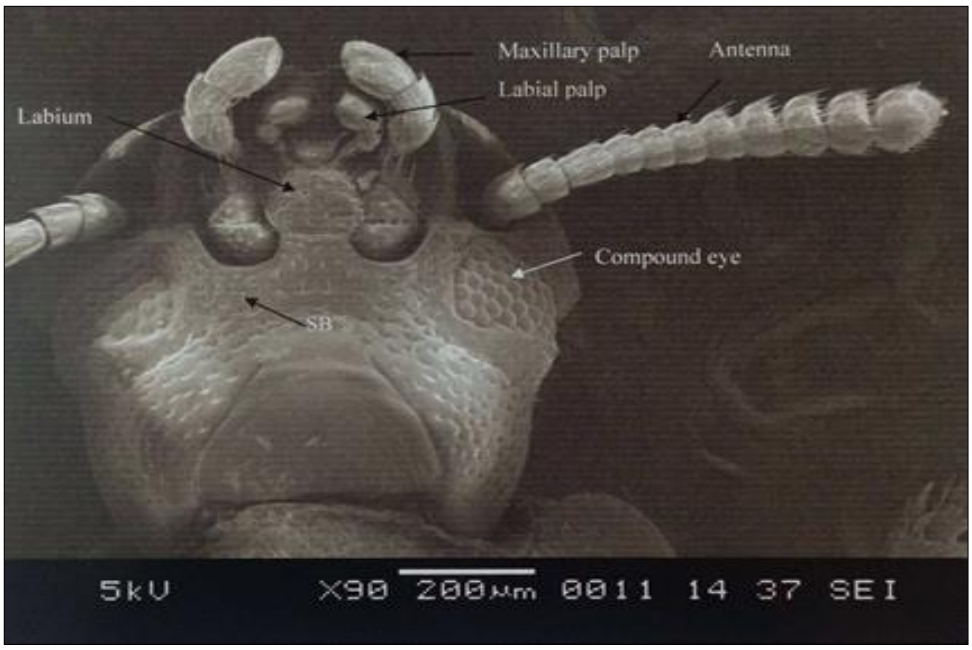

Fig 2: SEM of mouth parts of *Tribolium confusum*

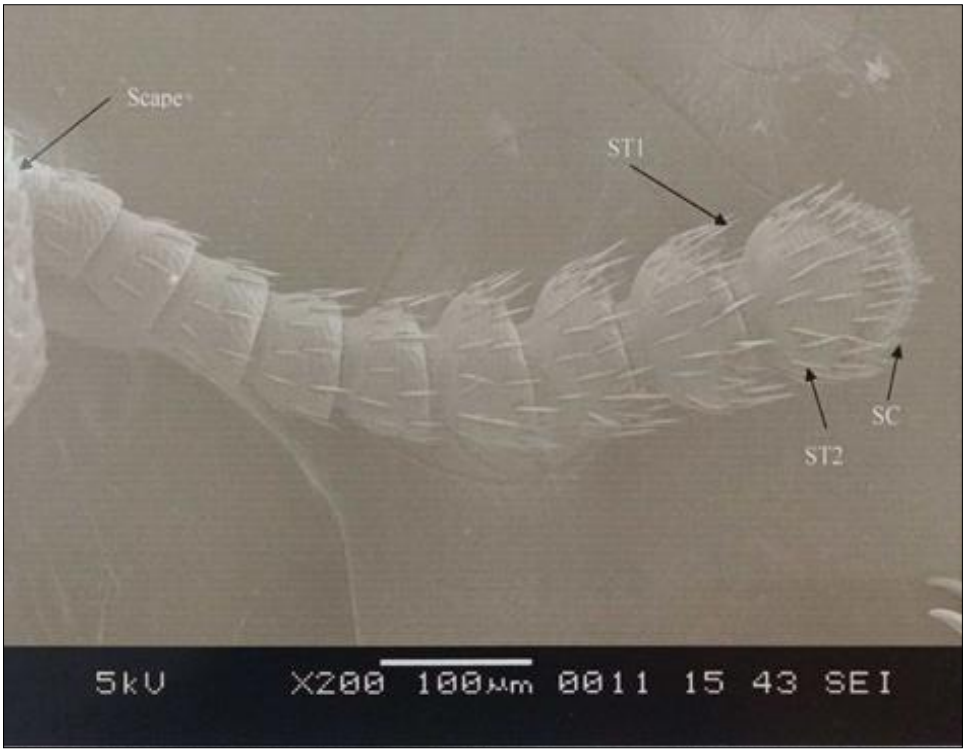

Fig 3: SEM showing the sensilla on antenna of *T.confusum*

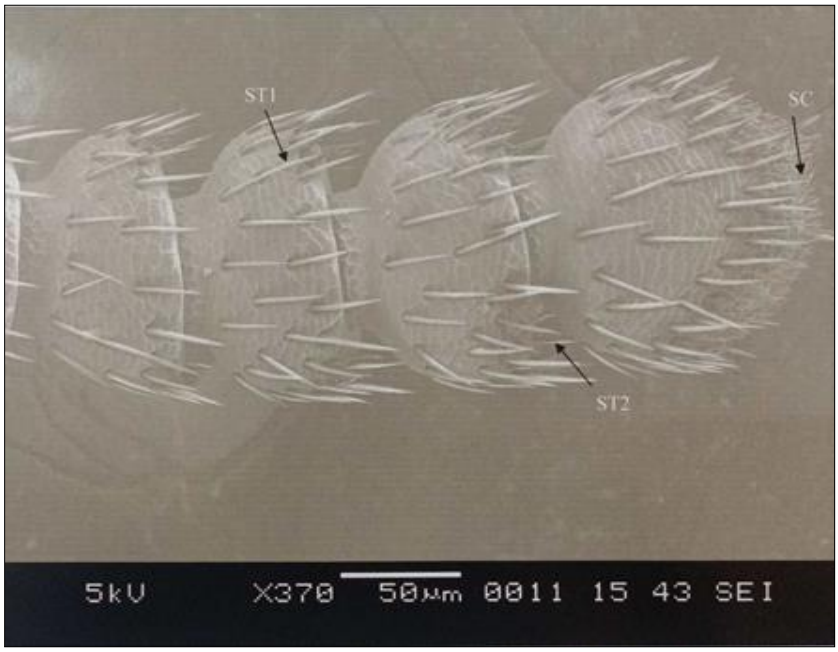

Fig 4: SEM showing the sensilla on last segment on antenna of *T. confusum*

Fig 5: SEM showing sensilla on terminal segment in antenna of *T. confusum*

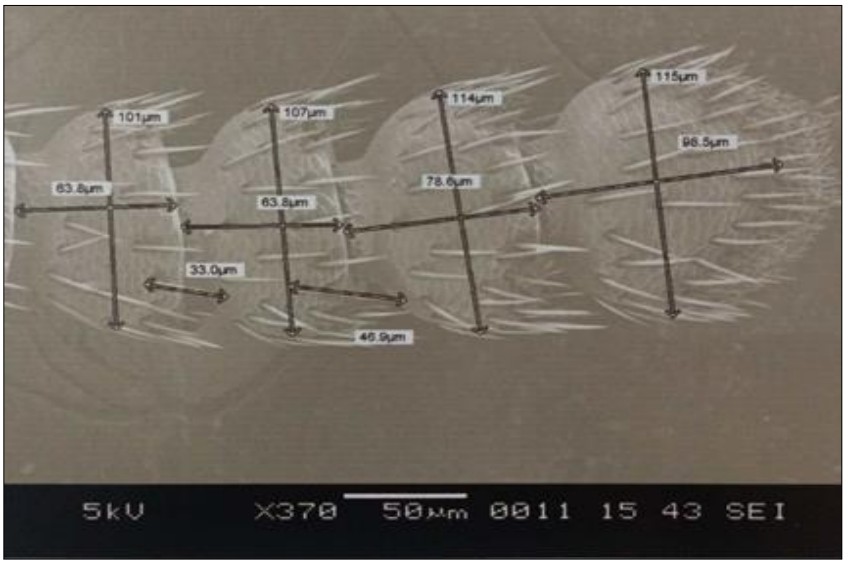

Fig 6: SEM showing length of terminal four antennal segments of *T. confusum*

Conclusion

The antennal segments of *Tribolium confusum* scanned and observed by using Scanning Electronic Microscopy. Through this study, it is concludes that whole beetle is measured from its dorsal and lateral view. With the help of SEM length of antenna and each of antennal segments are measured. Five types of sensilla found *viz*., Trichoidea, Chaetica, Basiconica, Coeloconica and Ampulacea.

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