MORPHOLOGICAL FEATURES OF THE SENSORY ORGANS IN RELATION TO FEEDING RESPONSE ON ARTIFICIAL DIET IN THE SILKWORM Bombyx mori L.

By

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Abstract

The Silkworm feeding behaviour reveals two types of responses, energetic and inert feeding response to diet. These two technical terms are introduced in the present study. It was deserved that the Sensilla besiconica at the top of maxillary palpus of maxilla and antennal segments are well developed in the energetic larva while in the inert larva, these organs on right side are extremely deformed. It was also observed in this study that feeding behaviour of silkworm depends on the development of maxillary palpus, and on number of sensilla on the third segments of antannae.

Introduction

The feeding response is most important for growth and development of the silkworm. Before feeding starts, the insect brings its mouth parts into a suitable position to bite the food. Maxillae play an important role in feeding response as it contains contact sensilla which determines the taste of food.

The silkworm Bombyx mori was grown on artificial diet for one successful generation at temperature of 24-29^{O}C throughout its life cycle by Fukuda et al (1960). This was first experiment of its kind for silkworms. Maxillory lobes contain sugar and water sensory hairs. Therefore, maxillectomized larva do not feed on wrong leaves for a long period and there appears to have be other organ of taste besides those on the maxilla Ishikawa et al (1963, 1966, 1959 and 1978) reported that antannae act as feelers which are used to locate the direction of food. Different varieties have different feeding response. The present investigation was conducted to investigate the morphological features of the mouth parts in relation to feeding response. These organs play an important role in determination of feeding response and for location of the feed.

Material And Methods

The detailed study of mouth parts and antennae of silkworm, Bombyx mori was studied under standard conditions. The hydrochloric acid treatment was given to silkworm eggs and larvae were grown on artificial diet. The composition of artificial diet is given below in Table 1.

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Table 1. Composition of artificial diet

Item	Percentage
Mulberry leaf powder	24.0
Corn starch	3.0
Sucrose	4.0
Soybean meal defatted	38.0
Soybean oil	1.5
Ascorbic acid	2.0
Cellulose	13.0
Agar	8.0
B-sitosterol	2.0
Citric acid	3.0
Sorbic acid	0.2
Inorganic salt*	1.3
Vitamin B mixture**	added
Total	100.00

Distilled water

* Inorganic

0

; Kcl 0.02g, $Cacl_2$ 0.036g, $MgSO_4$ 0.18g $FePO_4$ 0.09g, $Si0_2$ 0.06g and KH_2PO_4 0.98g.

** Vitamin B mixture; Biotin 0.01g, Cholin chloride 1.5g, Folic acid 0.002g, Inositol 2.0g, Nicotinic acid 1.5g, Pyridoxal hydrochloride 0.15g, Riboflavin 0.02g and thiamin 0.02g.

The hatching started after ten days and the artificial diet was supplied to larvae. Rearing temperature and relative humidity were kept at 29^{0}C and 95% from first instar to third instar and at 25^{0}C and 85% respectively for fourth and fifth instar.

After four hours larvae were categorized into two groups on the basis of feeding response, i.e. energetic and inert feeding response to diet. For this purpose five larvae were selected in each group. The sensory organs in their head parts were fixed and examined under electron microscope. The rest of larvae continued their growth upto 5th instar in separate batches for testing the protein and esterase activities in the hemolymph.

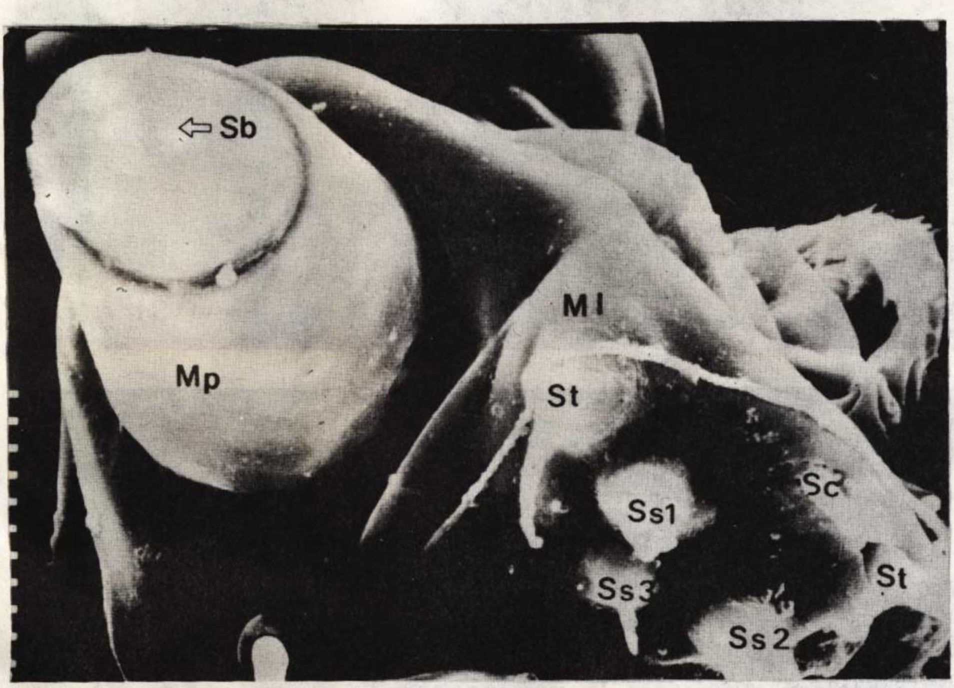

Fig.1 Scanning electron micrograph of maxilla with sensory hairs in the silkworm, Bombyx mori L. Ml, Maxillary lobe: Mp, Maxillary palpus: sb, Sensilla basiconica: Sc, Sensillum chaeticum: Ss, Sensilla styloconica 1,2,3: St, Sensilla tricodea.

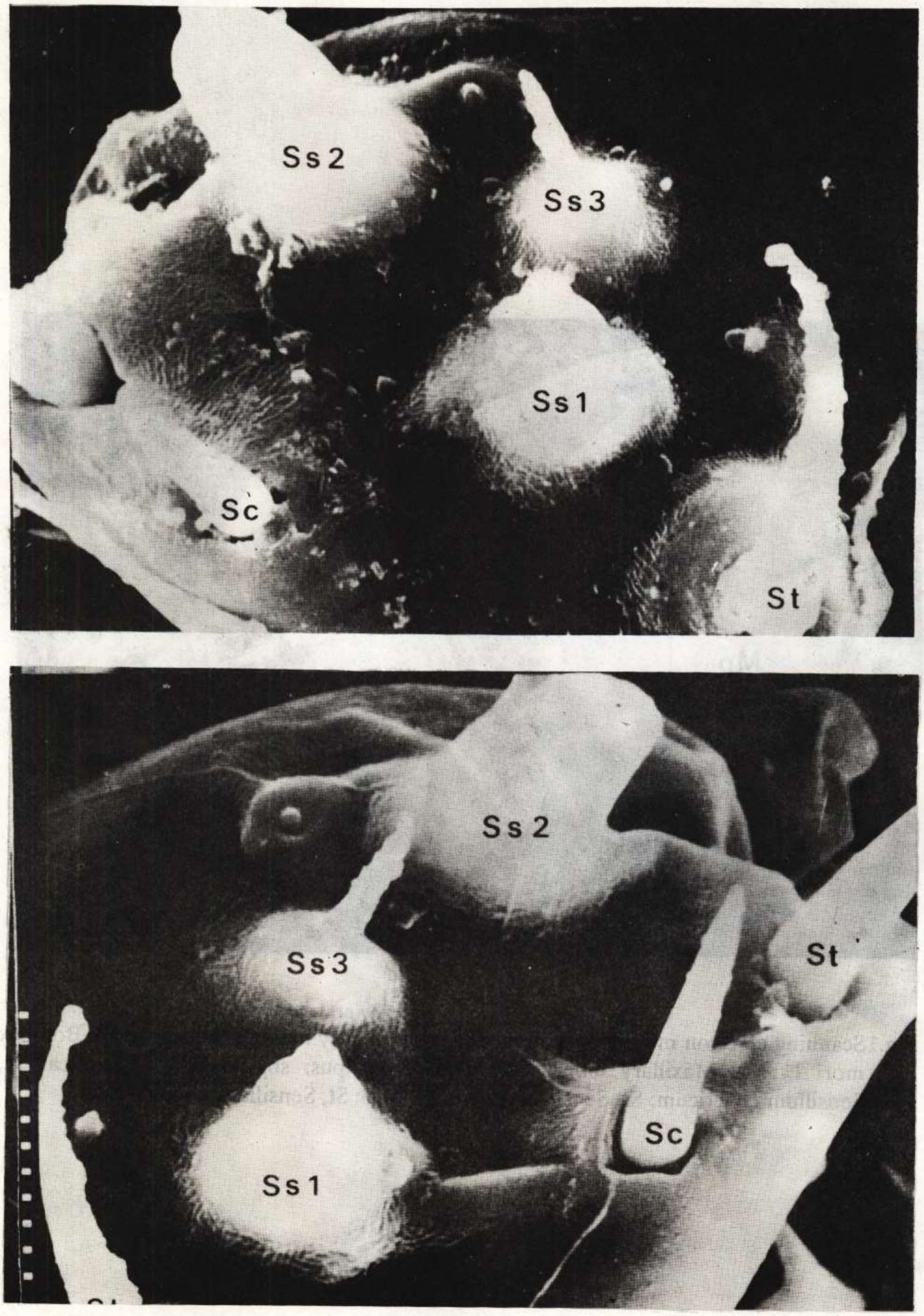

Fig.2Scanning electron micrograph of sensory hairs on left and right maxillary lobes of larvae in the silkworm, Bombyx mori, with energetic response to diet. Ss1, Ss2, Ss3, Sensilla styloconica: St, Sensilla tricodea: Sc, Sensillum chaeticum.

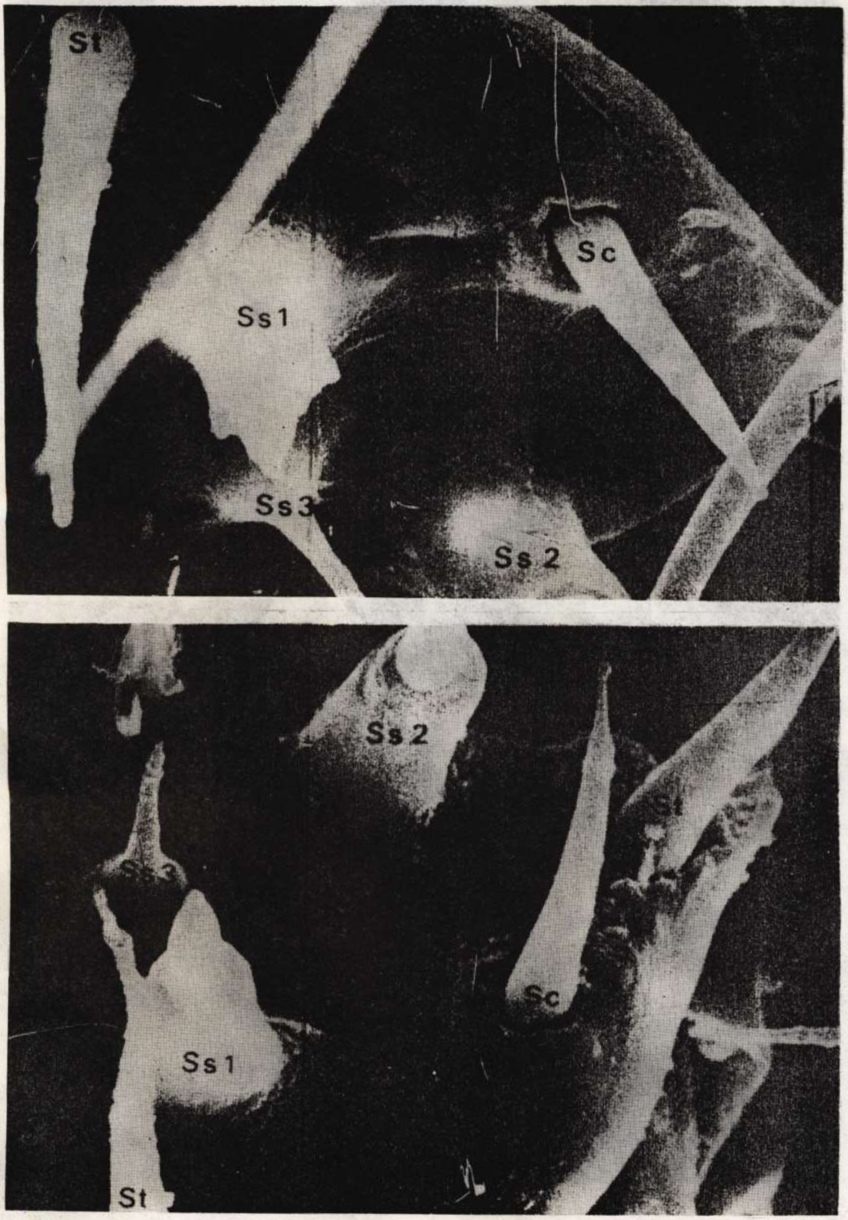

Fig.3Scanning electron micrograph of sensory hairs on left and right maxillary lobes of larva in the silkworm, Bombyx mori, with inert response to diet. M1, Maxillary lobe: Ss1, Ss2 and Ss3, Sensilla styloconica: St, Sensilla tricodea: Sc, Sensillum chaeticum.

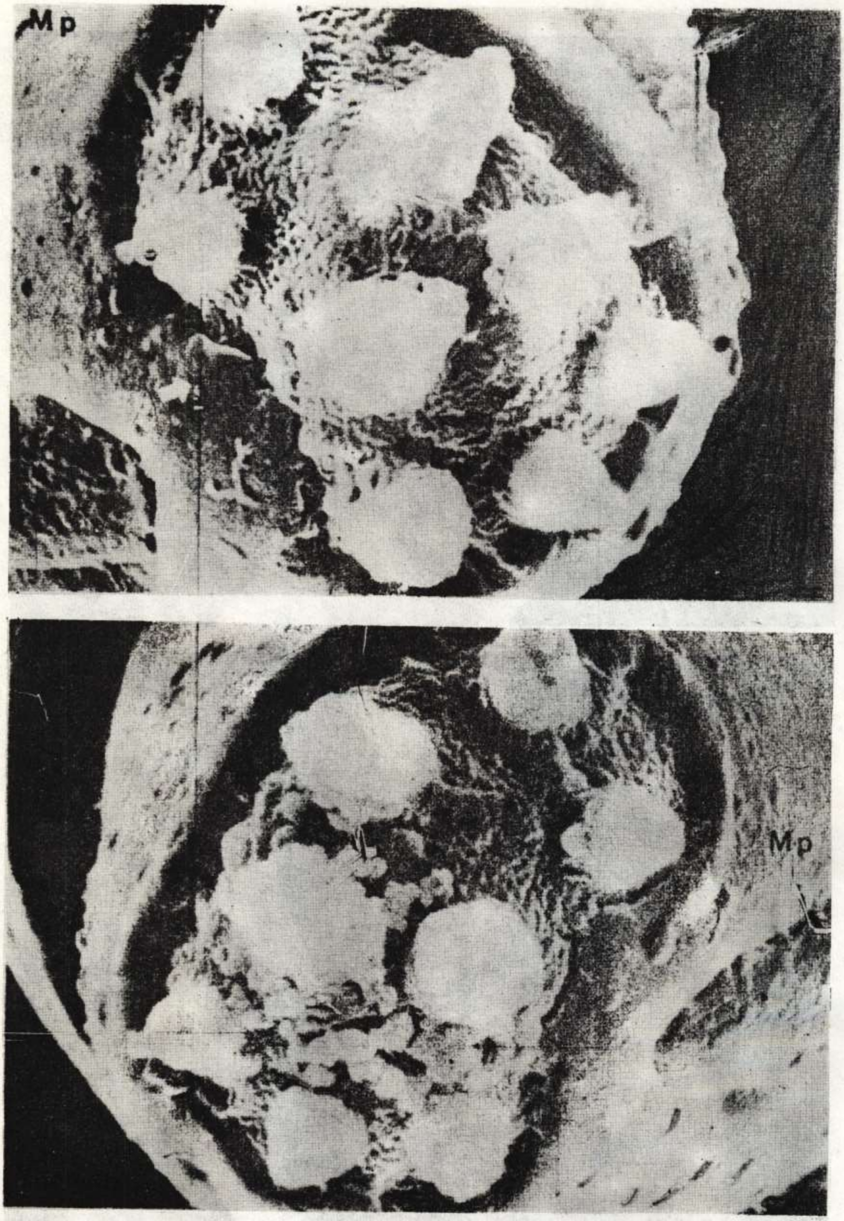

Fig.4Scanning electron micrograph of sensory hairs on left and right maxillary palpus of larvae in the silkworm, Bombyx mori, with energetic response to diet. Mp, Maxillary palpus: Sb, Sensilla basiconica.

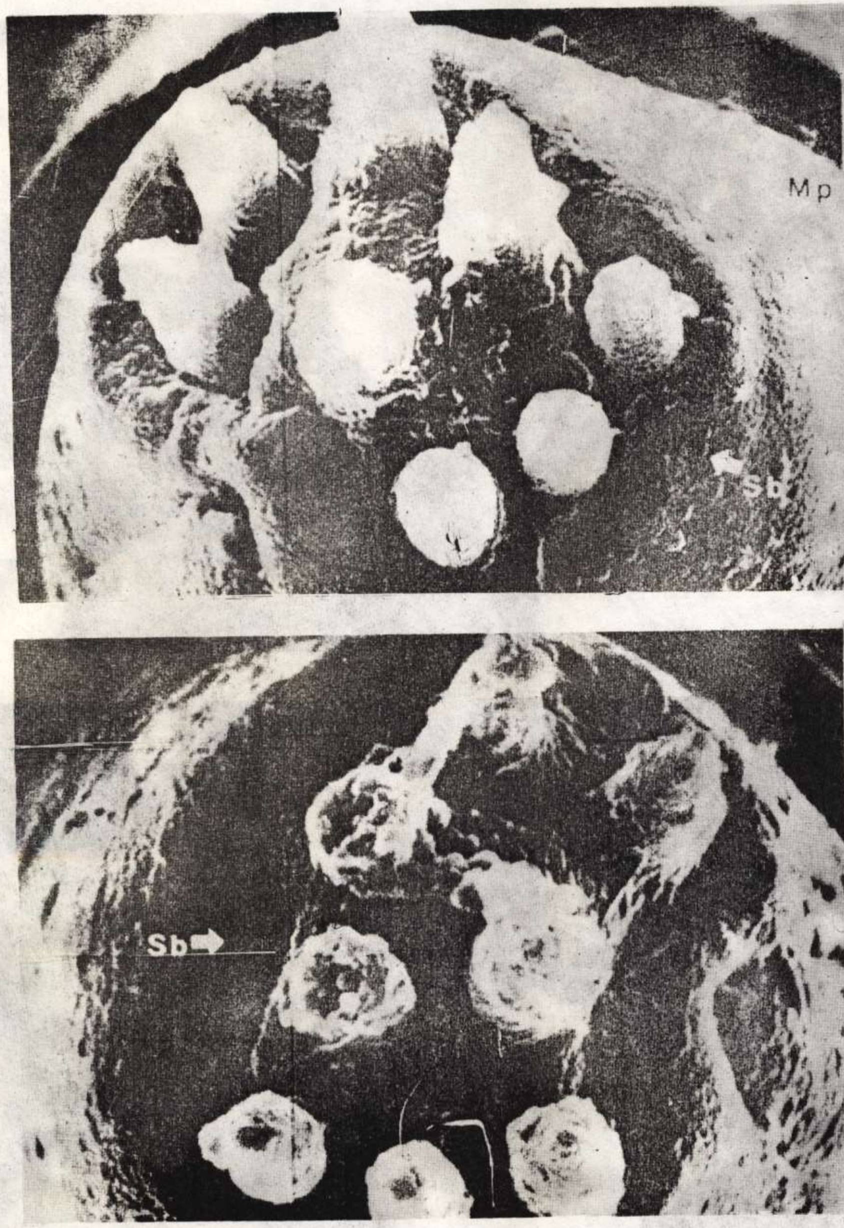

Fig.5Scanning electron micrograph of sensory hairs on left and right maxillary palpus of larvae in the silkworm, Bombyx mori, with inert response to diet. Mp, Maxillary palpus: Sb, Sensilla basiconica.

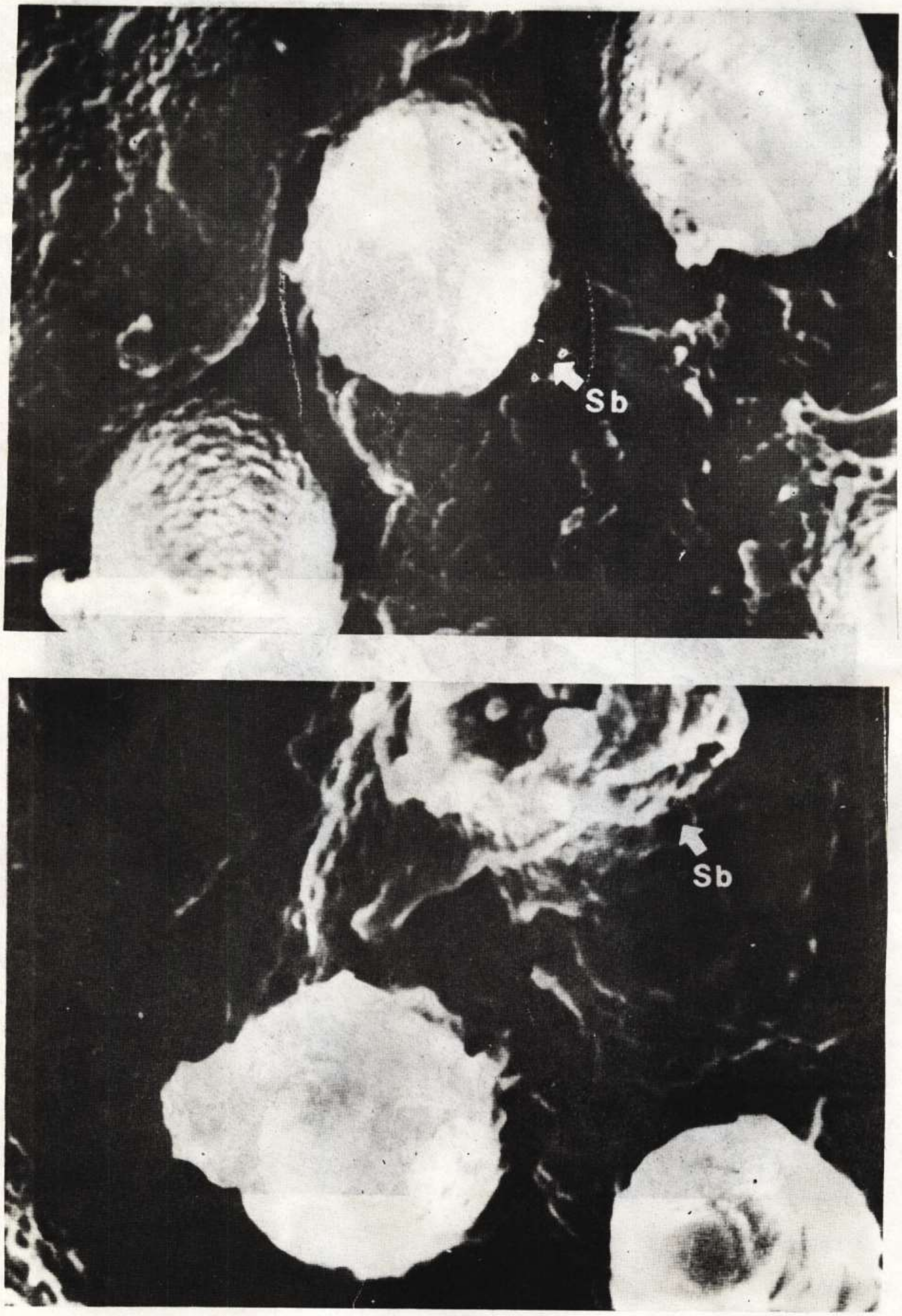

Fig.6Scanning electron micrograph of sensory hairs on left and right sensilla basiconica of maxillary palpus of larvae in the silkworm, Bombyx mori, with energetic (top) and inert (bottom) response to diet. Sb, Sensilla basiconica.

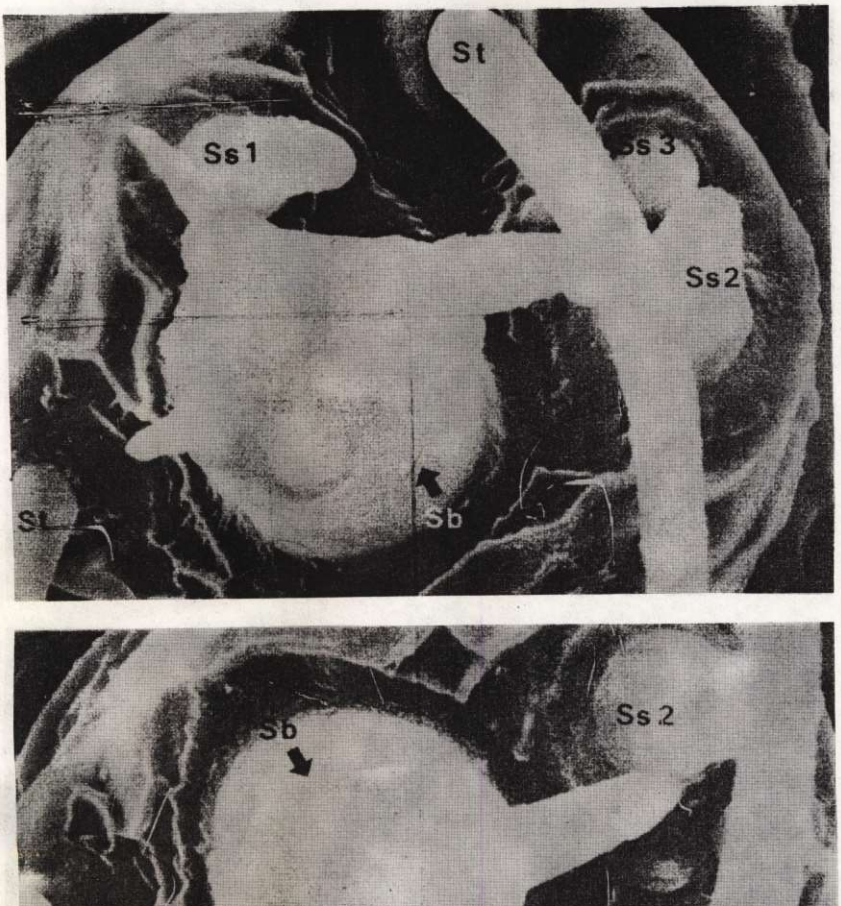

Fig.7Scanning electron micrograph of sensory hairs on left and right antenna of larvae in the silkworm, Bombyx mori, with energetic response to diet. St, Sensilla tricodium: Sc, Sensilla chaeticum: Sb, Sensilla basiconica: Ssl, Ss2, and Ss3, Sensilla styloconica.

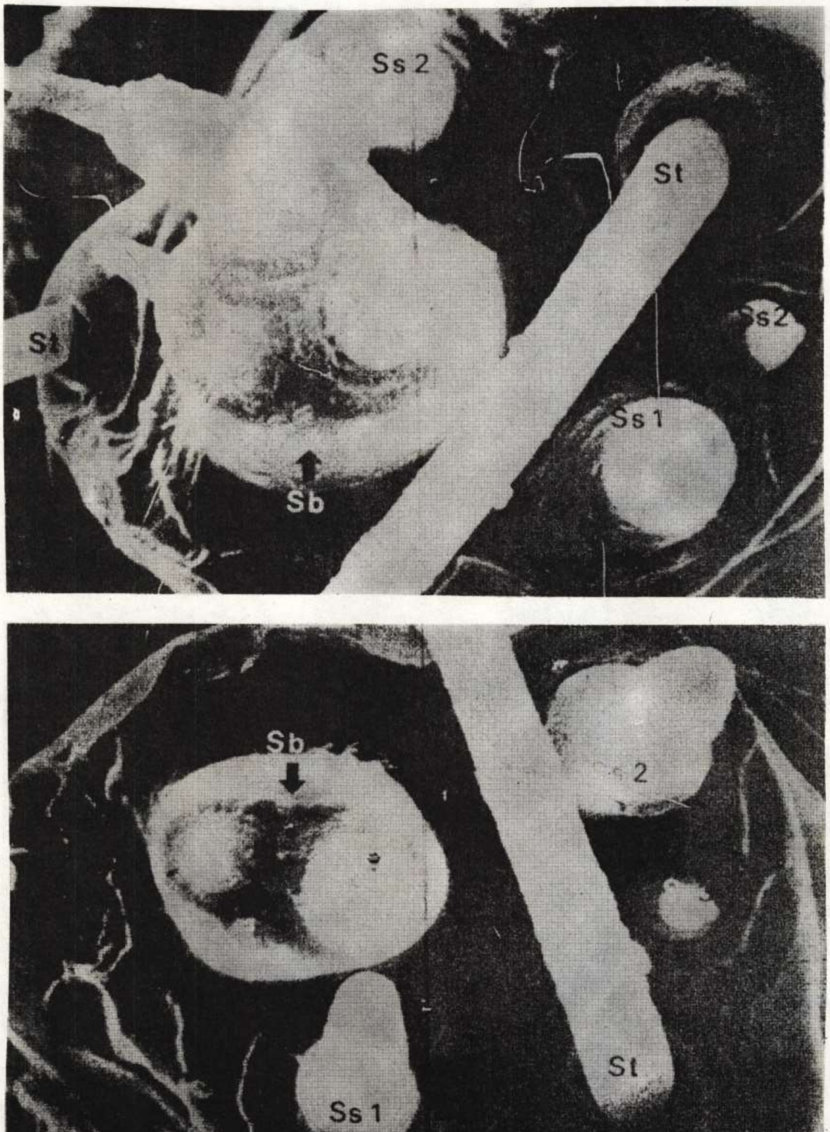

Fig.8Scanning electron of micrograph of sensoryhairs on left and right antenna of larvae in the silkworm,Bombyx mori, with inert response to diet. St, Sensilla tricodium: Sc, Sensilla chaeticum: Sb, Sensilla basiconica: Ss1, Ss2 and Ss3, Sensilla styloconica.

Results And Discussion

The study of silkworm feeding habits reveals two types of feeding responses. One is continuous feeding habits known as energetic feeding response while other is inert feeding response to diet. These term are quite different from those of Hamano, and Associates (1986), who Categorized the feeding responses of the silkworms into high, medium and low feeding response. The feeding behaviour is important for the growth and development of the silkworm. Before feeding starts, the silkworm brings its mouth part into a suitable position to taste the diet with sensory hairs which have contact receptors. If contact sensilla are well developed, the feeding response is good but if some defects are present in contact sensilla, the feeding response is low and larvae die because of starvation. The structure of sensilla and functional organs within the mouth and antennae were examined in the energetic and insert larvae under scanning electron microscope.

In Fig.1 and Fig.2 in the energetic larvae, the sensilla are shown with maxillary palpus and maxillary lobes. There are eight maxillary palpi grown at the top of the maxillary palpus known as sensilla basiconica which differentiate the taste of food. The energetic larvae revealed the right and left maxillary lobes with sensilla Styloconica Ss(Fig.2). These are three in number i.e., Ss 1, Ss 2 and Ss 3 which are associated with contact chemoreceptors. Ss 1 is sugar and water sensory hair and Ss 3 is little developed and functions are unknown (Ishikawa and coworkers 1963). The other three sensory hairs are contact sensilla, two are large and called sensilla trichodea and small one is known as sensilla chaeticum.

In Fig.3, in the inert larvae, the maxillary lobes with sensory hairs are exhibited and function are the same as expressed in energetic larvae.

In the energetic larvae the sensilla basiconica are shown in Fig.4. Left and right as both sides are well developed and are eight in number. When they touch an organ or food, the taste is discriminated and if found suitable, larva starts to eat the food otherwise reject it. The ultrastructures are fully grown at the top of the maxillary palpus. The action of mouth part is working in relation to the function of their chemosensilla. On the other hand, the left and right maxillary palpus with sensilla basiconica are shown in the inert larvae in Fig.5. The ultrastructures of sensilla basiconica on the left side are fully developed and are eight in number but on right sides these structures are deformed and can not perform their function fully.

Therefore, when larvae with deformed organs to select food, they try, but fail to discriminate the taste.

In Fig.6 comparison of sensilla basiconica of the energetic and inert larvae is also shown with high magnification.

These morphological observations reveal that if maxillary sensory hairs are fully developed, they act as contact chemoreceptors, easily discriminate the food and move in search of diet but if sensilla are deformed or absent, no feeling of taste exists, larvae have sluggish movement, can not grow well and finally die of starvation.

Sensory hairs of antennal organs

There is a pair of antennae composed of five jointed segments which is used as sensory organs. The antennal lobes contain contact sensilla and act as a feeler.

In Fig.7, the right and left sensory hairs of antennal organs in the energetic larvae are shown. There are four sensilla trichodea on second antennal segment which and are fully grown. Four sensilla basiconica are well developed on third segment, when larvae move in search of food, these contact sensilla play as important role to locate the food and direction as feelers. After identifying the food and direction, the maxillary sensory hairs perform the subsequent function of food selection as well as determination of its taste.

The sensory hairs of inert larvae are shown in Fig.8. On the left side, the four sensillum trichodium on second antennal segment are well developed. Similarly, four sensillum basiconicum which are located on third segment are fully grown. When these sensilla contact an organism or food, they feel its presence or absence as well as direction.

On right side, the four sensillum trichodium on second antennal segment are developed but on the third segment only two deformed sensilla basiconica are present. These deformed structures cannot feel the presence of food or locate the direction. That is why,though the larvae may have strong desire to find the direction and check the food but because of deformed sensilla cannot do so. Therefore they become sluggish, do not grow well and finally die of starvation.

Conclusion

The structures of functional organs of mouth part and antenna of energetic and inert feeding response of silkworm larvae to diet were examined under by scanning electron microscope. There is a large variation in the ultrastructures of different sensilla. The maxillary palpi or sensilla basiconica at the top of maxillary palpus of maxilla are well developed in the energetic larva while in the inert larva, these organs on right side are extremely deformed. Similarly, these sensilla on the third segment of antenna are well developed in the larva energetic to diet and four in number but in the larva inert to diet has only two deformed sensilla basiconica. That is why in the latter case the silkworm cannot show a proper form, fail to locate the food and die of the starvation.

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