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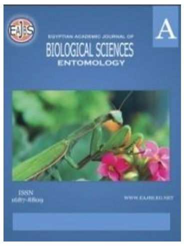

Comparative Morphogenesis of Mouth Parts Sensilla Between the *Leptocybe invasa* and *Ophelimus maskelli* (Hymenoptera: Eulophidae) and Its Relationship to Their Vital Capacity

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ABSTRACT

Insects have a large number of sensory organs (sensilla) on their mouth parts, which play crucial roles in the host acceptance and localization processes as well as in detecting environmental stimuli. Sensilla, therefore, play a crucial part in the location, selection, and acceptance of a potential host by parasitoid hosts. Based on the types, numbers, and distributions of sensory organs, one can deduce how they function. These biological parameters have been tested. In this work, the external sensilla on the mouth portions of *Leptocype invasa* (Fisher and La Salle) and *Ophelimus maskelli* (Ashmead) were described (Hymenoptera: Chalcidoidea: Eulophidae). In Egypt, these two inducer gall species primarily affected *Eucalyptus camaldulensis.* Using electron scanning microscopy, the sensilla were categorised based on their size, distribution, and shape; some may even have sense organs visible. On the mouthparts of *L. invasa* and *O. maskelli*, eight different types of sensilla were found, and depending on their length and distribution, some of them can be further split into numerous categories. Sensilla came in 16 different varieties overall. In the current study, *O. maskelli* had more sensilla overall on oral parts than *L. invasa*, with 109 sensilla on O. maskelli compared to more than 95 on *L. invasa* along the mouthparts. Results from the examined biological characteristics were explained by qualitative and quantitative differences in the type of sensilla on both species' mouthparts, favouring *O. maskelli*. These findings tend to imply that *O. maskelli* is a more advantageous rival that could supplant *L. invasa*. Despite the two species' similar body sizes, *O. maskelli* was smaller than *L. invasa*. However, *O. maskelli* mouth showed more sensilla types overall than *L. invasa.*

INTRODUCTION

In the low-altitude arid and semiarid lands of the Middle East and North Africa, eucalyptus trees are the foundation of wooded areas. Eucalyptus plantations are a significant source of wood, firewood, and honeybee foraging. They are also used as windbreaks, recreation spaces, shelter from sandstorms, and windbreaks around farmed and residential areas. In the Middle East and the Mediterranean region, eucalyptus trees were thought to be almost completely free of harmful insect pests until a few years ago. In the past ten years, two bug species that cause galls have been introduced to the Mediterranean basin. A gall inducer on Eucalyptus spp. was originally observed by

Ramadan (2004) on the North West coast of Egypt, although it was mistakenly identified as *Aprostocetus sp. Ophelimus maskelli* (Ashmead), another gall-inducing agent, was observed by Ramadan & Karam (2005) on eucalyptus trees in Alexandria. *Leptocybe invasa* (Fisher and La Salle) and *Ophelimus maskelli*(Ashmead) were recently used to identify these two wasps. When compared to the second species, *O. maskelli*, the first species, *L. invasa*, was found to solely infest the leaf blade, petoil, and young shoots. The current studies sought to understand the distribution of these two species' sensory organs on their individual mouthparts as well as to estimate the various measurements of these organs, there should also be a comparison between the two species based on the number and size of sense organs and their relationship to their vital capacity and competitive ability to feed.

A sensory organ's relevance to the animal is often correlated with how big it is in relation to the body size. Although they entail a higher energetic expenditure, larger organs can aid in improving the sensitivity and/or selectivity of pertinent signals. The ability of various organs to grow relative to body size must be balanced against each other since sensory systems require a lot of energy to develop and sustain. Such trade-offs provide variation in the relative sizes of sensory qualities both within and across species, and they ultimately affect how an individual can react to changes in their environment and changes inside themselves. Stevens (2015) during its life.

A thorough allometric investigation on the sensory systems of females of *Leptocybe invasa* and *Ophelimus maskelli* was conducted to start filling in this information gap. Allometry is the study of how organ size varies in relation to body size. Due to their ecological specialisation and habitat-specific activity, these wasps probably need to adapt to a variety of sensory cues in order to recognise their hosts. The analyses primarily focused on the allometric scaling relationship of sensory qualities associated with foraging behaviour and reproductive organs mouthparts. The density of the mouthpart sensilla was also examined to give further clarity on how the size of these sensory organs impacts the number of sensory structures that they express. We postulate that, similar to the numerous insects that have been the focus of allometric analyses to date (Kramer *et al*. 2015; Jander and Jander 2002; Kunte 2007; Taylor *et al*. 2019), there would be a positive relationship between mouth parts size and the sensory organs under study, but that the rates at which each trait increases in size with body size would differ between species to reflect the differences in their behavioural ecology.

Most insects' heads are equipped with a variety of complex organs, including antenna and mouthpart appendages, which serve as the primary centres for sensing and food absorption. Almost all of the behaviours that insects engage in depend on these organs, such as locating oviposition sites, identifying partners, locating host plants, and feeding. The most significant multimodal sensory organs are the antennae, which have an enormous number of sensilla for detecting not only odours but also tastes, carbon dioxide, and mechanical stimulation (Keil, 1999). The mouthpieces serve as the only organ used for eating and have chemoreception-related functions. The mouthparts' morphology and evolutionary biology have previously been thoroughly examined (Kristensen, 1984; Krenn *et al*., 2005; Nielsen and Kristensen, 2007; Lehnert *et al*., 2016).

Important information about the mouth parts and their ancillary sensilla of both species has been gathered by these studies, but further in-depth information about these structures for other species is still required. Its use to regulate two species may be suggested by their shared habits. Understanding the qualities of the mouth parts can aid in comprehension of their inducer galls' behavioural features. This work is the first to describe the sensilla of both *L. invasa* and *O. maskelli* mouthparts.

SEM was employed in this study to describe the external morphology, type, and distribution sensilla of mouth parts of *L. invasa* and *O. maskelli*. Moreover, based on comparisons between them and other Hymenopteran wasps as well as morphological characteristics, their possible activities were discussed. This information helps to clarify the role that these sensilla play in the process of selecting hosts and lays the groundwork for future research on the behaviour of *L. invasa* and *O. maskelli* that cause galls (host location, recognition, and acceptance). Consequently, devising strategies for managing and exercising control over them.

MATERIALS AND METHODS

Biological Studies:

40 newly emerging adults of each species were used to calculate the two species' fecundity. Every individual was held in a 6 x 3 centimetre plastic tube that had a plastic cover. With the use of a rubber band, each tube was suspended from a eucalyptus sapling. Each tube had a leaf that was clean and devoid of infection. Eucalyptus leaf tubes contained adults who were kept there until they passed away. The number of laid eggs was counted after a few days and the leaves were examined. Calculated for each species was the average number of eggs laid by 40 females.

Sampling Procedures:

For the purpose of collecting *Leptocype invasa* and *Ophelimus maskelli* throughout the course of one year only, beginning on January 1 and ending on December 31, 2020, frequent field trips were made to the university's agricultural agriculture at intervals of 10 days.

From the tagged trees for both species, 30 infected leaf samples were randomly selected, preserved in polyethylene bags, and brought to the lab for analysis. A stereoscopic binocular microscope was used for counting. Using a sharp razor, the galls of both species were dissected, separated into immature stages (larva + pupa), and adult stages (inside the galls or emerging from holes) and numbered. From 30 leaves of each species, the means for each stage/leaf were determined.

Insects:

The *Eucalyptus camaldulensis* trees grown in the Farm of the Faculty of Agriculture, Shoubra El-Kheima, Qalyubiya Governorate, provided the Eucalyptus specimens for the current study. The two species that cause galls were severely overpopulated on these trees. Leaf samples with each species' infestations were stored in a breeding cage and watched until the adults emerged. Using an aspirator, the wasps were collected and preserved in specimen tubes.

Scanning Electron Microscopy:

Wasps were washed multiple times with distilled water to prepare specimens for scanning electron microscopy (SEM), and then fixed for two hours at 4 degrees Celsius using 2.5 gluteralhyde in 1M phosphate buffer (two changes). Increasing concentrations of ethanol, culminating in pure ethanol, were used to induce dehydration (10 minutes for each concentration). On aluminium stabs wrapped in double stickum solytape, specimens that had been dehydrated were mounted. Using a Ladd sputter-coater, a small layer of carbon was applied to dehydrated specimens before they were coated with a gold-palladium alloy. In the Electron Microscopic Unit, Central Laboratory, coated specimens were analysed using a JEOL JSM- T300A Scanning EM. University of Cairo's Agriculture Faculty.

Terminology of Sensilla:

Sensilla were recognised and given names based on their exterior morphology in accordance with the nomenclature suggested by Zhou et al. (2013a), which was formerly based on the terminologies of Amornsak *et al.* (1998).

Data Analysis:

On the dorsal and ventral sides of the mouthpart for both species of *L. invasa* and *O. maskelli*, the morphology of the sensilla was examined. With the aid of Image-Pro Plus and nonparametric Mann-Whitney U statistical tests with a 5% level of significance, the mouthparts of an organism were measured from pictures taken with a scanning electron microscope (version 22.0).

RESULTS AND DISCUSSION

Table 1 lists the conclusions reached after testing several biological parameters. According to these findings, *O. maskelli* had an average of 146.69±14.55 galls per leaf, 130.14±1.58 galls per stage of overall development, and 259±47 eggs per female. As opposed to *L. invasa*, which had a mean fecundity of 50 eggs per female and a mean number of galls per leaf of 17.61±1.34; as well as a mean time for the entire developing stage of 112.64±1.86 and shows that *O. maskelli* is a more formidable rival that could replace *L. invasa*.

Table 1: Comparison of the mean number of induced galls, fecundity and developmental stages per eucalyptus leaf for L. invasa and O. maskelli in 2019**.**

Parameter species	*L. invasa*	*O. maskelli*
Mean number of galls /leaf	17.61 ± 1.43	146.69 ± 14.55
Fecundity/(eggs/f)	50 ± 20	259 ± 47
Developmental stages/ (in days)	112.64 ± 1.86	130.14 ± 1.58

The sizes and other sensory characteristic parameters, including mouth parts, were measured in a thorough allometric investigation on female *Leptocybe invasa* and *Ophelimus maskelli* animals. These results demonstrated that, among all sensory characteristics measured, mouth parts have an allometric connection with body size and that the energetic investment in various sensory systems varies between *L. invasa* and *O. maskelli*. Additionally, *L. invasa* had distinctly bigger mouth parts than *O. maskelli*, suggesting that they use more energy on these organs in exchange for a rise in the latter's sense organ count, which accounts for *O. maskelli* relative numerical density to *L. invasa*. Overall, the results of this study show that the size of sensory traits in *L. invasa* and *O. maskelli* are not always correlated with the size of the mouth parts, raising questions about other factors that drive sensory trait investment in these wasps. Instead, the numerical density of the sense organs determines the vital efficiency of the wasps that cause galls. From the subsequent research, this will be evident.

Sensilla of Mouthparts:

Gross Morphology of The Mouthparts:

Adult *L. invasa* and *O. maskelli* mouthparts are made up of the labrum, mandible, maxillae, labium, and hypopharynx. On the front of the head, only the labrum, the maxillary palpi, and a portion of the labial palpi are visible from the dorsal view (Figs. 1a & Fig. 2a)

Below the labrum, on the ventral side, are the top and lateral portions of the mandibles. The hypopharynx, a non-sclerotized structure, is situated on the inner wall of the labium, which is where the labium can be seen in the centre of the skull between the left and right maxillae (Figs. 1b and 2b). The maxillary palpi are quite developed and symmetrically positioned appendages. The labrum, mandible, maxillae, and labium are the four sclerotized structures that were primarily studied for their fine morphology in this study. The labrum of females *L. invasa* was bigger (average length 10±2.39µm and width

30±1.02µm) (Table 2 and Fig. 1b), than labrum of females *O. maskelli* (average length 7±2.59µm and width 27.33±1.23µm) (Table 2, fig. 2b) also, mandible of females *L. invasa* was bigger (average length 21.34±1.64µm and width 30±1.02µm) (Table 2 and Fig. 1b), than mandible of females *O. maskelli* (average length 25.78±1.27µm and width 60.62±0.26µm) (Table 2 and Fig. 2b). while, maxilla was double size of females *L. invasa* more than in females *O. maskelli* with average length of 75.66±1.83µm and width of 59.93±0.40µm (Table 2, fig. 1b) , while labrum of *O. maskelli* with average length of 63.67±1.98µm and width of 22.73±0.52µm (Table 2 nd Fig. 2b) , stipes of females *L. invasa* was bigger than in females *O. maskelli* with average length of 52.6± 4.77µm and width of 59.93±0.40µm (Table 2 and Fig. 1b) , while stipes of *O. maskelli* with average length of 31.83±0.90µm and width of 22.73±0.52µm (Table 2 and Fig. 2b). Galea of females *L. invasa* were great than in females *O. maskelli* with average length of 29.34± 0.88µm and of width 4.21±0.92µm (Table 2 and Fig. 1b), while galea of *O. maskelli* with average length of 26.34± 0.98µm and width of 6.31±0.72µm (table 2, fig. 2b). Lacinia of females *L. invasa* were also greater than in females *O. maskelli* (average length 9.78±0.88µm and width 20±1.01µm) (Table 2 and Fig. 1b), while lacinia of *O. maskelli* (average length 8.66±0.81µm and width 18.33±1.02µm) (Table 2 and Fig. 2b). Maxillary palp of females *L. invasa* were greater than in females *O. maskelli* (average length 27.84±1.27µm and width 10.21±0.82µm) (Table 2, fig. 1b), while lacinia to *O. maskelli* (average length of 25.74±1.34µm and width of 5.61±0.92µm) (table 2 and Fig. 2b). Maxillary palp of females *L. invasa* consist of one joint with six setae were great than in females *O. maskelli* (average length of 27.84±1.27µm and width of 10.21±0.82µm) (Table 2, fig. 1b), while in *O. maskelli* , also consist of one joint with three setae with average length of 25.74±1.34µm and width of 5.61±0.92µm (Table 2 and Fig. 2b).

Table 2. Length and Width (Mean ±SE, n = 10) of mouth parts in *L.invasa* and *O.maskelli* (Hymenoptera: Eulophidae).

Mouthparts	Length		Width	
	L.invasa	***O. maskelli***	***L.invasa***	***O. maskelli***
Labrum	10±2.39	7±2.59	30±1.02	27.33±1.23
Mandible	21.34±1.64	25.78±1.27	62.49±0.74	60.62±0.26
Maxilla	75.66±1.83	63.67±1.98	59.93±0.40	22.73±0.52
Stipes	52.6± 4.77	31.83±0.90	59.93±0.40	22.73±0.52
Galea	29.34± 0.88	26.34± 0.98	4.21±0.92	6.31±0.72
Lacinia	9.78±0.88	8.66±0.81	20±1.01	18.33±1.02
Maxillary palp	27.84±1.27	25.74±1.34	10.21±0.82	5.61±0.92
Labium	37.56±0.62	32.66±0.92	21.94±1.32	6.34±1.62
Prementum	31.56±0.62	16.66±0.92	21.94±1.32	6.34±1.62
Labial palp	10.47±0.77	7.49±0.87	6.31±0.67	5.91±0.87

Means followed by different letters in the same line are significantly different by the nonparametric Mann–Whitney U test ($p<0.05$)

Labium of females *L. invasa* was bigger than in females *O. maskelli* (average length of 37.56±0.62µm and width of 21.94±1.32µm) (Table 2 and Fig. 1b), while Labium of *O. maskelli* with an average length of 32.66±0.92µm and width of 6.34±1.62µm (Table 2 and Fig. 2b). Prementum of females *L. invasa* were great than in females *O. maskelli* (average length 31.56±0.62µm and width 21.94±1.32µm) (Table 2 and Fig. 1b), while prementum of *O. maskelli* with an average length of 16.66±0.92µm and width of 6.34±1.62µm (Table 2 and Fig. 2b). Labial palp of females *L. invasa* has one joint with three setae and was greater than in females of *O. maskelli* (average length of 10.47±0.77µm and width of 6.31±0.67µm) (table 2 and Fig. 1b), while Labial palp of *O. maskelli* also has one joint but with four setae (average length 7.49±0.87µm and width 5.91±0.87µm) (Table

2 and Fig. 2b).

Morphological Characters of The Sensilla on Mouthparts:

On the mouthparts of *L. invasa* and *O. maskelli*, eight varieties of sensilla were identified based on morphology; some of them can be further classified into numerous categories based on their length and distribution. Sensilla were identified in 16 different varieties in all.

Sensilla campaniformia (Sca) are shaped like papillae and are spherical, convex on the outside and concave on the inside, with a little round bump in the middle. These sensilla's surface is smooth, and there are no pores that can be seen there. (Fig. 1c, 2c). They distributed only on the mandible (average length 1.34±0.061µm and width 1.34±0.061µm) to be the sum of their number 6 sensillum of *L. invasa* (Table 3 and Fig. 1C), while Sca of *O. maskelli* was with an average length of 1.94±0.031µm and width of 1.94±0.031µm. Their number was 8 sensillum where there are fewer on *L. invasa* compared to *O. maskelli* mouth parts (Table 3 and Fig. 2c).

Sensilla coeloconica (Sco) is round with a noticeable round bump in the middle; however, it is difficult to tell where the margin begins and ends. They have a smooth, poreless surface. (Figs. 1c, 2c). They distributed on the stipes of *L. invasa* (average length 0.23±0.0091µm and width 0.23±0.0091µm) to be the sum of their number 12 sensillum (Table 3 and Fig. 1c). On the other hand, Sco of *O. maskelli* distributed on the end front of clypeus (average length 0.97±0.81µm and width at the base is 0.97±0.81µm). Their number was 8 sensillum. These mean, there are more *L. invasa* compared to *O. maskelli* mouth parts (Table 3 and Fig. 2c).

Cuticular pores (Cp) on the surface of the mouthpart are small, rounded concave pores known as cuticular pores (Cp). (Figs. 1c, 2c) and from the dorsal view (Figs. 1a, 2a). In general, they are distributed in more numbers on the mandible. The average length was 4.93±0.71µm and width was 4.93±0.71µm and the sum of their number 6 sensillum of *L. invasa* (Table 3 and Fig. 1C), while (Cp) of *O. maskelli* was very small compared to *L. invasa* (average length 0.97±0.81µm and width at the base is 0.97±0.81µm) and the same number of both species (6 sensillum) (Table 3 and Fig. 2c).

Sensilla basiconica I (Sb1) are short, straight, and placed in a pit with a smooth-surfaced, spherical, concave socket. They are thick at the base and pointy at the tip. (Fig. 1c, 2c)., universally distributed on the end of the front (within clypeus), labrum, mandible and maxilla, they were found on the end of the front (within clypeus) (average length 26.23±0.83µm and width 1.21±0.031µm), on Labrum (average length 7.43±0.72µm and width 3.21±0.042µm), on the mandible (average length 13.32±0.64µm and width 4.24±0.098µm), and on lacinia (average length 8.6±1.73µm and width 1.53±0.33µm) to be the sum of their number 16 sensillum (Table 3, fig. 1c)., while (Sb1) of *O. maskelli* end front(within clypeus) (average length 7.63±0.82µm and width 1.91±0.081µm), on Labrum (average length 17.32±0.63µm and width 1.73±0.051µm), on the mandible (average length 9.23±0.43µm and width 1.34±0.055µm), and on lacinia (average length 4.6±1.61µm and width 0.83±0.43µm) to be the sum of their number 24 sensillum. However, there are fewer on *L. invasa* compared to *O. maskelli* mouth parts (Table 3 and Fig. 2c).

Sensilla basiconica II (Sb2) Compared to Sensilla basiconica I (Sb1), Sb2 is more straight and lengthier. It is smooth on the outside, thick at the base and pointed at the tip (Fig. 1c, 2c). They are mainly distributed on the mandible, maxilla and labium. they were found on the mandible (average length 43.53±0.61µm and width 3.58±0.032µm), on galia (average length 21.44±0.28µm and width 0.93±0.043µm), on stipes (average length 17.36±0.62µm and width 1.42±0.22µm), and on prementum (average length 21.46±0.72µm and width 1.72±0.62µm), to be the sum of their number 33 sensillum (Table 3 and Fig. 1c)., while (Sb2) of *O. maskelli* distributed on the mandible (average length

23.23±0.21µm and width 1.98±0.012µm), on galia (average length 14.64±0.36µm and width 0.91±0.023µm), on stipes (average length 19.32±0.56µm and width 2.32±0.033µm), and on prementum (average length 8.52±0.53µm and width 0.62±0.095µm), to be the sum of their number 41 sensillum. Where, there are fewer *L. invasa* compared to *O. maskelli* mouth parts (Table 3 and Fig. 2c).

Sensilla basiconica III (Sb3) is stronger than Sensilla basiconica I and II and is put into concave sockets in a peg-like fashion. These sensilla have a very smooth exterior surface without any pores. (Figs. 1c, 2c). They can only be found on the maxillary palp of the maxilla and labial palp of the labium. It was found on maxillary palp with an average length of 13.54±0.78µm and width of 1.61±0.092µm) and on labial palp (average length 7.54±0.98µm and width of 1.64±0.54µm), to be the sum of their numbers 16 sensillum (Table 3 and Fig. 1c)., while Sb3 on *O. maskelli* distributed on maxillary palp (average length 9.84±0.78µm and width 0.92±0.053) and on Labial palp (average length 5.21±1.01µm and width 1.72±0.098), to be the sum of their number 16 sensilla. Where, there is the same number of sensilla on *L. invasa* and *O. maskelli* mouth parts (Table 3 and Fig. 2c).

Sensilla styloconica I (Sty1) are conical with a convex socket like a petal. The surface features a clear terminal pore and is strongly ribbed. The micro-digitations on the top region, which are grouped together (sometimes separately) in some sensilla, are a typical feature of this variety. (Fig. 3c, 4c). They distributed on the maxillary palp of *L. invasa* (average length 5.74±0.98µm and width 2.34±0.084µm) to be the sum of their numbers 2 sensilla (Table 3 and Fig. 1c)., while (Sty1) in *O. maskelli* also distributed on the maxillary palp (average length 3.75±0.97µm and width at the base is 1.54±0.054µm) and their numbers were 2 sensilla (Table 3and Fig. 2c).

Table 3. Length and Width (Mean ±SE, n = 10) sensilla of mouth parts in *L.invasa* and *O.maskelli* (Hymenoptera: Eulophidae).

Mouth parts	*L.invasa*				*O. maskelli*			
	Type of sensilla	No.	Length	Width	Type of sensilla	No.	Length	Width
End front (within clypeus)	Sb1	6	26.23±0.83	1.21±0.031	Sb1	14	7.63±0.82	1.91±0.081
					Sco	8	0.93±0.078	0.93±0.078
Labrum	Sb1	2	7.43±0.72	3.21±0.042	Sb1	2	17.32±0.63	1.73±0.051
Mandible	Sb1	2	13.32±0.64	4.24±0.098	Sb1	2	9.23±0.43	1.34±0.055
	Sb2	2	43.53±0.61	3.58±0.032	Sb2	10	23.23±0.21	1.98±0.012
	Sca	6	1.34±0.061	1.34±0.061	Sca	8	1.94±0.031	1.94±0.031
	Cp	6	4.93±0.71	4.93±0.71	Cp	6	0.97±0.81	0.97±0.81
Maxillary palp	Sb3	10	13.54±0.78	1.61±0.092	Sb3	10	9.84±0.78	0.92±0.053
	Sty1	2	5.74±0.98	2.34±0.084	Sty1	2	3.75±0.97	1.54±0.054
	Sty2	2	3.93±0.76	3.14±0.084	Sty2	2	2.330.86	3.14±0.084
Galea	Sb2	28	21.44±0.28	0.93±0.043	Sb2	28	14.64±0.36	0.91±0.023
Lacinia	Sb1	6	8.6±1.73	1.53±0.33	Sb1	6	4.6±1.61	0.83±0.43
Stipes	Sb2	2	17.36±0.62	1.42±0.22	Sb2	2	19.32±0.56	2.32±0.033
	Sco	12	0.23±0.0091	0.23±0.0091	Sco	0	---	---
Prementum	Sb2	1	21.46±0.72	1.72±0.62	Sb2	1	8.52±0.53	0.62±0.095
Labial palp	Sb3	6	7.54±0.98	1.64±0.54	Sb3	6	5.21±1.01	1.72±0.098
	Sty2	2	7.45±0.58	1.35±0.84	Sty2	2	7.25±0.88	1.35±0.84
Total number of sensilla		95				109		

Means followed by different letters for the same item in the same line are significantly different by the nonparametric Mann–Whitney U test ($p<0.05$)

Sensilla styloconica II (Sty2) is cylinder-shaped and positioned inside a clear convex socket. These sensilla have smooth top surfaces and grooved bottom surfaces. Their tips are plump and packed with numerous little spherical prominences. (Figs. 1c, 2c). They can only be found on the central part of the maxillary palpi and labial palp. distributed on the maxillary palp of *L. invasa* (average length 3.93±0.76µm and width 3.14±0.084µm) and on labial palp (average length 7.45±0.58µm and width 1.35±0.84µm) to be the sum of their numbers 4 sensilla (Table 3 and Fig. 1c)., while (Sty2) of *O. maskelli* also distributed on maxillary palp (average length 2.33±0.86µm and width 3.14±0.084µm) and on labial palp (average length 7.25±0.88µm and width 1.35±0.84µm) to be the sum of their numbers 4 sensilla (Table 3 and Fig. 2c).

Due to the different food varieties or feeding habits, the mouthparts may differ greatly (Karolyi et al. 2016). According to studies, some species' chewing mouthparts may also play a key role in other biological behaviours, such as drilling holes for laying eggs in the case of the Platypus koryoensis (Moon *et al*. 2008). As a result, these mouthparts may have evolved with a distinctive, function-dependent morphology.

Sensilla campaniformia, sensilla coeloconica, and sensilla basiconica were assumed to be mechanical receptors because no pores on them were found in this study. Sensilla styloconica I and sensilla styloconica II were separated into gustatory receptors because they share a single apical pore. According to a previous study, differences in shape are not always consistent with differences in internally relevant functional components (Altner and Prillinger 1980).

The sensilla types in *O. maskelli* and *L. invasa* are the same in both species. The mouthparts of *L. invasa* are larger than those of *O. maskelli*, though. Our results showed that *O. maskelli* had more sensilla than other species since there were eight different types of sensilla on its mouthparts (Table 3, Figs.1c, 2c). 109 sensilla were found along the mouthparts of *O. maskelli*, compared to more than 95 in *L. invasa*, making up the total number of sensilla, which was higher in *O. maskelli* than *L. invasa* (Table 3).

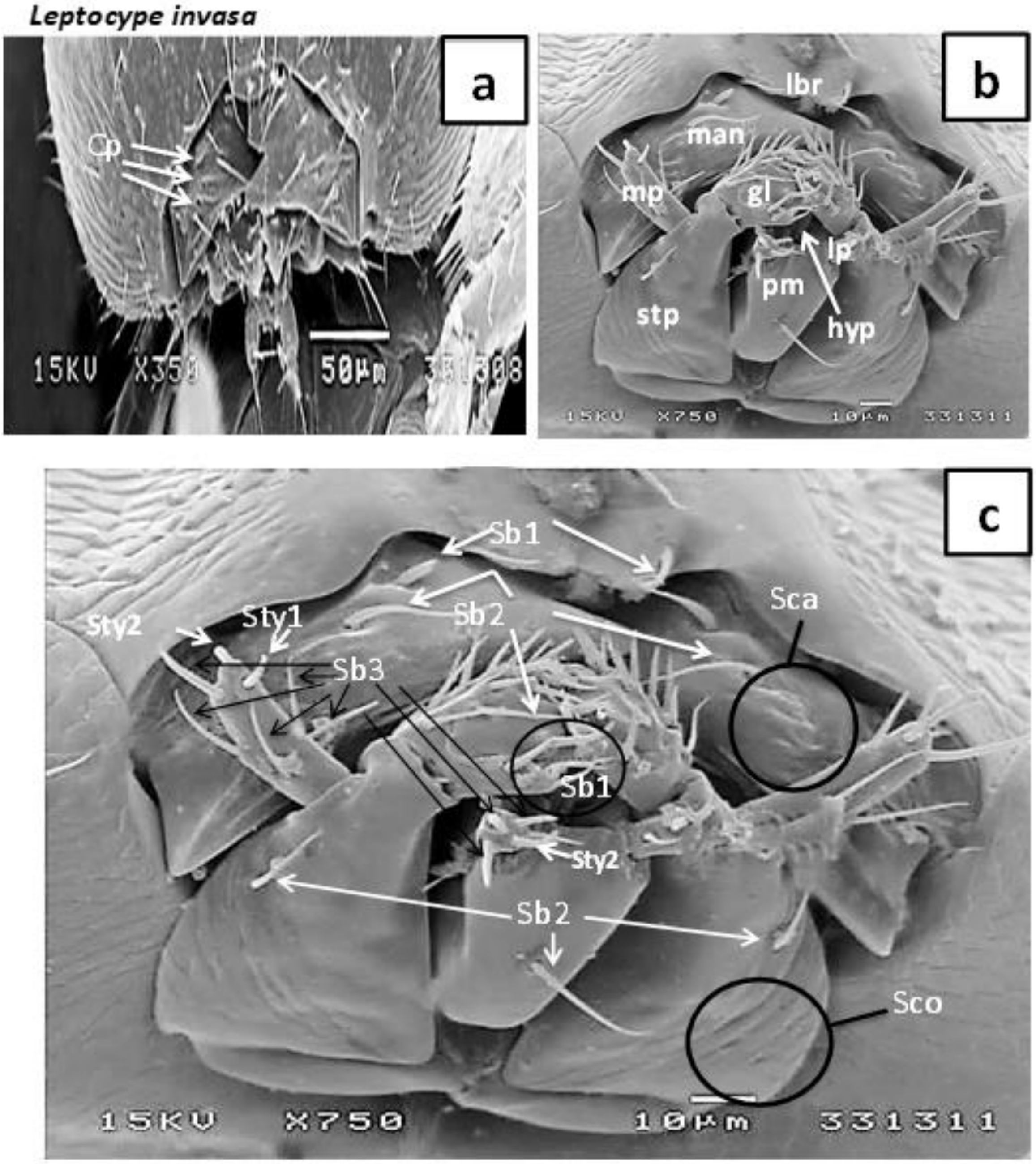

Fig. 1: Scanning electron micrographs of ***Leptocype invasa*** mouth parts**,** (a) dorsal view of mouthparts , mandible with a cuticular pore (Cp), (b) ventral view of mouthparts with Clarification of its components, gl., Galea; lac., Lacinia; lp., labial palp; lbr., labrum; man., mandible; mp., maxillary palp; pm., prementum; stp., stipes; hyp., hypopharynx, (c) ventral view of mouthparts with the different types of sensilla, a Sensilla campaniformia (Sca); sensilla coeloconica (Sco); sensilla basiconica I (Sb1); sensilla basiconica II (Sb2); sensilla basiconica III (Sb3); Sensilla styloconica I (Sty1); Sensilla styloconica II (Sty2).

Opelimus maskelli

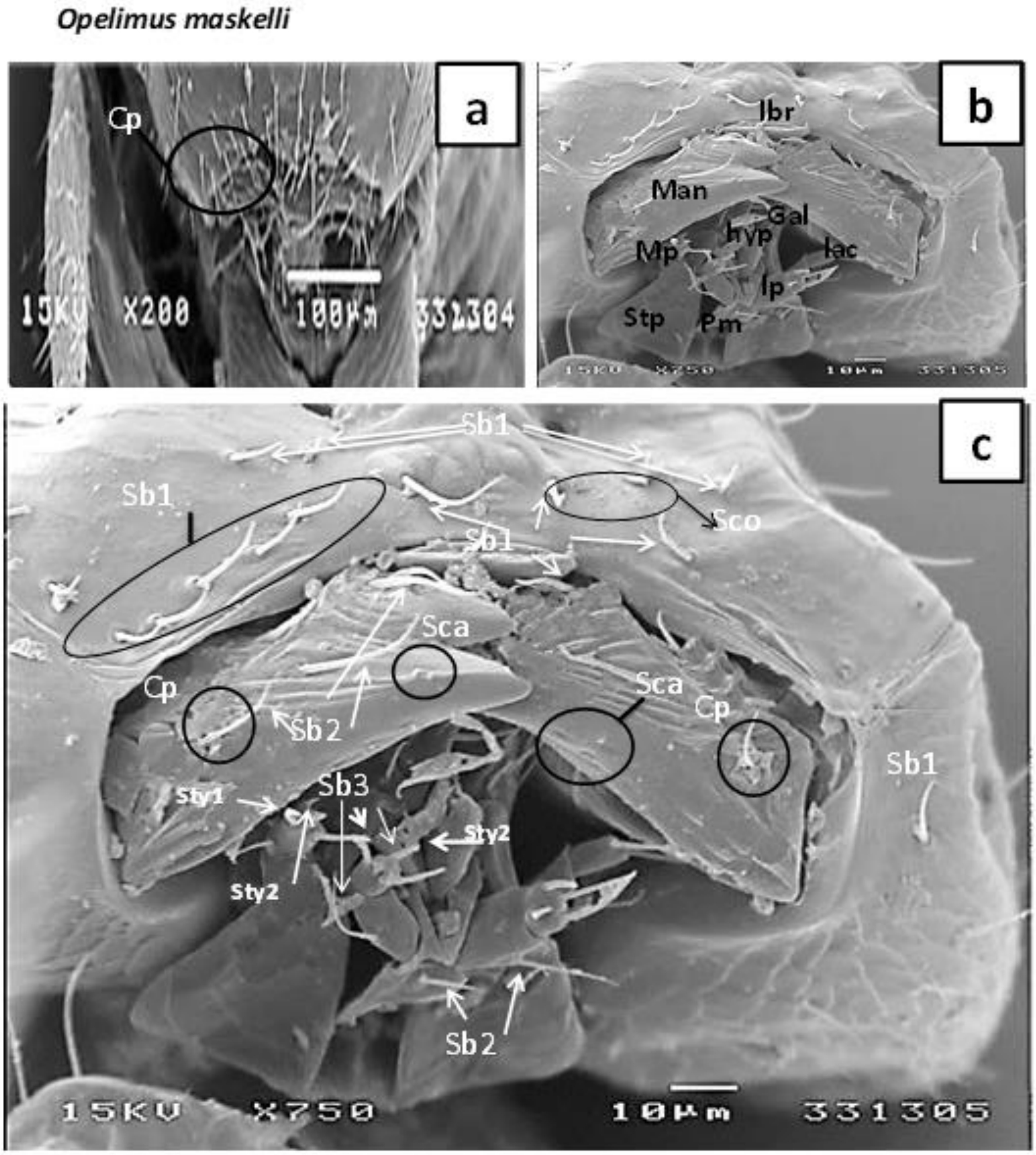

Fig. 2: Scanning electron micrographs of ***Opelimus maskelli*** mouth parts**,** (a) dorsal view of mouthparts, mandible with a cuticular pore (Cp), (b) ventral view of mouthparts with Clarification of its components, gl., Gallea; lac., Lacinia; lp., labial palp; lbr., labrum; man., mandible; mp., maxillary palp; pm., prementum; stp., stipes; hyp., hypopharynx, (c) ventral view of mouthparts with the different types of sensilla, a Sensilla campaniformia (Sca); sensilla coeloconica (Sco); sensilla basiconica I (Sb1); cuticular pore (Cp); sensilla basiconica II (Sb2); sensilla basiconica III (Sb3); Sensilla styloconica I (Sty1); Sensilla styloconica II (Sty2).

When comparing the highest density of sense organs, their distribution and density on the different parts of the mouth parts for each type separately, and then comparing them with the other type, for the two types under study, *L.invasa* and *O.maskelli*, we find this clearly evident in Figures (3 and 4). with regard to *L.invasa* which has the highest density of sensilla Sb2 on Galea (28), followed by its presence on the stipes(2) and mandible(2) with equal values, followed by the lowest density on the prementum (1), following the sensilla Sb2 in terms of density, type Sb1, which is equally dense on the end front (6) and lacinia(6), followed by the least density equally for the same organ on the labrum(2) and mandible (2) follows the Sb1 sense organ in terms of density, type Sb3, which is most dense on the maxillary palp(10), then the labial palp (6), next to the Sb3 sense organ in terms of density, Sco type, which is most dense on the Stipes(12), followed equally by the sense organ Cp (6)and Sca(6) on the mandible, followed by the sense organ Sty2 Which have the same density on the maxillary palp(2) and labial palp(2) and the least sense organ in terms of density Sty1 on the maxillary palp (2)and the sum of the values for the number of different types of sense organs from the most dense to the least dense regardless of the distribution in series as follows 33, 20, 16, 12, 6, 6 , 4, 2 respectively And the results that we obtained for *O.maskelli* were close to *L.invasa* in terms of the degrees of density and distribution of the sense organs over the oral parts with the difference in the number, which is clearly evident in Figure 3 and 4, where we find with regard to *O.maskelli* which has the highest density of sensilla Sb2 on Galea (28), followed by its presence on the mandible (10), followed by the lowest density on the prementum (1), following the sensilla Sb2 in terms of density, type Sb1, which is dense on the end front (14) followed by presence lacinia (6)then mandible(2), followed by the least density equally for the same organ on the labrum(2) follows the Sb1 sense organ in terms of density, type Sb3, which is most dense on the maxillary palp(10), then the labial palp (6), next to the Sb3 sense organ in terms of density, Sca type, which is most dense on the mandible(8), followed by the sense organ sco the same value (8) on the end front, followed by the sense organ Sty2 Which have the same density on the maxillary palp(2) and labial palp(2) and the least sense organ in terms of density Sty1 on the maxillary palp (2)and the sum of the values for the number of different types of sense organs from the most dense to the least dense regardless of the distribution in series as follows 39, 24, 16, 8, 8, 4, 2 respectively.

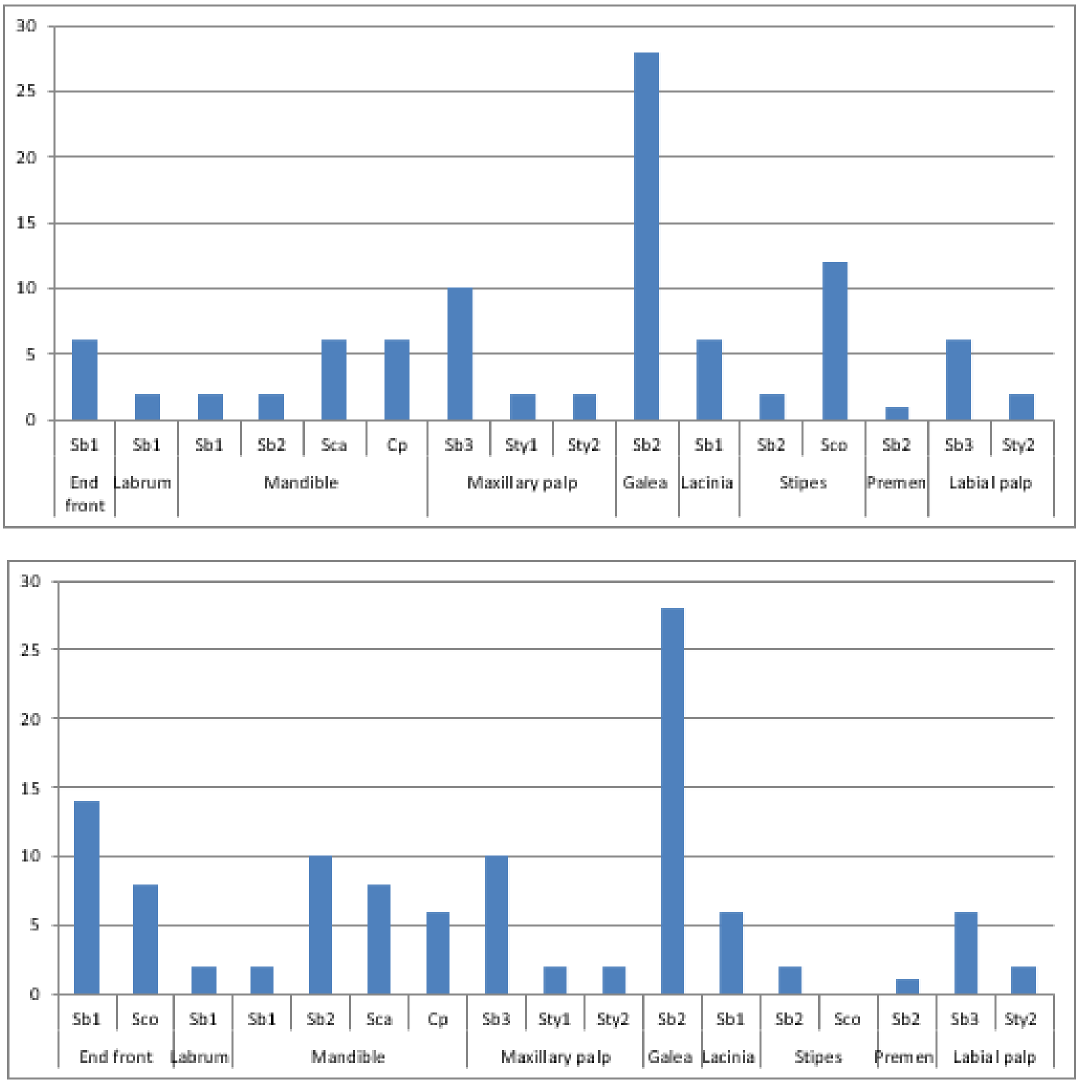

Fig.3: Showing a comparison between the numbers of type sensilla and their distribution on the different parts of the mouth parts for both species A: ***Leptocybe invasa***, b: ***Ophelimus maskelli***

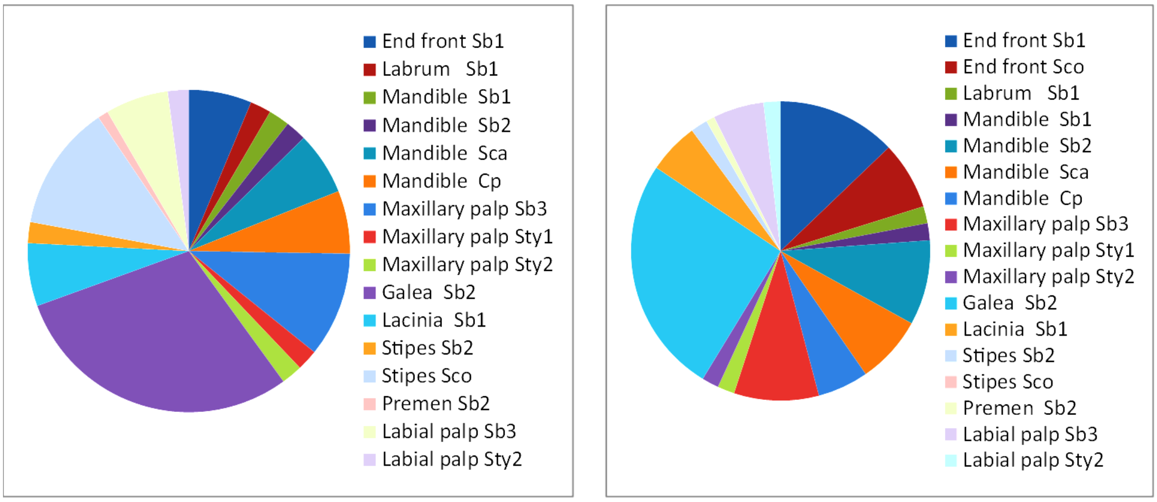

Fig.4: Showing a comparison between the proportions of the presence of different types of sensilla and their distribution on the mouth parts for both species A: ***Leptocybe invasa***, B: ***Ophelimus maskelli***

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