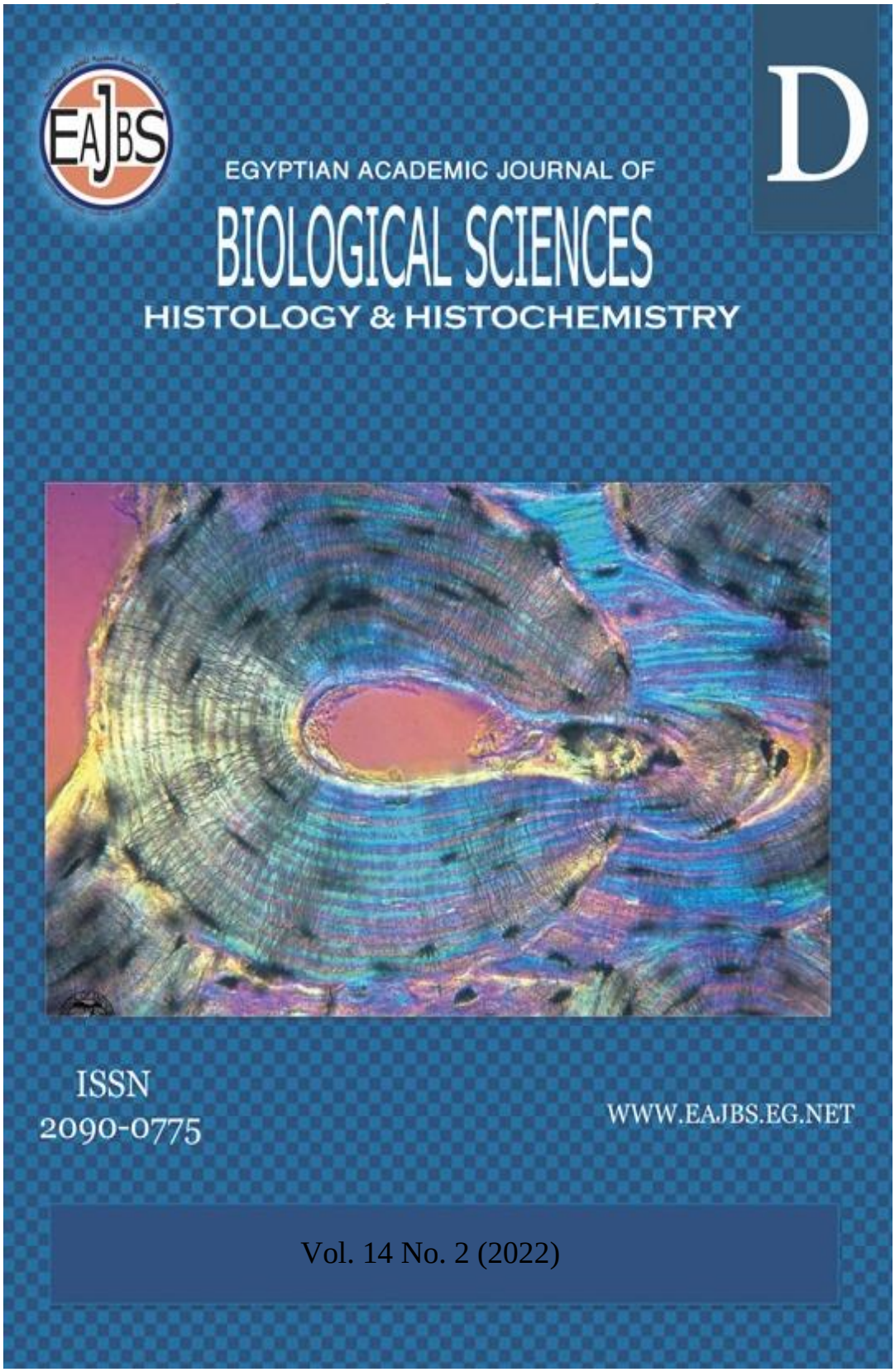
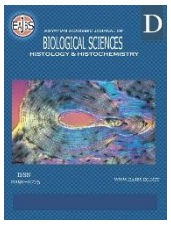


Citation: Egypt. *Acad. J. Biolog. Sci. (D-Histology and histochemistry) Vol.14(2) pp105-117(2022)*
DOI: 10.21608/EAJBSD.2022.268186

Egypt. Acad. J. Biolog. Sci., 14(2): 105-117 (2022)

Egyptian Academic Journal of Biological Sciences
D. Histology & Histochemistry
ISSN 2090 – 0775
http://eajbsd.journals.ekb.eg



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

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ARTICLE INFO
Article History
Received:30/8/2022
Accepted:31/10/2022
Available:3/11/2022

***Keywords*:**
Leptocybe invasa, *Ophelimus maskelli*, Eucalyptus, Gall inducer, ovipositor sensilla, Eulophidae.

ABSTRACT

The ovipositor is heavily populated with insect sensory structures (sensilla). Sensilla, therefore, play a significant role in oviposition, stinging, and the process of choosing a host. Based on the types, numbers, and distributions of sensory organs, one can deduce how they function. These biological parameters have been tested. In this study, the external sensilla on the ovipositor of *Leptocype invasa* (Fisher and La Salle) and *Ophelimus maskelli* (Ashmead) were described (Hymenoptera: Chalcidoidea: Eulophidae). In Egypt, these two inducer bug species primarily affected Eucalyptus camaldulensis. Using electron scanning microscopy, the sensilla were categorized based on their size, distribution, and shape; some may even have sense organs visible. At the level of the ovipositor, it was possible to distinguish eight different types of sensilla on the *L. invasa* and *O. maskelli* species' ovipositors. With 50 sensilla along the ovipositor on *L. invasa* against more than 40 sensilla on *O. maskelli* in the current study, *L. invasa* had a higher overall sensilla count than *O. maskelli*. While results tend to suggest that *L. invasa* is more specialized for laying eggs than *O. maskelli*, it may be because *O. maskelli* lays eggs all over the leaf blade while *L. invasa* species lay eggs on the middle race, necessitating greater differentiation in the puncture area. The qualitative and numerical difference for the type of sensilla in both species on ovipositor in favour of *L. invasa* was what explained the results obtained from the tested biological parameters given. Despite the fact that *O. maskelli* and *L. invasa* have different body sizes in favour of *L. invasa*, *L. invasa* has a larger reproductive tract with a wider diversity of sensilla types.

INTRODUCTION

The Middle East and North Africa's low-altitude arid and semiarid plains are covered in eucalyptus forests, which serve as the foundation of these ecosystems. Eucalyptus plantations are a significant source of wood, firewood, and honeybee foraging. They are also used as windbreaks around farmed and residential areas, as well as recreation spaces, shelterbelts from sandstorms, and as shelter from the sun. Eucalyptus trees in the Middle East and Mediterranean region were thought to be almost completely free of harmful insect pests until a few years ago. The Mediterranean basin has received two bug species that cause galls during the past ten years.

The first gall-inducing agent was discovered by Ramadan (2004) on Eucalyptus species along Egypt's northwestern coast, although it was mistakenly classified as Aprostocetus species. *Ophelimus maskelli* (Ashmead), a different galls-inducing compound, was observed by Ramadan & Karam (2005) on eucalyptus trees in Alexandria. *Leptocybe invasa* Fisher and La Salle and *Ophelimus maskelli*, two wasps that were recently identified (Ashmead). While the second species, *O. maskelli*, was discovered to solely infest the leaf blade, the first species, *L. invasa*, was found to also infest the petiole and young shoots. The current research aims to examine the distribution of the sensory organs in these two species on each of the ovipositors, as well as to estimate the various measurements of these organs. As wasps that cause galls and are aware of the mechanisms and sense organs inherent in ovipositors for excreting poison that irritates plant tissues, given that they are wasps that cause galls and that ovipositors have built-in sensing organs and systems for excreting poison that irritates plant tissues and causes galls to form during egg laying.

Usually, an organ's relevance to the animal can be determined by how big it is in relation to the animal's body size. The sensitivity and/or selectivity of pertinent signals can be improved with larger organs, but doing so requires higher energy expenditure. The amount to which various organs can grow relative to body size must be balanced against each other because sensory systems require a lot of energy to develop and sustain. Schneider and Koontz (1987). These compromises 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. Throughout its life, Stevens (2015)

A thorough allometric investigation of 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. These wasps are ecological specialists that only inhabit one sort of habitat; thus, they probably need to adapt to a variety of sensory clues to recognise their hosts. The analysis was concentrated on the allometric scaling relationship of sensory qualities primarily related to foraging behaviour and reproduction ovipositor. We also examined the density of the ovipositor sensilla to provide us with a better understanding of how the size of these sensory organs influences the number of sensory structures that they express. We hypothesise that there would be a positive relationship between body size and the studied sensory organs, similar to the numerous insects that have been the subject of allometric analyses to date (Kramer *et al.*, 2015; Jander and Jander 2002; Kunte 2007; Taylor *et al.*, 2019), but that the rates at which each trait increases in size with the body size difference between sexes to reflect the differences in their behavioural ecology.

Insect females have a complex mechanism called the ovipositor that is connected to their 8th and 9th abdominal segments (Dweck *et al*., 2008). Members of the order Hymenoptera (bees and wasps), which are endopterygote insects, have evolved a highly developed ovipositor apparatus with a variety of functions. The primary purpose of insect ovipositors, which requires the synchronisation of several sensory inputs, is the deposition of eggs onto suitable substrates. The ovipositors of Hymenoptera also have related venom glands and ducts for the injection of venom into prey insects or for use as a defensive mechanism, and this additional development necessitated the evolution of special ovipositor structures. Additionally, parasitic Hymenopteran wasps have specific sensory organs that are necessary for the

detection, identification, and control of parasites (Le Ralec *et al.*, 1996). Identifying and approving the right insects to serve as hosts for oviposition (Papp, 1974). Complex physical structures derived from gonad tissues that coordinate these processes are called gonads (Snodgrass, 1931, Snodgrass, 1933).

Sensilla of the ovipositor and its accessories are present in both species, but further information on these structures in other species is still required. Its use to regulate two species may be suggested by their shared habits. Understanding the characteristics of their ovipositor can aid in understanding the behavioural aspects of their inducer galls. This work is the first to describe the ovipositor sensilla of both *L. invasa* and *O. maskelli*.

Earlier studies using scanning and transmission electron microscopy (SEM and TEM) of Hymenopteran ovipositor sense organs stylets and sheaths have been successful in determining species-specific morphologies (Le Ralec and Wajnberg, 1990, Brown and Anderson, 1998, Rahman *et al.*, 1998, Vilhhelmsen, 2000, Roux *et al.*, 2005, Dweck *et al*., 2008, Nacro and Nenon, 2009, Wang *et al*., 2010, Shah, 2012). The classification of parasitoids belonging order Hymenoptera, as well as defining evolutionary links and connecting ovipositor structures with potential functions, have all benefited from variety in ovipositor structures (Austin and Field, 1997). (Quicke and Fitton, 1995, Quicke *et al.*, 1995, Dweck *et al.*, 2008).

Here, the external morphology, type, and distribution sensilla of antennal, mouth, and ovipositor of *L. invasa* and *O. maskelli* were described using scanning electron microscopy (SEM). On the basis of both their morphological characteristics and comparisons to other Hymenopteran wasps, their possible roles were also discussed. This information helps to clarify how these sensilla work in the host selection process and forms the basis for further research on the behaviours of *L. invasa* and *O. maskelli* that cause galls (host location, recognition, and acceptance). To find methods for managing and controlling them.

MATERIALS AND METHODS

Biological Studies:

The fecundity of the two species was determined using 40 freshly hatched individuals from each species. Each individual was contained in a 6 x 3-centimetre plastic tube with a plastic lid. Each tube was strung from a eucalyptus sapling with a rubber band. Each tube contained a leaf that was germ-free and pristine. Adults were kept in tubes made of eucalyptus leaves until they died. After a few days, the leaves were inspected and the number of eggs that had been placed was counted. The average number of eggs laid by 40 females for each species was calculated.

Sampling Procedures:

Leptocype invasa and *Ophelimus maskelli* were collected over the course of a single year, from January 1 to December 31, 2020, by means of routine field trips to the university's farm agriculture facility, which were conducted every ten days.

Randomly selected from the labelled trees for both species, samples of 30 infected leaves were collected, stored in polyethylene bags, and transported to the lab for analysis. Counts were performed using a stereoscopic binocular microscope. Using a sharp razor, the galls of both species were dissected, the immature stages (larva + pupa) and adult stages (inside the galls or emerging via holls) were separated, and the number of each stage was recorded. The averages for each stage and leaf were determined using 30 leaves from each species.

Insects:

The *Eucalyptus camcludulensis* trees that were established at the Farm of the Faculty of Agriculture, Shoubra El-Kheima, Qalyubiya Governorate, provided the

Eucalyptus specimens for the current study. The two gall-inducing species had a bad infestation of these trees. Infested leaf samples from each species were stored in a breeding cage and watched until adults emerged. In specimen tubes, the wasps were preserved after being aspirator-assisted in the collection.

Scanning Electron Microscopy:

Wasps were cleaned multiple times with distilled water before being fixed for two hours at 4 degrees Celsius using 2.5 gluteralhyde in 1M phosphate buffer (two changes). Ascending ethanol concentrations, culminating in 100% ethanol, were used to induce dehydration (10 minutes for each concentration). A double layer of solytape was used to mount the dehydrated specimens on the aluminium stabs. In order to coat the dehydrated specimens with gold-palladium alloy, a tiny layer of carbon was first applied to them. In the Central Laboratory's Electron Microscopic Unit, coated specimens were analysed using a JEOL JSM- T300A Scanning EM. Egypt University's Faculty of Agriculture.

Sensilla terminology:

According to the nomenclature suggested by Zhou *et al*. (2013a), which was based on the terminologies of Amornsak *et al*., Sensilla were named and recognised based on their exterior morphology (1998).

Data Analysis:

The dorsal and ventral ovipositor surfaces of *L. invasa* and *O. maskelli* species' ovipositor and sensilla morphology were studied. Ovipositors were measured from images taken using a scanning electron microscope and Image-Pro Plus. Then, using SPSS software, data were subjected to nonparametric Mann-Whitney U statistical tests at a 5% significance level (version 22.0).

RESULTS AND DISCUSSION

Table 1 presents the findings from the biological parameters that were put to the test. These findings showed that for *O. maskelli*, the mean number of galls per leaf was 146.69 ± 14.55, the mean time of all developmental stages was 130.14 ± 1.58 and the mean fecundity was 259 ± 47 eggs/female. For *L. invasa*, the average number of galls per leaf was 17.61 ± 1.43; the average fecundity was 50 ± 20 eggs/ female, and the average length of time for each developmental stage was 112.64 ± 1.86. These findings are consistent with those made by La Salle et al. and suggest that *O. maskelli* is a more formidable rival that could replace *L. invasa* (2007).

Table 1: Comparison between *L. invasa* and *O. maskelli* in the mean number of induced galls /leaf of eucalyptus during 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

In a detailed allometric examination, the sizes and other sensory distinctive parameters, including the ovipositor, of female *Leptocybe invasa* and *Ophelimus maskelli* were measured. These findings showed that among the sensory characteristics evaluated, With regard to body size, ovipositors are allometric. and that *L. invasa* and *O. maskelli* differ in how much energy they use on different sensory systems. *O. maskelli* relative numerical density to *L. invasa* can be explained by the fact that *O. maskelli* had substantially larger ovipositors, which shows that *L. invasa* spends more energy on them. *L. invasa*, on the other hand, uses less energy on ovipositors. Overall, the findings of this study demonstrate that body size is not always connected with the size of sensory features in *L. invasa* and *O. maskelli*. Generating concerns about additional variables that affect these wasps' investment in sensory traits.

Instead, the vitality of the wasps that produce galls is controlled by the number of sense organs. This will be clear from the research that comes next.

Sensilla of Ovipositor:

Description of the Ovipositor of *L. invasa* and *O. maskelli*:

The stylet and paired third valvulae make up the ovipositor of *L. invasa* and *O. maskelli*, respectively (Figs. 1a & 2a). These valvulae have the greatest Proxima, yet their distal edges are a little pointy. The stream entrance of the male genitalia is located below the third valvulae, along the ridge with skin striations, and below that, this is the opening ovipositor, which is semi-knobbed in shape, and on its side, there is a pair of anal cerci, each of which has one joint.

In comparison to *O. maskelli* females, *L. invasa* females had a larger third valvular, measuring an average of 175.56 2.83 m and 75.16 1.38 µm (Table 2 & Fig. 1a), compared to 73.16 2.38 µm and 23.73 0.62 µm for *O. maskelli* (Table 2, Fig. 2a). The ovipositor opening of female *L. invasa*, however, was significantly larger than that of female *O. maskelli* (average length 37.341.74µm and width 35.441.54µm) (Table 2, Fig. 1a). In contrast, the ovipositor opening of *O. maskelli* was smaller (average length 6.781.25µm and width 4.620.36µm) (Table 2, Fig. 2a). Females of *L. invasa* had larger anal cerci than females of *O. maskelli*, with average anal cerci lengths of 18.54 µm and 12.56 µm (Table 2, Fig. 1a), While *O. maskelli* anal cerci had an average length of 10.33 µm and diameter of 13.13 µm (Table 2 & Fig. 2a).

Morphological Characters of the Sensilla on The Ovipositor:

Six varieties of sensilla were identified on the ovipositor of *O. maskelli*, whereas seven types of sensilla were identified on the *L. invasa* ovipositor based on their morphologies.

The ovipositor and its accessories have five different types of sensillae, four of which are trichoid sensillae that can be found on the ovipositor of *L. invasa* (Ts1 to Ts4) and one more on *O. maskelli* (Ts5).

(i) Type 1 (Ts1): a long trichoid sensillum that is found on cerci and measures (an average length of 31.43±0.63µm and width at the base of 1.11±0.041µm). Also, it is located on the ovipositor opening (average length 42.43±0.32µm and width at the base is 3.11±0.063µm) to be the sum of their number 13 sensilla of *L. invasa* (Table 3, fig. 1C). While Ts1 of *O. maskelli* was found only on cerci (average length 20.73±0.72µm and width at the base is 1.41±0.061µm). Their numbers were 3 sensilla were, there were fewer on *O. maskelli* compared to *L. invasa* ovipositor (Table 3 & Figs. 2c, 6d).

(ii) Type 2 (Ts2): On the paired third valvulae, this particular form of trichoid sensillum is particularly prevalent. When viewed under the scanning electron microscope, they seem smooth. (Average length 27.12±0.74µm and width at the base is 1.74±0.058µm). Their number 2 sensilla on *L. invasa* (Table 3, fig. 1b), while (Ts2) of *O. maskelli* was found only on cerci (average length 10.23±0.55µm and width at the base is 1.14±0.023µm). Their numbers were 6 sensilla However, there are more on *O. maskelli* compared to *L. invasa* ovipositor (Table 3 & Fig. 2b).

(iii) Type 3 (Ts3): Curved trichoid sensillae are these. They have a distal groove and are slightly rounded. (Average length was 25.83±0.31µm and width at the base was 2.58±0.042µm). Their numbers 4 sensilla on *L. invasa* (Table 3, fig. 1b), while (Ts2) of *O. maskelli* was found on 3rd paired valvulae (average length 8.63±0.51µm and width at the base is 1.18±0.011µm) and they

were located on peri-ovipositor opening (average length 14.82±0.34µm and width at the base is 1.27±0.043µm) to be the sum of their numbers 24 sensillia However, there are more sensillia on *O. maskelli* compared to *L. invasa* ovipositor (Table 3 & Fig. 2b).

(iv) Type 4 (Ts4): They are trichoid sensillae, which can be seen near the third paired valvulae's proximal end. Depression is where it started. The proximal half of its somewhat curved structure has a sharper edge than the basal half. (Average length 12.24±0.21µm and width at the base 3.34±0.021µm). Their number 10 sensillia of *L. invasa* (Table 3, fig. 1b), while Ts4 to *O. maskelli* (average length 6.14±0.041µm and width at the base 1.24±0.031µm) and their number was 2 sensillum, however, there are fewer on *O. maskelli* compared to *L. invasa* ovipositor (Table 3 & Fig. 2b).

(v) Type 5 (Ts5): Trichoid sensillae were visible adjacent to the ovipositor orifice and on the sides. Depression is the cause of it. Its proximal portion is sharper than its large basal part, and it features an excessive degree of curvature. (Average length 6.52±0.54µm and width at the base is 4.23±0.093µm) and their number 4 sensillum of *O. maskelli* only (Table 3 & Fig. 2c).

The finger-like sensilla (FL), which has two separate sections, a large and robust base attached to a tapered tip, was found near the tip of the anal cerci of *L. invasa* and *O. maskelli.* (Average length of 23.43±0.33µm and width at the base is 1.53±0.035µm) of *L. invasa*, while (FL) to *O. maskelli* was found in cerci only (average length 4.94±0.077µm and width at the base is 0.63±0.038µm)

Styloconic sensillae of type 1 and type 2 are found on near tip of 3rd paired valvula of *L. invasa* only: one group consists of 4 sensilla at the far end of the valve to be total their number of two valves 8 sensilla of type 1 (Ss1), (average length 0.32±0.021µm and width at the base is 0.32±0.021µm) (Table 3 & Fig. 1b), while the type 2 (Ss1) their one group consists of 6 sensilla at the close end of the valve to be total their number of two valves 12 sensilla (average length 1.34±0.051µm and width at the base is 1.34±0.051µm)

There are different types of sensilla in the two species of *L. invasa* and *O. maskelli*. *O. maskelli* is smaller than *L. invasa*, which is larger overall. Our results show that both species almost always have sensilla on the ovipositor, although *O. maskelli* ovipositor has fewer accessories than L. invasa does. O. maskelli also exhibits greater sensory sensitivity because there are six different types of sensilla distributed on its ovipositor (Fig. 2). Five varieties of trichodea sensilla (TS1, TS2, TS3, TS4, TS5), finger-like sensilla (FL), and seven types of sensilla were dispersed on the ovipositor of *L. invasa*, including four types of trichodea sensilla (TS1, TS2, TS3, TS4), finger-like sensilla (FL), and Styloconic sensillae of types 1 and 2. The overall number of sensilla in *O. maskelli* was similar to that of *L. invasa*, with the ovipositor and accessories making up 40 sensilla in *O. maskelli* and 50 sensilla in *L. invasa*, as shown in Table 3.

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

Mouthparts	Length		Width	
	L. invasa	***O. maskelli***	***L.invasa***	***O. maskelli***
Anal cerci	18.54±1.39	10.33±1.53	12.56±1.32	13.13±1.29
Ovipositor opening	37.34±1.74	6.78±1.25	35.44±1.54	4.62±0.36
3rd valvulae	175.56±2.83	73.16±2.38	75.16±1.38	23.73±0.62

The nonparametric Mann-Whitney U test ($p<0.05$) finds a significant difference between means that are separated by different letters on the same line.

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

Ovipositor parts	*L.invasa*				*O. maskelli*			
	type of sensilla	N. O	Length	Width	type of sensilla	N.O	Length	Width
Anal cerci	Ts1	3	31.43±0.63	1.11±0.041	Ts1	3	20.73±0.72	1.41±0.061
	FL	1	23.43±0.33	1.53±0.035	FL	1	4.94±0.077	0.63±0.038
Ovipositor opening	Ts1	10	42.43±0.32	3.11±0.063	Ts1	---	---	---
3rd valvulae	Ts2	2	27.12±0.74	1.74±0.058	Ts2	6	10.23±0.55	1.14±0.023
	Ts3	4	25.83±0.31	2.58±0.042	Ts3	8	8.63±0.51	1.18±0.011
	Ts4	10	12.24±0.21	3.34±0.021	Ts4	2	6.14±0.041	1.24±0.031
	Ss1	8	0.32±0.021	0.32±0.021	Ss1	---	---	---
	Ss2	12	1.34±0.051	1.34±0.051	Ss2	---	---	---
Peri-ovipositor opening	Ts5	---	---	---	Ts5	4	6.52±0.54	4.23±0.093
	Ts3	---	---	---	Ts3	16	14.82±0.34	1.27±0.043
Number total of sensilla		50				40		

The nonparametric Mann-Whitney U test ($p<0.05$) finds a significant difference between means thatare separated by different letters on the same line.

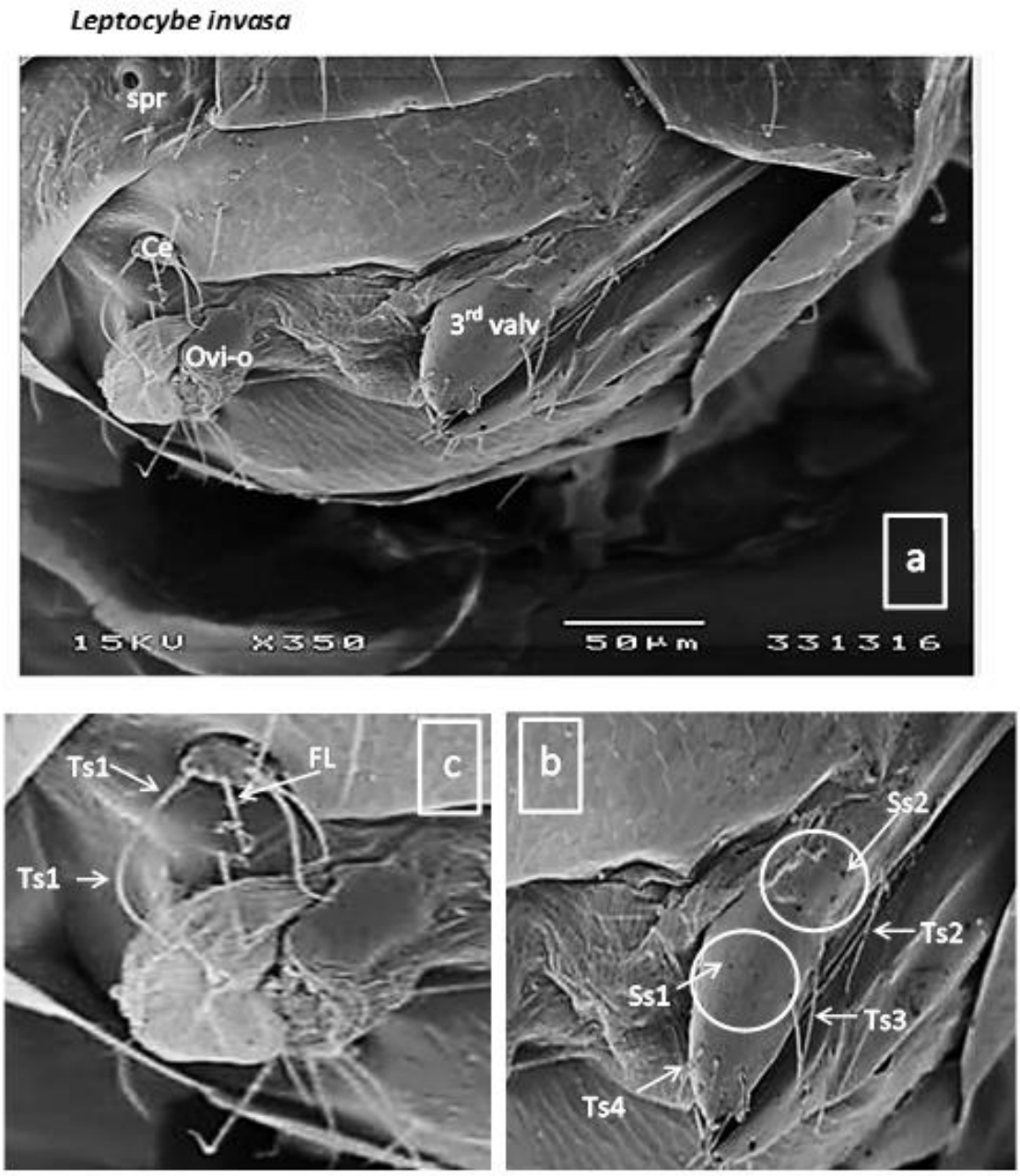

Fig. 1: Scanning electron micrographs sensilla on ovipositor parts and its accessories of ***Leptocybe invasa***, (a) ventral view of abdomen Illustrates ovipositor parts and its accessories, ce., cerci; spr. , spiracle; Ovi-o., ovipositor opening ; 3rd valv., 3rd valvulae , (b) 3rd valvulae with the different types of sensilla, trichoid sensillae type 2 (Ts2) ; trichoid sensillae type 3 (Ts3) ; trichoid sensillae type 4 (Ts4); styloconic sensillae of type 1 (Ss1) ; styloconic sensillae of type 2.

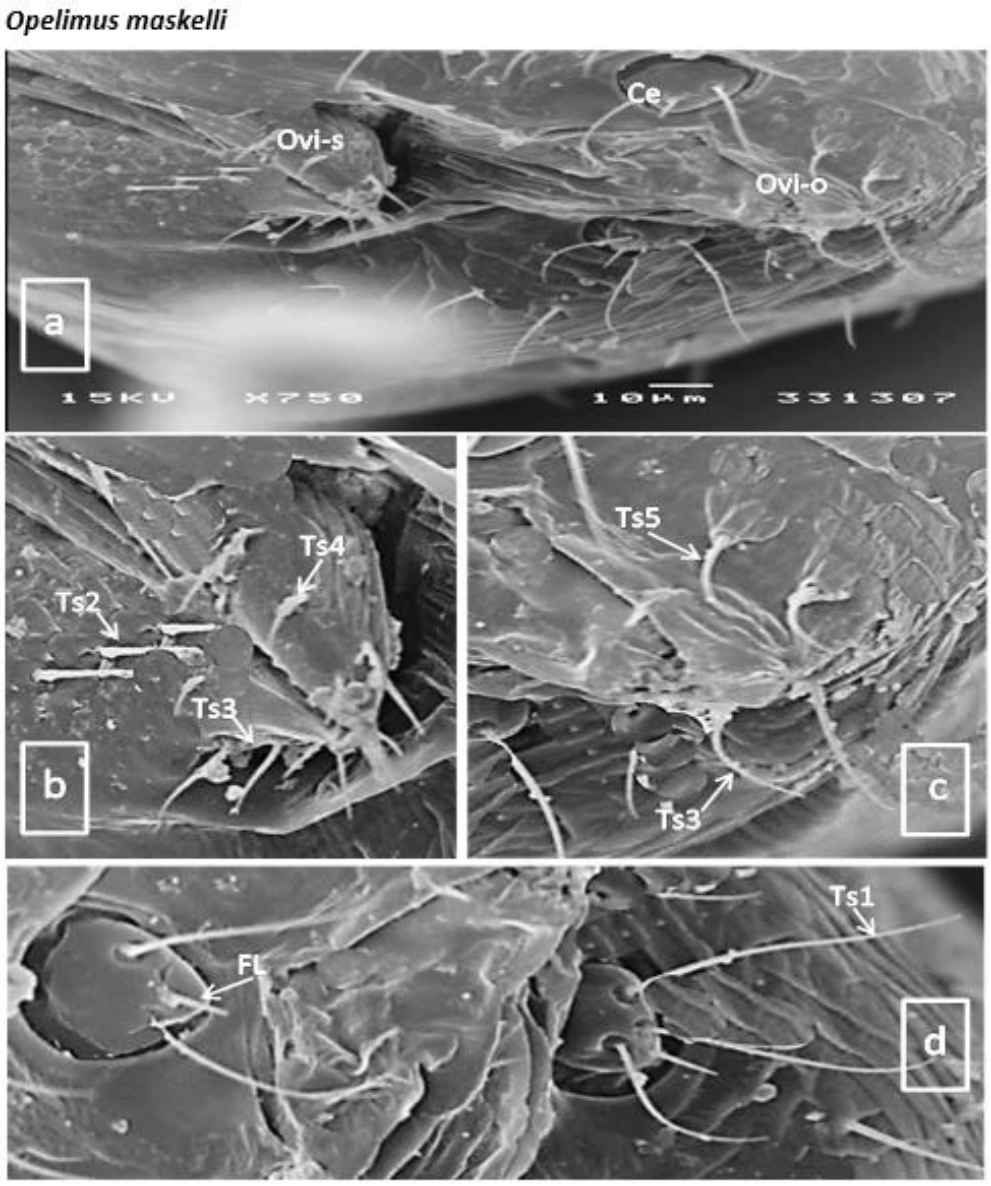

Fig 2: Scanning electron micrographs sensilla on ovipositor parts and its accessories of *Ophelimus maskelli*, (a) ventral view of abdomen Illustrates ovipositor parts and its accessories, ce., cerci; spr. , spiracle; Ovi-o., ovipositor opening ; 3rd valv., 3rd valvulae , (b) 3rd valvulae with the different types of sensilla, trichoid sensillae type 2 (Ts2) ; trichoid sensillae type 3 (Ts3) ; trichoid sensillae type 4 (Ts4), (c) opening ovipositor with the different types of sensilla, trichoid sensillae type 3 (Ts3); trichoid sensillae type 5 (Ts5), (d) trichoid sensillae type 1 (Ts1); finger-like sensilla (FL).

For the two varieties under study, *L. invasa* and *O. maskelli*, we can see this is clearly obvious in Figures when comparing the highest density of sense organs, their distribution, and density on the various regions of the ovipositor for each type separately, and then comparing them with the other type (fig. 3 and fig. 4). Regarding *L.invasa*, which features sensilla Ts4 with the highest density on the third valvule (12), followed by sensilla Ts1 with an equal density on the third valvule (10) and ovipositor opening (10), following the Ss1 sense organ in terms of density on the third valvule (8), the sense organ Ts3 which in terms of density on the third valvule (4), the sense organ Ts1 which in terms of density on the third valvule (3), and the least sense organ in terms of density FL on the ovipositor opening (1), as well as the sum of the values for the number of different types of sense organs from the densest to the least dense regardless of the distribution in

series as follows 12, 10, 10, 8, 4, 3, 1 respectively.

And with the difference in the number, the results we found for *O. maskelli* were similar to those for *L. invasa* in terms of the degrees of density and distribution of the sense organs over the oral parts. This is clearly shown in Figures 3 and 4, where we find that for *O. maskelli*, the sensilla Ts3 has the highest density on the pre-ovipositor opening (16), followed by its presence on the third valvulae (8), and is followed by the sensilla Ts (6), the Ts5 sense organ in terms of density on pre-ovipositor opening (4), then the Ts1 sense organ in terms of density on anal cerci (3), then the Ts4 sense organ in terms of density on third valvulae (2), and finally the least sense organ in terms of density FL on the anal cerci (1). The sum of the values for the number of different types of sense organs from the densest to the least dense regardless of the distribution in series is as follows: 23, 6, 4, 3, 2, 1 respectively.

It has already been noted that a variety of ectoparasitoid species, including hyperparasitoids of Aphidiine in the mummy stage, have sensilla trichoid mechanoreceptors and parasitize buried hosts (Le Ralec *et al*., 1996; Quicke *et al*., 1999). Last but not least, the third valvulae of both *L. invasa* and *O. maskelli* species feature trichoid sensilla that display all the external signs of mechanoreceptors along the ventral border. Scanning microscopy data imply the presence of chemoreceptors on two separate areas of both *L. invasa* and *O. maskelli* ovipositor species. Chemosensory sensilla at this region have been described in the majority of hymenopteran parasite species whose ovipositor's sense organs have been studied (Brown and Anderson, 1998; Larocca *et al*., 2007; Le Ralec and Rabasse, 1988; Le Ralec *et al*., 1996; Quicke et al., 1999; van Lenteren *et al*., 2007). They have been involved in various stages of the host selection process, particularly in evaluating host quality and recognising already-parasite hosts, according to several studies (Ganesalingam, 1974; Greany and Oatman, 1972; van Baaren and Ne'non, 1994; van Lenteren, 1972).

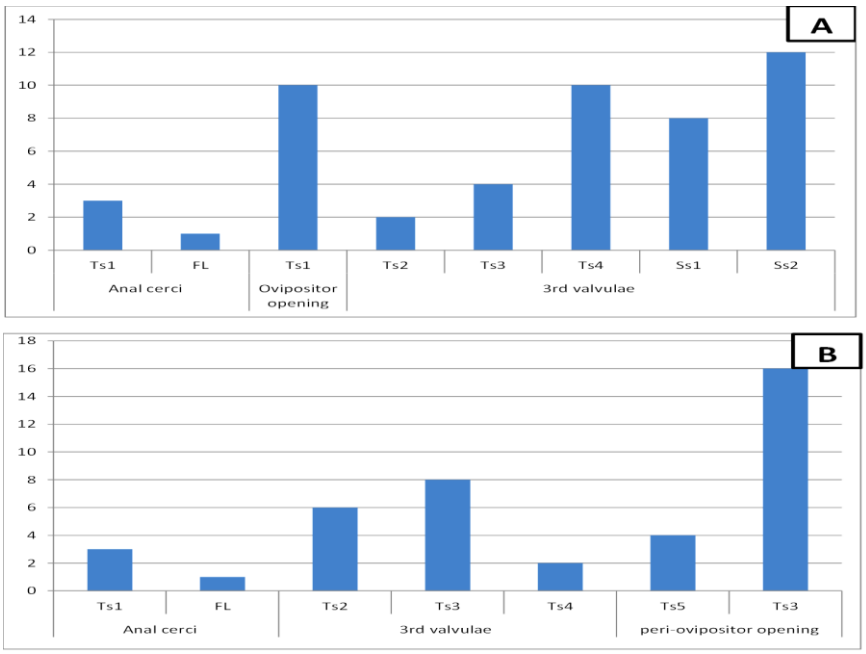

Fig. 3: A comparison between the numbers of sensilla types and their distribution on the different parts of the ovipositor of both species A: *Leptocybe invasa*, b: *Ophelimus maskelli*

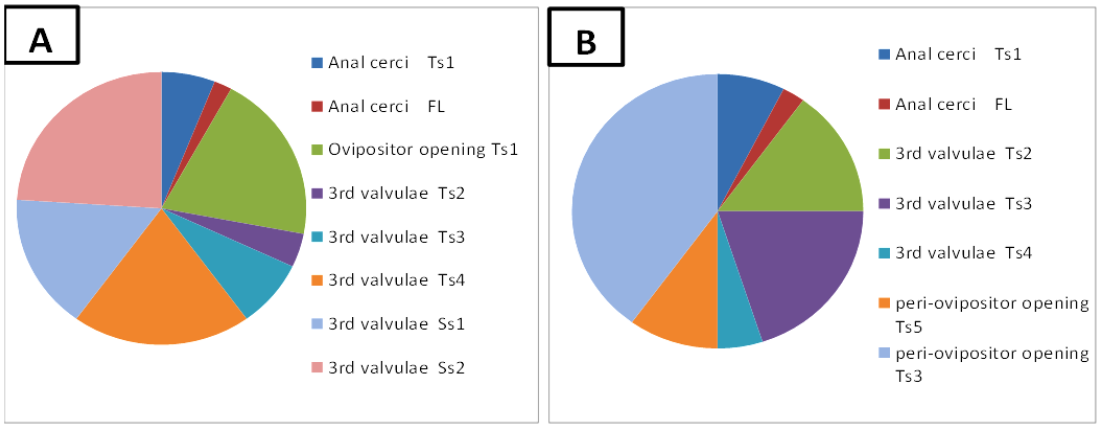

Fig.4: A comparison between the proportions of the presence of different types of sensilla and their distribution on the ovipositor of both species A: *Leptocybe invasa*, B: *Ophelimus maskelli*

The results from the examined biological characteristics are explained by the qualitative and quantitative differences of sensilla for both species on the antenna, mouthparts, and ovipositor that was in favour of *O. maskelli* in the two articles. According to Hamdy and Emam, 2022a, one of the two publications analysed the numerical density of sense organs for females of the two species on the antennal, and the results were in favour of *O. maskelli* over *L. invasa*. Also, their study about the evaluation of the numerical density of sense organs on the mouth parts of the two female species was in favour of *O. maskelli* over *L. invasa*, according to Hamdy and Emam (2022b). Based on the study of the numerical density and its diversity on ovipositor for females of the two species, they were demonstrated that the results were closely linked in the context of the current investigation, with a little differential favouring *L. invasa* at the expense of *O. maskelli*. The findings are in line with those in Table 1 and appear to support the idea that *O. maskelli* is a more advantageous rival who could take *L. invasa* away out of its place. Despite the fact that the egg-laying machine *L. invasa* has more sense organs than before, which may be a result of its specialisation in laying eggs on the middle race of the leaves rather than its reproductive effectiveness.

However, the evidence tends to point to *L. invasa* as a stronger rival who might supplant *O. maskelli*. Regardless, it could be because *O. maskelli* lays eggs all over the leaf blade, but *L. invasa* specially lays eggs on the middle race, necessitating greater differentiation in the puncture area.

Conclusion: Comparing the total number of sensilla along the bodies of the two species, *O. maskelli* had more sensilla than *L. invasa*, which had 182 sensilla. *O. maskelli* sensillum numbers along the body were 249 vs greater than *L. invasa* sensillum.

Furthermore, these qualitative and numerical sensilla for both species are crucial because they offer a morphological foundation for comprehension of behaviour mediated by the antennal perception in both species as well as insights into its purpose in closely related species. Overall, this study offers fundamental knowledge for potential applications combining functional morphology and a grasp of the mechanisms behind behavioural reactions to semi-chemicals utilized in host recognition.

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