

An account of males in primitively Eusocial
wasp *Polistes wattii*

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*A dissertation submitted for the partial fulfilment of BS-MS dual degree in
Science*



Indian Institute of Science Education and Research Mohali

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Certificate of Examination

This is to certify that the dissertation titled “**An account of males in primitively eusocial wasp *Polistes wattii***” submitted by **Ms Komal (Reg no – MS14161)** for the partial fulfillment of BS-MS dual degree programme of the institute, has been examined by the thesis committee duly appointed by the institute. The committee founds the work done by the candidate satisfactory and recommends that the report be accepted.

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Declaration

The work presented in this dissertation has been carried out by me under the guidance of **Dr. Rhitoban Raychoudhury** at the Indian Institute of Science Education and Research Mohali. This work has not been submitted in part or in full for a degree, a diploma, or a fellowship to any other university or institute. Whenever contributions of others are involved, every effort is made to indicate this clearly, with due acknowledgement of collaborative research and discussions. This thesis is a bonafide record of original work done by me and all sources listed within have been detailed in the bibliography.

Komal

Date:

In my capacity as the supervisor of the candidate's project work, I certify that the above statements by the candidate are true to the best of my knowledge.

Dr. Rhitoban Raychoudhury

(Supervisor)

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Abstract

Polistine wasps are the most common type of paper wasps found in North America. They belong to order hymenoptera and family vespidae. *Polistes wattii* is one of the temperate species of paper wasp. Males of tropical *Polistes* are available throughout year while males of temperate species are always produced near the end of the colony cycle and do not overwinter (Ross and Carpenter 1991). Also these wasps are infected with Strepsipteran endoparasite which leads to the stylopization of the host. Our data gives an account of males in *P. wattii*, their occurrence, mating and the effect of Strepsiptera on these males.

Chapter 1

Introduction

1.1 Basic Theory

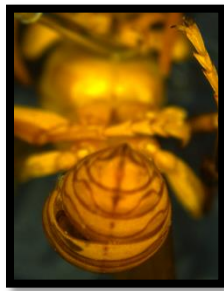
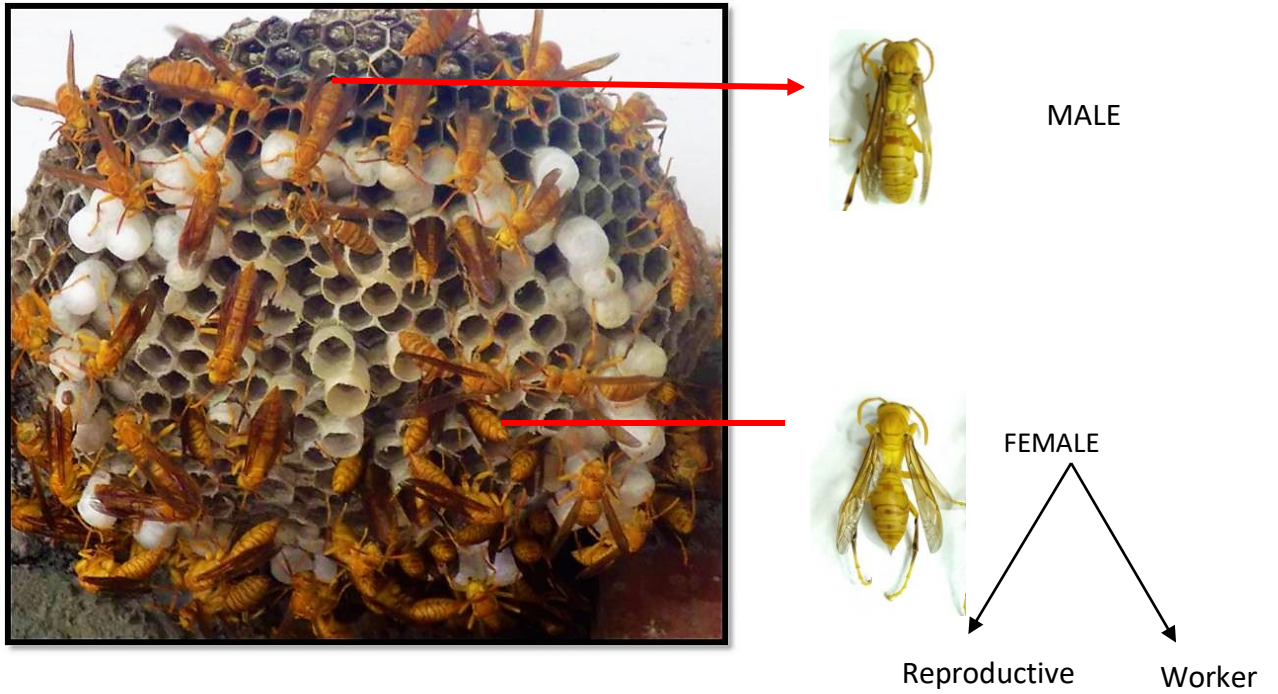
1.2 Experimental Methods

Introduction

Polistine wasps are eusocial hymenopteran found in tropical and temperate regions. *Polistes* belongs to Kingdom-Animalia; Phylum-Euarthropoda; Class-Insecta; Order-Hymenoptera; Family-Vespidae; Tribe-Polistini; Genus-*Polistes*. It is the largest genus of family vespidae with over 300 recognized species and subspecies. These wasps are considered beneficial as they consume a large number of caterpillars. A diversity of hymenopterans have the ability to recognize their conspecific nestmates. The foundresses of *P. metricus* recognize nestmate foundresses by utilizing individually borne recognition cues (Ross & Gamboa, 1986). The nest recognition cues are nest surface hydrocarbons that are learned and that may be acquired by *P. metricus* workers as adults on the natal nest (Singer & Espelie).

In eusocial animals like ants, termites etc. the colony has caste differences: Queen and reproductive males take the sole role of reproducers while soldiers and workers help in brood care. In *Polistes versicolor*, dominant females have a function of ovipositing and building of new cells while other females have a role of foraging and feeding the larvae (Cervo, Rita, 2006). Similarly, in *P. wattii* there are females (reproductives and workers) and males. But they do not have morphological differences between reproductives and non reproductives, therefore they are called **Primitively eusocial**. The workers are the female wasps that perform the colony maintenance function. Workers primarily forage and do not lay eggs. Reproductive females are the egg layers. Males in social hymenopterans do not work, therefore there are only reproductive males.

Different castes in *Polistes wattii*



Parasitized wasp

Photograph 1.1- Castes in *Polistes wattii*

These were the normal castes in *Polistes*. Sometimes these wasps are attacked by some parasites. This kind of parasitization is known as stylopization. Strepsiptera is an endoparasite which is commonly known to affect Polistine wasps. These stylopized wasps are all together a different caste because they are castrated. They cannot reproduce and donot perform any colony maintenance activity. Within a few days after eclosion they leave the nest and form a social group and they remain in that group.

Polistes commonly build their nests in human habitation. Generally, they are not aggressive but can be provoked into defending their nests. They are yellow in color and they feed on caterpillars. They are holometabolous (complete metamorphosis) with four life stages:

- 1) Egg
- 2) Larva
- 3) Pupa
- 4) Adult

Sexual dimorphism in *P.wattii*

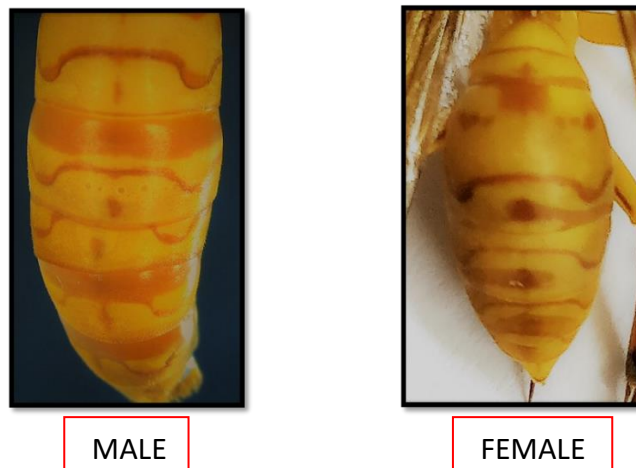
In *P.wattii*, males and females have morphological differences among them.

- 1) Males are bigger in size as compared to females



Photograph 1.2 *P.wattii* female and male

- 2) Males have blunt end of their abdomen whereas females have pointed end of their abdomen.



Photograph 1.3 - *P.wattii* abdomen

Colony cycle of *Polistes wattii*:

The colony cycle of *Polistes wattii* consists of social cycle followed by hibernation. In the beginning of March, the hibernated females comes out of hibernation and starts building the nests. New nests are generally build by solitary female or group of females. The colony multiplication primarily depends on the number of females which are able to found nest after overwintering. The foundress lays eggs in the brood canal. And the first seasonal brood of *Polistes* is entirely females destined to become workers which helps in the colony maintainance, foraging and brood care. Once the first reproductive female is produced, then the reproductive phase of the colony starts. These females are different from the workers. When the male reproductives emerge then these males and females undergo mating. After mating, the males die and the females go into hibernation.

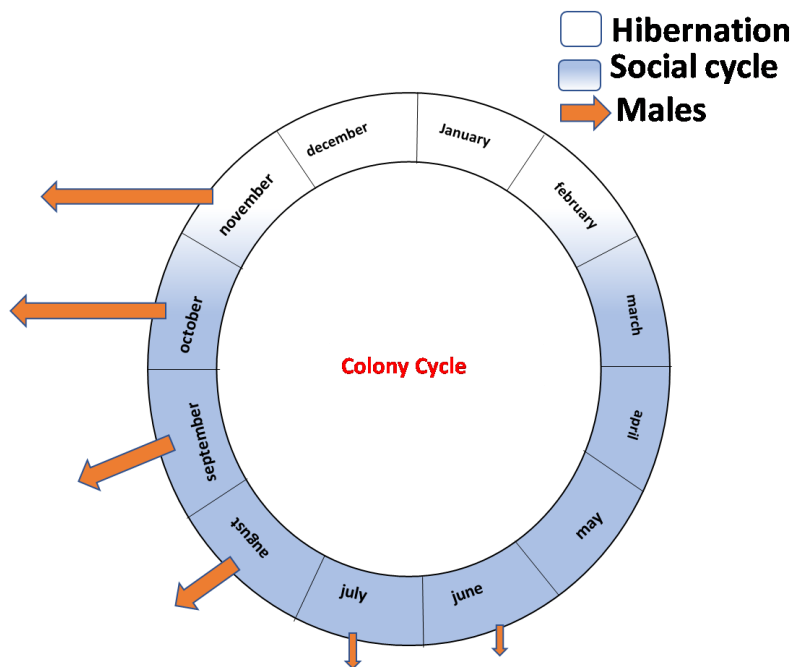


Fig 1.1 -Colony cycle of *P.wattii*

In *Polistes wattii*, the females are produced throughtout the colony cycle. But the males are not found all the time. They are produced towards the end of the social cycle.

Mating in *Polistes* :

In *Polistes*, mating occurs through lekking behaviour. Males gather at a particular place to engage in competitive displays to attract the females for copulation. Leks are commonly formed before or during breeding season. Generally, selected perches in close proximity to the nests like hibernacula, foraging patches, or sites such as hilltops are used to form leks. In summers, the males of *P. dominulus* form large aggregations at sunny landmarks (Beani et al 1987). The males fight with other males to demonstrate their attractiveness. The females fly near lekking areas to observe males before mating choice. In *P. dominulus* females use the abdominal spots of the males for the mate choice. Males with small, elliptical spots are chosen over the males with large irregular shaped spots (Tibbetts , 2012). In *P. nimpha*, mating occurs on high trees and in *P. biglumis bimaculatus*, mating occurs on stones in dry gravel beds. In *P. Canadensis*, males are territorial at small trees along the crest of dry ridges.



Polistes aurifer



Polistes fuscatus

Photograph 1.4 – Lek mating in *P. aurifer* and *P. fuscatus*

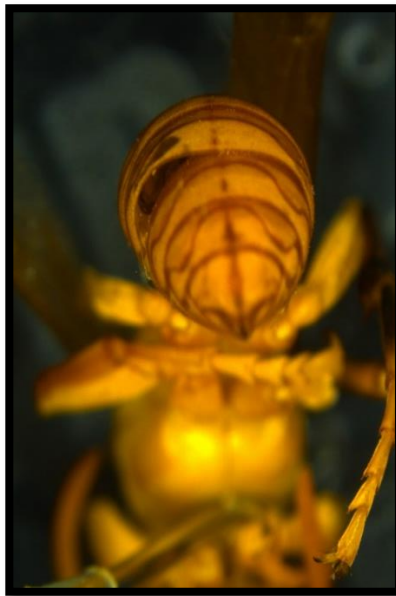
Mating type in different *Polistes* species:

S.NO	Polistes species	Mating type
1	<i>P.dominula</i>	Lek mating
2	<i>P.nimpha</i>	Lek mating
3	<i>P.gallicus</i>	Lek mating
4	<i>P. biglumisbimaculata</i>	Lek mating
5	<i>P.fuscatus</i>	Lek mating
6	<i>P. jadvigae</i>	Lek mating
7	<i>P.chinensis antennali</i>	Lek mating
8	<i>P.exclamans</i>	Lek mating
9	<i>P. bellicosus</i>	Lek mating
10	<i>P. dorsalis</i>	Lek mating
11	<i>P. metricus</i>	Lek mating
12	<i>P.Carolina</i>	Lek mating
13	<i>P. bahamensis</i>	Lek mating
14	<i>P.canadensis</i>	Lek mating
15	<i>P. commanchusnavajoe</i>	Lek mating
16	<i>P. wattii</i>	On nest mating

Table 1 – Mating In *Polistes*

Prevalence of the parasite Strepsiptera in *Polistes*:

Strepsiptera is an endoparasite found in insects such as wasps, bees, etc. it is also known as twisted winged parasite. They spend most of their life cycle as internal parasite of other insects and consequently have extreme sexual dimorphism and morphology. Infection with strepsiptera leads to stylopization of the host. Stylopization refers to protrusion of male melanised cephalotheca or less conspicuous female thorax through wasp cuticle (L Beani *et al*) These obligate parasites infect the developing wasp larvae in the nest and are present within the abdomens of the females. Once the strepsipteran parasite has infected the wasp, it takes up all the space in wasp's abdomen. Also, this parasite manipulates the phenotype of the host to maximize its own reproductive success.



Photograph 1.5- *P. wattii* infected with female parasite and *P. wattii* infected with male parasite

Sexual dimorphism in Strepsiptera:

Male and female strepsiptera have morphological differences among them.

Male Strepsiptera:

Males are winged and ephemeral (short lived)

Adult males are able to break the cap of puparium and fly off.

Multiple Strepsiptera male can be found within a single host.

Female Strepsiptera:

Females are flightless.

They are larviform parasite.

Mostly one female parasite is found within a single host.

Male strepsiptera



©Ruchira Sen

Female strepsiptera



©Kunika

Photograph 1.6 – Male and female Strepsiptera

Life cycle of strepsiptera:

Firstly, the free living male mates with the endoparasitic female through her extruded cephalothorax which comes out through host's cuticle



Then the female produces first instar larva which then comes out of female through brood canal



Then this first instar larva enters host within wasp's nest



After that, the first instar larva molts into second instar larva and third instar larva and then forth instar larva.



The forth instar larva then molts into to form a pupa which then protrudes from the abdomen of host's cuticle.



But the female forth instar larva donot undergo additional molts and develops a cephalothorax which extrudes through host's cuticle for mating.

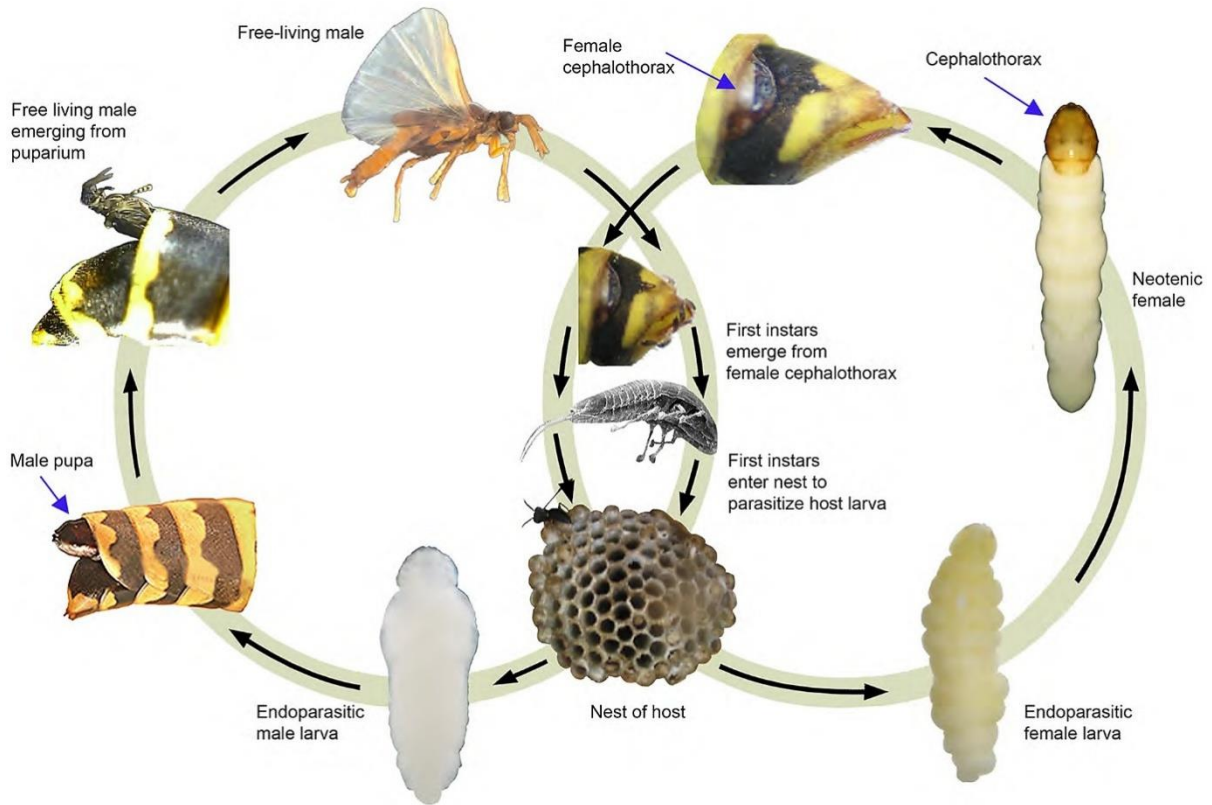


Fig 1.2 life cycle of Strepsiptera in *Polistes*

©F. Erezyilmaz et al

Effect of strepsiptera on its host:

Infection with strepsiptera leads to the stylopization of the host. Stylopization refers to protrusion of male melanised cephalotheca or less conspicuous female thorax through wasp cuticle. This is useful to detect parasitism. The strepsipteran parasites are the parasitic castrators (Sensu Baudion 1975). If female *Polistes* is infected with strepsiptera, it develops filiform ovaries. And if male *Polistes* is infected with strepsiptera then it doesn't develop testis (Beani et al 2004b).

1.2 AIM AND EXPERIMENTAL METHODS

Objective:

The main aim of this study is to give an account of males in *P. wattii*. The first objective is to quantify the occurrence of males in the colonies and to observe the mating in *P. wattii*.

Secondly, to check the effect of strepsiptera on males and to check the parasitic load on the infected wasps.

Material and Methods:

This study was carried out in field conditions in IISER Mohali Campus.

Total 25 colonies were observed to check the occurrence of males and mating.

Observations were made during evening around 5 pm from May 2018 to November 2018.

Snapshots of these colonies were taken and then the number of males were counted from those pictures.

Wasp collection:

Flying wasps were collected from IISER Mohali (AB2 Backside, MK and MJ block).

Time of collection : 12:00 pm to 3:00 pm from beginning of October to mid of November.

Both parasitized and unparasitized male and female wasps were collected.

Insect net was used to collect the wasps.

After collection, samples were conserved in ethanol (100%) in falcon tubes.

Location of observation and collection:

IISER Mohali campus



Fig 1.3 – Map of iiser mohali (area of collection)

Chapter 2

2.1 RESULTS

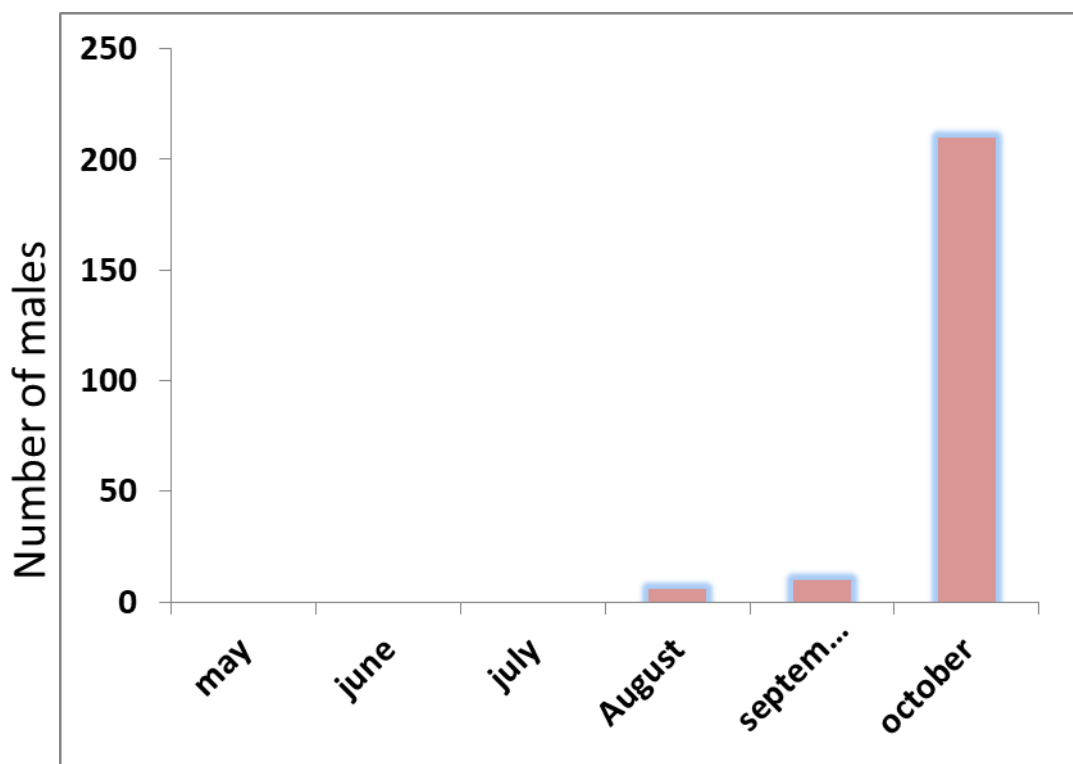
2.2 DISCUSSION AND CONCLUSION

2.1 Results:

Occurrence of males:

According to our data, males started appearing in the mid of August. But we have seen flying males in June and July as well but their occurrence is low on the nests at that time that it is very difficult to capture them. Another reason could be that the males generally hide themselves at the back of the nest. So, when there are plenty of males it is very easy to capture them. But in the beginning, when there are few males, it is very difficult to point them.

According to our data, total number of males keep on increasing from August to November.



Number of colonies observed = 25

Fig 2.1 Number of males

Nests with males are increasing from august to October.

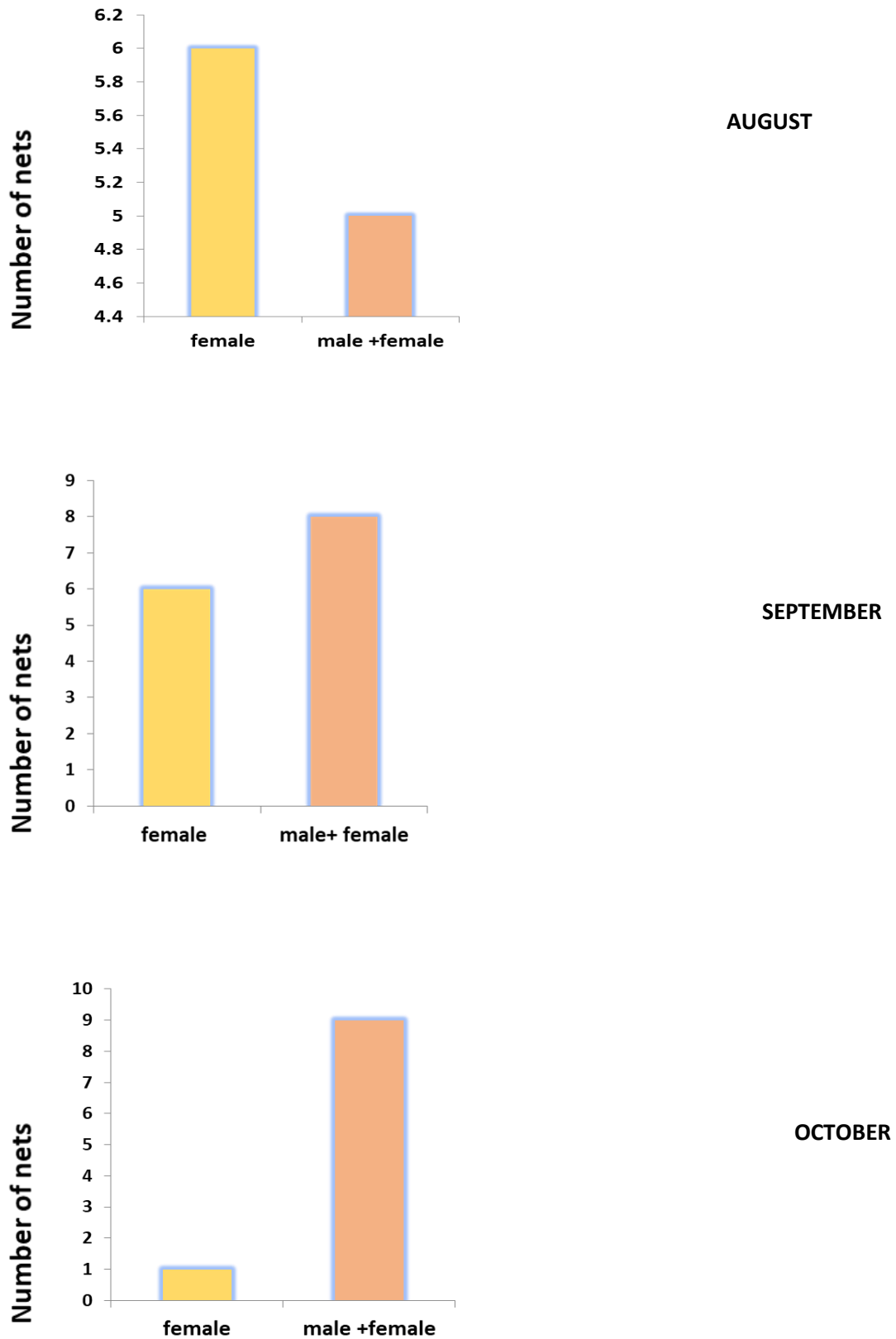
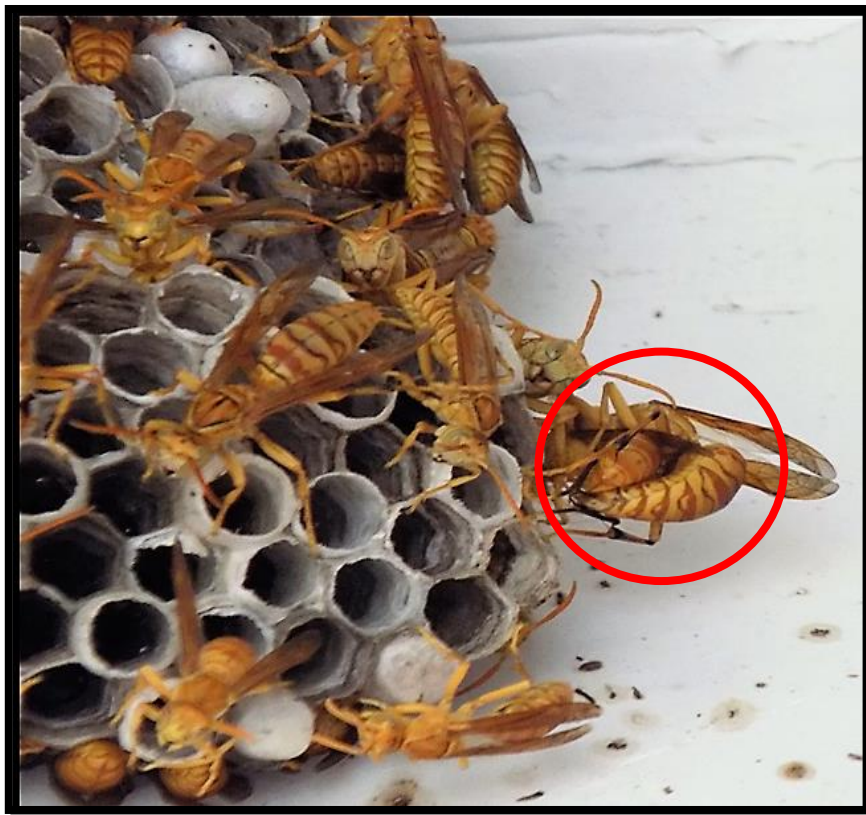


Fig 2.2 – Nests with males in August, September, October

Mating in *Polistes wattii*:

In other species of *Polistes*, mating occurs through lekking behavior. But we have observed for the first time that in *Polistes wattii*, mating occurs on the nests only. Once the males starts appearing then they leave their nest and go to other nests and mate with the females on the nests.



Photograph 2.1 – Mating in *P. wattii*

Parasitic load on the infected wasps:

Parasitic load refers to the number of parasite that an organism harbours.

To check the parasitic load on the wasps, flying wasps were collected.

Collection of wasps:

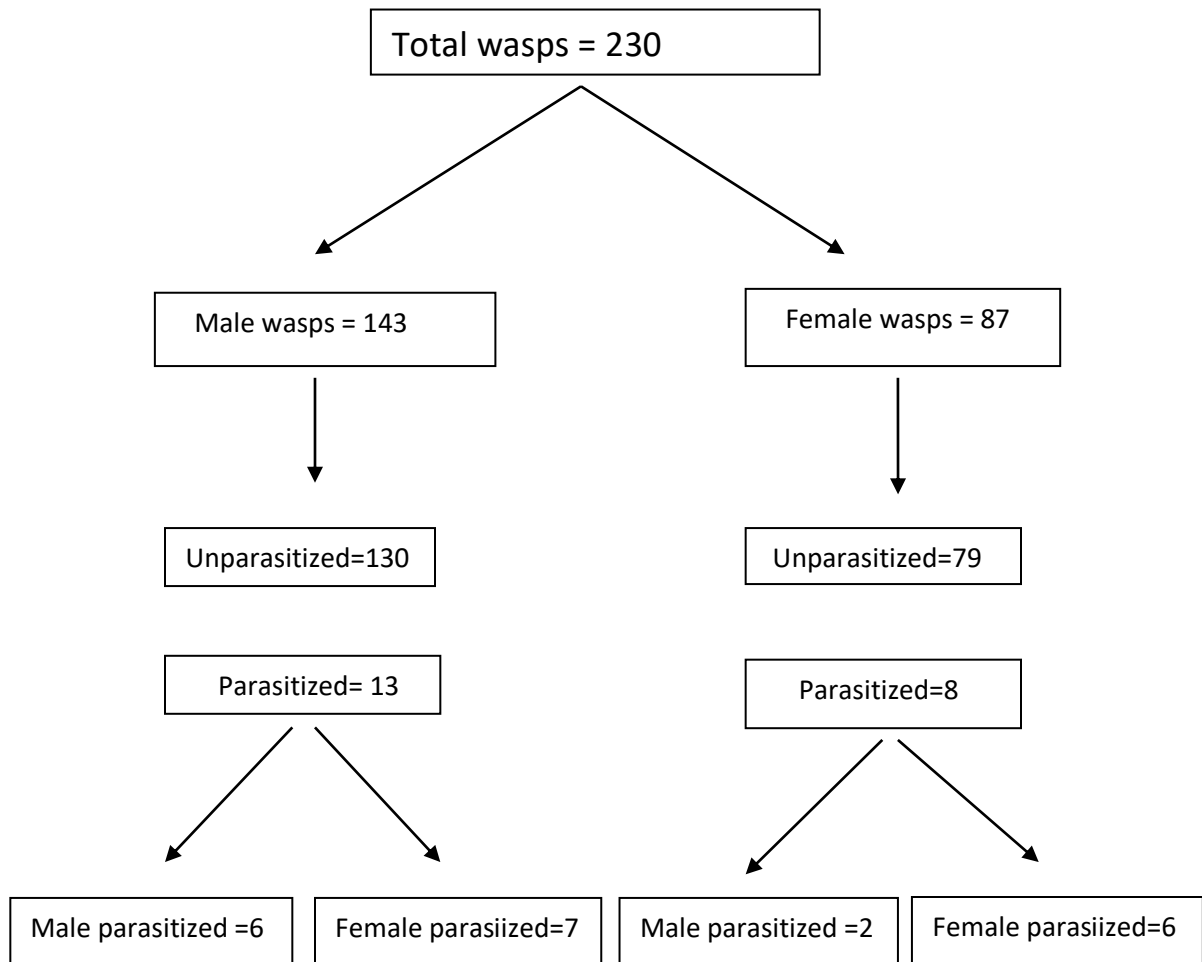
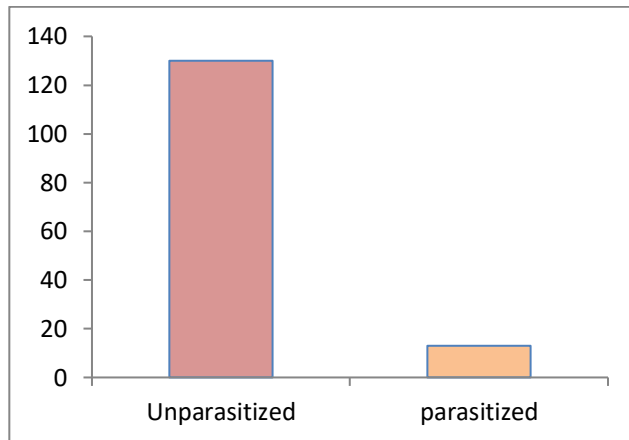


Table 2 : Collection sample

Proportion of parasitized and unparasitized males:



Proportion of parasitized and unparasitized females:

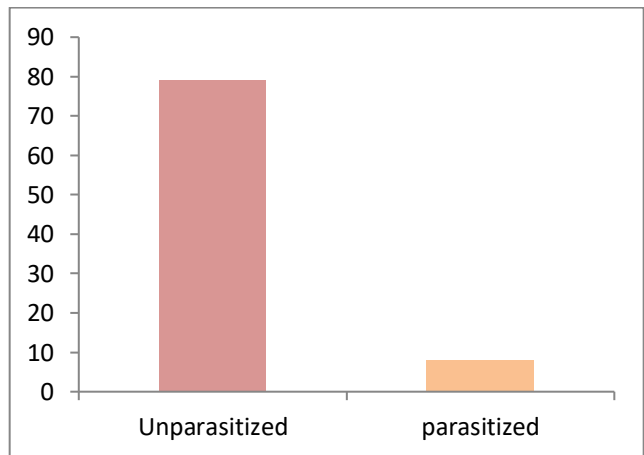
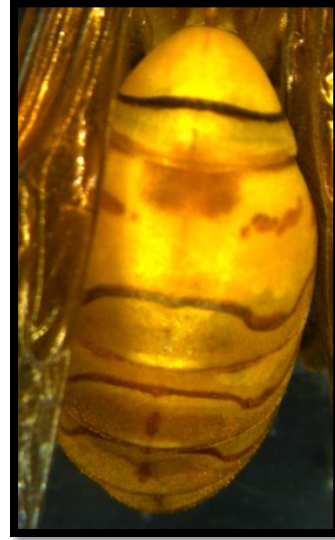


Fig 2.3 – Proportion of parasitized and unparasitized male and females

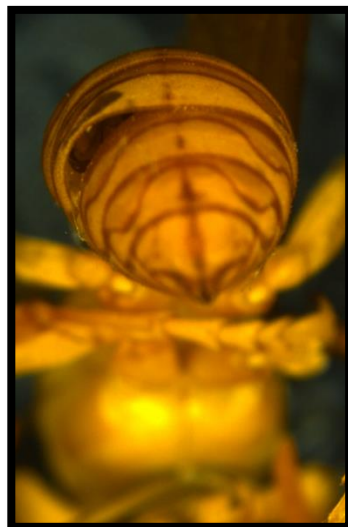
Pictures of collected samples:

MALES



Photograph 2.2 *P. wattii* male Infected with Male strepsiptera and female strepsiptera

FEMALES



Photograph 2.3 – *P. wattii* female Infected with Male strepsiptera and female strepsiptera

Parasitic load on the wasps:

In *P. wattii*, there can be more than one female strepsiptera in the infected wasps. But only one parasite is found in the wasps infected with male strepsiptera. In our collection, there was more parasitic load on male wasps as compared to female wasps.

Males	No. of male parasites	No of female parasites
PM1	1	0
PM2	1	0
PM3	1	0
PM4	1	0
PM5	1	0
PM6	1	0
PM7	0	1
PM8	0	1
PM9	0	1
PM10	0	1
PM11	0	2
PM12	0	2
PM13	0	2

Females	No. of male parasites	No of female parasites
PF1	1	0
PF2	1	0
PF3	0	1
PF4	0	1
PF5	0	1
PF6	0	1
PF7	0	1
PF8	0	1

Table 3: Parasitic load on males and females

Discussion :

The objective of this study was to give an account of males in *P. wattii*. In *Polistes*, females are found throughout the colony cycle and the males of tropical *Polistes* are available throughout year while males of temperate species are always produced near the end of the colony cycle and do not overwinter. Males in all other *Polistes* live on the nest for a short time and the females are so aggressive that they drive the males away, so the mating occurs through lekking behavior. But in *P.wattii* males go to nests and search for the females and the mating occurs on nests only. After mating the males die and females go into hibernation. According to some studies the female wasps which are affected by Strepsiptera are castrated. It has been shown in other species that parasitized males donot loose their reproductive potential. More than one female parasite can be found within a host but in the host infected with male parasite, only one parasite was found. Here, the parasite is reaching a blind end. Because when they are inside females, the females will go into hibernation and it will sprinkle larvae in the next generation. But the males donot go into hibernation, so the parasite dies along with the males. This is the cost that parasite has to met unless they evolve some strategies to distinguish between males and females.

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