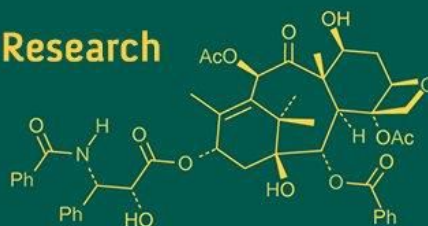
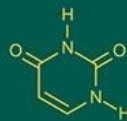
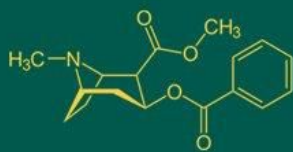


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## Population dynamics of cow bugs and their natural enemies in pigeon pea

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### Abstract

**Background:** Cow bugs are seen in groups, mainly in fresh and terminal branches on their host plants. Both nymphs and adults of cow bugs exude a sugary (honey dew) liquid which is consumed by ants which in return may help to protect the cow bugs from natural enemies. The common name of cow bug is derived from this habit of providing 'milk' to the ants. The most potential and abundant natural enemy observed was the aphelinid parasitoid parasitizing the cow bug eggs.

**Methods:** The population of cow bugs and ants were recorded on 10 randomly selected pigeonpea plants from different directions of the experimental plot. Under field condition, the natural enemies like predator and parasitoids were observed on different stages of cow bugs on randomly selected ten plants of pigeonpea. For parasitoids observation, collection of different stages of cow bugs and aphids was made from five randomly selected pigeonpea plants.

**Statistical analysis:** Mean population was calculated for the number of cow bugs per plant and correlation and regression analysis was done by using WASP software.

**Results:** Two predatory spiders belong to genus *Argiope* were observed throughout the period of observation from October 2020 to March 2021. The most potential and abundant natural enemy observed was the aphelinid parasitoid parasitizing the cow bug eggs. The egg parasitoid *Centrodora* sp. (Hymenoptera: Aphelinidae). The *Centrodora* sp. wasp, a solitary endoparasitoid had no species specificity and found parasitizing eggs of *Otinotus* sp. and *O. apicalis*. Parasitized eggs were differentiated from unparasitized as they took much longer time to hatch and upon hatching the parasitoid formed a distinct round emerging hole and the egg shape remained intact.

**Keywords:** Parasitoid, cow bug, spider, eggs, etc

### Introduction

Insects feed on all parts of the pigeonpea plant and insect pests are the most important biotic constraint affecting pigeonpea yields. Pest scenario varies from place to place with the variation in the agro-climatic conditions of the locality. Major insect pests of pigeonpea are Spiny brown bug, *Clavigralla gibbosa* Spinola, Tur pod bug, *Riptortus pedestris* Fb., Green stink bug, *Nezara viridula* Linn., Aphids, *Aphis craccivora* Koch, *Aphis fabae* Scopoli, Cow bugs, *Otinotus oneratus* W., *Oxyrachis tarandus* F., Scale insect, *Ceroplastodes cajani* Maskell, *Icerya purchasi* Maskell, Mealybugs, *Phenacoccus solenopsis* Tinsley, *Paracoccus marginatus* W. & G., *Coccidohystrix insolita* Green, Leaf hoppers, *Empoasca kerri* Pruthi, Plume moth, *Exelastis atomosa* Walshingham, Pod borer, *Helicoverpa armigera* Hubner, Spotted pod borer, *Maruca testulalis* Geyer, Hairy caterpillars, *Spilosoma obliqua* Walker, Leaf webbers/folders, *Grapholita critica* Meyr., Blue butterfly, *Lampides boeticus* Linn., Blister beetles, *Mylabris pustulata* Thumberg, Ash/Grey weevil, *Myloccerus undecimpustulatus* Faust, Thrips, *Megalurothrips usitatus* Bagnall, Pod fly, *Melanogromyza obtusa* Malloch, and Termite, *Odontotermes* spp. (Khajuria *et al.*, 2015) [1].

Cow bugs are seen in groups, mainly in fresh and terminal branches on their host plants. Many species such as *Oxyrachis rufescens* (Walker), *O. taranda*, *O. tuberculus* (Walker), *O. brevicornutus* (Ananthasubramanian and Ananthakrishnan.), *O. uncatus* (Melichar), *O. krusadiensis* (Ananthasubramanian and Ananthakrishnan), *Otinotus oneratus* (Walker), *Coccosterphus minutus* (F.), *Leptocentrus taurus* (Fab.) and *Gargara mixta* (Buckton) prefer the acacias and pigeonpea (Ananthasubramanian, 1996) [2]. The cow bug, *O. tarandus* is one of the abundant pest species found on pigeonpea (Ramar *et al.*, 2012) [3]. The cow bug (*O. oneratus*) infestation starts during vegetative stage and continued up to the reproductive stage of the pigeonpea (Bijewar *et al.*, 2019) [4].

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Both nymphs and adults of cow bugs exude a sugary (honey dew) liquid which is consumed by ants which in return may help to protect the cow bugs from natural enemies. The common name of cow bug is derived from this habit of providing 'milk' to the ants (Reed *et al.*, 1989) [5].

In the tropics, membracids species injure a variety of crop plants, including avocado, legumes, coffee, cacao, grape, and papaya. cow bugs may injure plants, not only through feeding, but also through laying their eggs in host plant tissue by making slits. Treehoppers (Membracidae) provide some of the best studied examples of parenting in insects by frequent maternal eggs guarding. The Membracinae exhibit the full range of social behavior found among treehoppers, ranging from solitary asocial individuals, aggregations of nymph or adult, to highly developed maternal care in the form of offspring- maternal communication (Lin, 2006) [8].

All the life stages (Egg, nymph and adult) of cow bugs are associated with their host plants. Female insert eggs into different parts of host plant tissues with their strong ovipositor. They may also lay eggs on the surface of the plant tissues. Egg masses are frequently coated with waxy substances derived from accessory glands. Ant mutualism is prevalent among membracine treehoppers and may play an important role in the evolutionary development of sub social behavior (Lin, 2006) [8].

## Materials and Methods

### Population dynamics of cowbugs

Pigeonpea variety TS-3R was sown as *kharif* crop in the year 2020. All the recommended agricultural package of practices were followed in the crop except crop protection measures. The crop was grown with spacing 120 cm X 30 cm. The population of cow bugs and ants were recorded on 10 randomly selected pigeonpea plants from different directions of the experimental plot. Observations were recorded by counting the total number of nymphs and adults of cow bugs and associated ants per plant in pigeonpea.

The observations were recorded at weekly interval from October, 2020 to March, 2021. The weather parameters like Temperature, Relative Humidity, Rainfall etc., were collected from Regional Agricultural Research Station, Vijayapur and an attempt was made to correlate the

population buildup of cow bugs and weather parameters from the location of study.

### Population dynamics of natural enemies of cowbug

The studies on predators and parasitoids attacking cow bugs in pigeonpea ecosystem was carried out at College of Agriculture, Vijayapur. The eggs, nymphs and adults of cow bug species infesting pigeon pea, was collected from five plants selected randomly in field at weekly intervals and were reared in the laboratory to study the occurrence of parasitoids and as well as extent of parasitization. For cow bugs, total parasitoids emerged was calculated by counting the number eggs which have distinct circular exit holes made by parasitoid during emergence. In contrast, the healthy hatching results in irregular vertical splitting of egg shell and have no peculiar exit holes. In this experiment, the percentage of parasitization of cow bug eggs has been estimated by simply dividing the number of eggs parasitized by the total number of eggs collected.

$$\text{Percent parasitization} = \frac{\text{Number of eggs parasitized}}{\text{Total number of eggs collected}}$$

**Statistical analysis:** Mean population was calculated for the number of cow bugs per plant and correlation and regression analysis was done by using WASP software.

### Results and Discussion

The nymphs and adults of cow bugs species infesting pigeon pea and ants associated with these cow bugs were counted from 10 randomly selected pigeonpea plants at weekly intervals. The initial incidence of cow bugs was noticed during fourth week of October (2.5 cow bugs/ plant) on three months old pigeonpea crop. The population reached its peak (72 cow bugs/ plant) during 49<sup>th</sup> standard week. The population of cow bug was maximum, when the temperature ranged from 14.2 to 30.2°C, relative humidity ranged from 34 to 82 per cent, zero rainfall, wind velocity 3.7 kmph, sunshine 9.4 hours and evaporation 3.8 mm. Cow bug population remained considerably high in the month of December and gradually declined during January month with increase in temperature.

**Table 1:** Population dynamics of cow bugs and their associated ants in pigeon pea during 2020-2021

| Month           | SMW | Cow bug (nymph and adult) population per plant* | Ant population per plant * | Month wise mean population (cow bugs / plant) |
|-----------------|-----|-------------------------------------------------|----------------------------|-----------------------------------------------|
| October         | 43  | 2.50                                            | 0.80                       | 6.40                                          |
|                 | 44  | 10.30                                           | 7.70                       |                                               |
| November        | 45  | 13.40                                           | 7.80                       | 23.13                                         |
|                 | 46  | 12.10                                           | 11.90                      |                                               |
|                 | 47  | 21.20                                           | 8.90                       |                                               |
|                 | 48  | 45.80                                           | 22.20                      |                                               |
| December        | 49  | 72.00                                           | 34.00                      | 56.90                                         |
|                 | 50  | 60.10                                           | 21.00                      |                                               |
|                 | 51  | 52.10                                           | 32.00                      |                                               |
|                 | 52  | 43.40                                           | 23.00                      |                                               |
| January         | 1   | 29.00                                           | 14.50                      | 22.20                                         |
|                 | 2   | 27.00                                           | 20.00                      |                                               |
|                 | 3   | 23.10                                           | 12.60                      |                                               |
|                 | 4   | 19.00                                           | 12.30                      |                                               |
|                 | 5   | 12.90                                           | 2.40                       |                                               |
| February        | 6   | 6.50                                            | 2.80                       | 2.60                                          |
|                 | 7   | 1.40                                            | 2.30                       |                                               |
|                 | 8   | 0.00                                            | 0.00                       |                                               |
| Mean population |     | 25.10                                           | 12.57                      | -                                             |

\*Average of 10 randomly selected plants, SMW: Standard meteorological week  
Population after 8<sup>th</sup> SMW was zero

Cow bug population buildup showed a significant and negative correlation with maximum temperature ( $r = -0.557$ ) and evaporation ( $r = -0.477$ ) whereas it was nonsignificant and negative association with minimum temperature ( $r = -0.440$ ), rainfall ( $r = -0.011$ ), windspeed ( $r = -0.129$ ) and sunshine hours ( $r = -0.007$ ). Pest population was non significantly and positively correlated with morning ( $r = 0.356$ ) and evening relative humidity ( $r = 0.176$ ) (Table 2). Upon analyzing the population data by using multiple linear regression analysis, the equation obtained was  $Y = 204.666 - 3.487 X_1 - 2.420 X_2 + 1.565 X_3 - 3.427 X_4 + 1.949 X_5 + 24.628 X_6 + 4.932 X_7 - 42.898 X_8 + 13.445$ . The value of

coefficient of determination i.e.,  $r^2$  was 0.782, which revealed that, population of cow bugs was influenced by weather parameters to the extent of 78.2 per cent (Table 3). Ants population also followed the same trend as it was directly associated with cow bugs population for the honeydew they excrete. Ant population was 0.8 per plant when the cow bug incidence started, and reached maximum number (34 ants/plant) with peak incidence of cow bugs (72 cow bug/plant) during 49<sup>th</sup> standard week. Correlation between ant and cow bug population showed a highly significant and positive ( $r = +0.917$ ) relationship.

**Table 2:** Correlation coefficient of population of cow bugs with weather parameters

| Weather parameters          | Temperature (°C)      |                       | RH (%)                 |                         | Rainfall (X <sub>5</sub> ) (mm) | Wind speed (X <sub>6</sub> ) (kmph) | Sunshine (X <sub>7</sub> ) (h) | E pan (X <sub>8</sub> ) (mm) |
|-----------------------------|-----------------------|-----------------------|------------------------|-------------------------|---------------------------------|-------------------------------------|--------------------------------|------------------------------|
|                             | Max (X <sub>1</sub> ) | Min (X <sub>2</sub> ) | RH I (X <sub>3</sub> ) | RH II (X <sub>4</sub> ) |                                 |                                     |                                |                              |
| Correlation coefficient (r) | -0.557*               | -0.440 <sup>NS</sup>  | 0.356 <sup>NS</sup>    | 0.176 <sup>NS</sup>     | -0.011 <sup>NS</sup>            | -0.129 <sup>NS</sup>                | -0.007 <sup>NS</sup>           | -0.477*                      |

\*Correlation is significant at the 0.05 level

NS: Non-Significant

**Table 3:** Multiple linear regression for population dynamics of cow bugs and weather parameters

| Coefficient of determination ( $r^2$ ) | Regression equation                                                                                                      |
|----------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| 0.782                                  | $Y = 204.666 - 3.487 X_1 - 2.420 X_2 + 1.565 X_3 - 3.427 X_4 + 1.949 X_5 + 24.628 X_6 + 4.932 X_7 - 42.898 X_8 + 13.445$ |

**Table 4:** Multiple linear regression for population dynamics of cow bugs and weather parameters

| Coefficient of determination ( $r^2$ ) | Regression equation                                                                                                     |
|----------------------------------------|-------------------------------------------------------------------------------------------------------------------------|
| 0.777                                  | $Y = 406.968 + 2.131 X_1 - 7.104 X_2 - 0.533 X_3 - 1.947 X_4 + 4.76 X_5 + 10.604 X_6 + 3.995 X_7 - 68.672 X_8 + 25.319$ |

$X_1$ =Maximum temperature,  $X_2$ =Minimum temperature,  $X_3$ =Morning relative humidity,  $X_4$ =Evening relative humidity,  $X_5$ =Total Rainfall,  $X_6$ =Windspeed,  $X_7$ = Sunshine hours,  $X_8$ =Pan evaporation

### Natural Enemies of Cow bugs

Two predatory spiders belong to genus *Argiope* were observed throughout the period of observation from October 2020 to March 2021. Spiders were feeding on the cow bug nymphs and adults which accidentally caught into spider webbing and spiders were the only predators observed feeding on cow bugs in field. Initially spiders immobilized the prey by webbing its silk around prey, transported prey towards nest hub and then started feeding. In laboratory observation, many mites were observed feeding on cow bug eggs and many were found inside the egg shells after hatching. One predatory bug nymph with reddish brown thorax found feeding on egg content by inserting its stylet.

The most potential and abundant natural enemy observed was the aphelinid parasitoid parasitizing the cow bug eggs. The egg parasitoid *Centrodora* sp. (Hymenoptera: Aphelinidae) is a minute wasp measuring less than one mm in length, with a greenish yellow body. This wasp was mainly observed during reproductive and maturity stage of the crop, with parasitization increased towards the maturity stage of the crop owing to reduction in population of guarding adult cow bugs and the ants. In this study, the percentage of eggs parasitized has been estimated by simply dividing the number of eggs parasitized by the total number of eggs collected. The total mean parasitization by this wasp was 19.06 per cent, with peak parasitization (67.69%) during month of February.

The *Centrodora* sp. wasp, a solitary endoparasitoid had no species specificity and found parasitizing eggs of *Otinotus* sp. and *O. apicalis*. Parasitized eggs were differentiated from unparasitized as they took much longer time to hatch and upon hatching the parasitoid formed a distinct round

emerging hole and the egg shape remained intact. But in case of healthy cow bug hatchlings, the egg shell split vertically and chorion folded inwards.

### Discussion

Two species of predatory spiders under the genus, *Argiope* were found feeding on cow bug nymphs and adults. Data collected during field observation revealed that there were no such potential predators available to reduce the population of cow bugs. In laboratory observation, many mites were found feeding on cow bug eggs and many were found inside the egg shells after hatching. One predatory bug nymph with reddish brown thorax found feeding on egg content by inserting its beak. These results were supported by Yothers (1934) [12] who reported two species of spiders, *Philodromus minuta* Bks. and *Dendryphantas militaris* Hentz feeding upon the hatching eggs and emerging nymphs. A mite belonging to the genus *Seius* was found in high numbers inside discolored, empty, shriveled eggshells of overwintering tree hopper eggs. Ananthasubramanian (1996) [2] recorded many species of spiders found to catch the membracids and suck their haemolymph. Mites were found to damage membracids embryos and live in the empty shells in large numbers.

Two coccinellid species, *Adalia bipunctata* L. and *Hyperaspis quadrivittata* Lee. have been observed feeding upon the nymphs. An ant, *Formica fusca* Wheeler, found eating the hatching nymphs of cow bug (Yothers, 1934) [12]. In contrary, this study recorded no coccinellids and ant predators on cow bugs. Observations on seasonal abundance of predators of cow bugs revealed that, prey population

remained considerably high with a maximum predator- prey ratio of 1:458 during 48<sup>th</sup> standard week.

The most potential and abundant natural enemy observed was aphelinid parasitoid, *Centrodora* sp. parasitizing eggs of cow bugs. The egg parasitoid, *Centrodora* sp. was a minute wasp measuring less than one millimeter in length, with a greenish yellow body color. This result is in agreement with Hayat (1973) <sup>[9]</sup> who recorded two new species of aphelinids parasitizing the eggs of cow bugs, they were *Centrodora azizi* Hayat and *Centrodora mumtazi* Hayat which found parasitizing *Otinotus oneratus* walker and *Oxyrgachis tarandus* Fab., respectively.

Ananthasubramanian (1996) <sup>[2]</sup> reported that, a high percentage of the *O. tarandus* eggs parasitised mostly by *Gonatocerus brevifuniculatus* (Subba Rao.), *C. azizi* and *Mirufens afrangiata* (Viggiani and Hayat). An interesting feature of many of these Chalcidoid egg parasitoids was that they lack absolute host specificity. All the above species of parasitoids that attack the eggs of *O. tarandus* also parasitize the eggs of *O. rufescens* and *O. oneratus* which were easily accessible to the parasitoids. This agrees with present study with respect to lack of host specificity in case of *Centrodora* sp. wasp, which were found parasitizing eggs of both *O. apicalis* and *Otinotus* sp.

Regarding the number of parasitoids emerged per egg, it was always one parasitoid per parasitized egg i.e., the wasp is a solitary endoparasitoid. Parasitized eggs were

differentiated from unparasitized as they took much longer time to hatch and upon hatching the parasitoid formed a distinct round emerging hole and the egg shape remain intact. But in case of healthy cow bug hatchings, the egg shell split vertically and chorion folded inwards. This wasp was mainly observed during reproductive and maturity stage of the crop with parasitization increased towards the maturity stage of the crop owing to reduction in population of guarding adult cow bugs and the ants. In this study, the percentage of eggs parasitized has been estimated by dividing the number of eggs parasitized by the total number of eggs collected.

The parasitization of cow bug by *Centrodora* sp. wasp started in the month of December with mean monthly parasitization rate 8.18 per cent. It gradually increased towards the crop maturity and the peak parasitization recorded during the month of February with mean monthly parasitization of 67.69 per cent (Fig. 1), due to decrease in number of guarding female and ants. This result is supported by the studies of Cocroft (2002) <sup>[11]</sup> who reported that, predation risk in broods of thorn bug (*Umbonia crassicornis* Amyot and Serville) by a predatory wasp, *Pseudopolybia compressa* (de Saussure) was more in the absence of guarding female, since the wasp was successful in 90 per cent of attempts in the absence of maternal guarding when compared to 19 per cent successful predation in the presence of guarding female.

**Table 5:** Natural enemies of cow bugs in pigeonpea

| Sl. No.           | Natural enemy    | Scientific name       | Family      | Order       | Affected stage of cow bug | Crop Stage                                  |
|-------------------|------------------|-----------------------|-------------|-------------|---------------------------|---------------------------------------------|
| <b>Predators</b>  |                  |                       |             |             |                           |                                             |
| 1                 | Spider           | <i>Argiope</i> sp.    | Araneidae   | Araneae     | Nymphs and adults         | Vegetative, Flowering and Pod setting stage |
| 2                 | Spider           | <i>Argiope</i> sp.    | Araneidae   | Araneae     | Nymphs and adults         | Vegetative, Flowering and Pod setting stage |
| 3                 | Heteropteran bug | Unidentified          |             | Hemiptera   | Eggs                      | Flowering and Pod setting stage             |
| 6                 | Mite             | Unidentified          |             | Acarina     | Eggs                      | Flowering and Pod setting stage             |
| <b>Parasitoid</b> |                  |                       |             |             |                           |                                             |
| 4                 | Yellow wasp      | <i>Centrodora</i> sp. | Aphelinidae | Hymenoptera | Eggs                      | Pod setting stage                           |



**Un- identified species of hemiptera**



**Un- identified species of predatory mite**

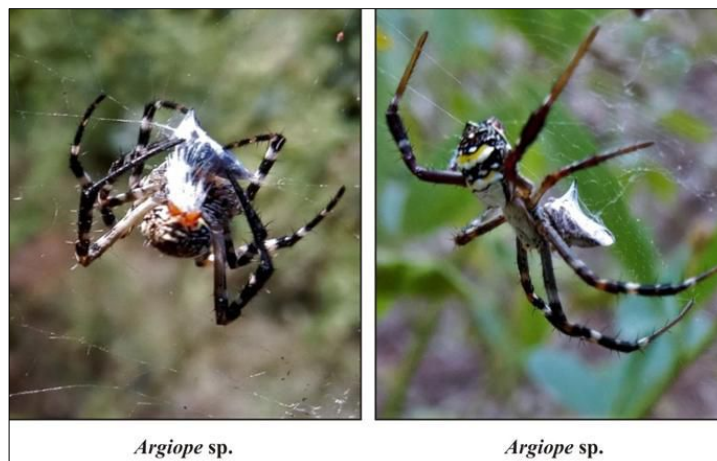


Fig 1: Predators on cow bugs in pigeonpea ecosystem

Table 6: Seasonal abundance of predator population of cow bugs in pigeonpea ecosystem during 2020-21

| Month    | SMW | Population of Spiders, <i>Argiope</i> spp. * | Cow bug population * | Predator: prey |
|----------|-----|----------------------------------------------|----------------------|----------------|
| October  | 43  | 1.00                                         | 25.00                | 1: 25.00       |
|          | 44  | 3.00                                         | 103.00               | 1: 34.33       |
| November | 45  | 2.00                                         | 134.00               | 1: 67.00       |
|          | 46  | 3.00                                         | 121.00               | 1: 40.33       |
|          | 47  | 1.00                                         | 212.00               | 1: 212.00      |
|          | 48  | 1.00                                         | 458.00               | 1: 458.00      |
| December | 49  | 4.00                                         | 720.00               | 1: 180.00      |
|          | 50  | 5.00                                         | 601.00               | 1: 120.20      |
|          | 51  | 2.00                                         | 521.00               | 1: 260.50      |
|          | 52  | 1.00                                         | 434.00               | 1: 434.00      |
| January  | 1   | 1.00                                         | 290.00               | 1: 290.00      |
|          | 2   | 2.00                                         | 270.00               | 1: 135.00      |
|          | 3   | 2.00                                         | 231.00               | 1: 115.50      |
|          | 4   | 1.00                                         | 190.00               | 1: 190.00      |
|          | 5   | 2.00                                         | 129.00               | 1: 64.50       |
| February | 6   | 0.00                                         | 65.00                | 0: 65.00       |
|          | 7   | 0.00                                         | 14.00                | 0: 14.00       |
|          | 8   | 0.00                                         | 0.00                 | 0:0.00         |
| Mean     |     | 1.61                                         | 251.00               | 1:155.79       |

\* Population on 10 randomly selected plants

Population after 8<sup>th</sup> SMW was zero

Table 7: Percent parasitization of cow bug eggs in pigeon pea ecosystem

| Month    | SMW* | No. of eggs collected | No. of parasitized eggs | Parasitization (%) | Monthly average parasitization (%) |
|----------|------|-----------------------|-------------------------|--------------------|------------------------------------|
| October  | 43   | 87.00                 | 0.00                    | 0.00               | 0.00                               |
|          | 44   | 144.00                | 0.00                    | 0.00               |                                    |
| November | 45   | 252.00                | 0.00                    | 0.00               | 0.00                               |
|          | 46   | 263.00                | 0.00                    | 0.00               |                                    |
|          | 47   | 217.00                | 0.00                    | 0.00               |                                    |
|          | 48   | 331.00                | 0.00                    | 0.00               |                                    |
| December | 49   | 303.00                | 0.00                    | 00.0               | 8.18                               |
|          | 50   | 364.00                | 8.00                    | 2.19               |                                    |
|          | 51   | 289.00                | 26.00                   | 8.99               |                                    |
|          | 52   | 311.00                | 67.00                   | 21.54              |                                    |
| January  | 1    | 276.00                | 75.00                   | 27.17              | 32.99                              |
|          | 2    | 238.00                | 59.00                   | 24.78              |                                    |
|          | 3    | 292.00                | 85.00                   | 29.10              |                                    |
|          | 4    | 282.00                | 98.00                   | 34.75              |                                    |
|          | 5    | 248.00                | 122.00                  | 49.19              |                                    |
| February | 6    | 265.00                | 130.00                  | 49.05              | 67.69                              |
|          | 7    | 173.00                | 104.00                  | 60.11              |                                    |
|          | 8    | 113.00                | 90.00                   | 79.64              |                                    |
|          | 9    | 61.00                 | 50.00                   | 81.96              |                                    |
| Total    | -    | 4795.00               | 914.00                  | 19.06              | -                                  |
| Mean     | -    | 252.36                | 48.10                   | 19.06              | -                                  |

SMW = standard meteorological week

Population after 8<sup>th</sup> SMW was zero

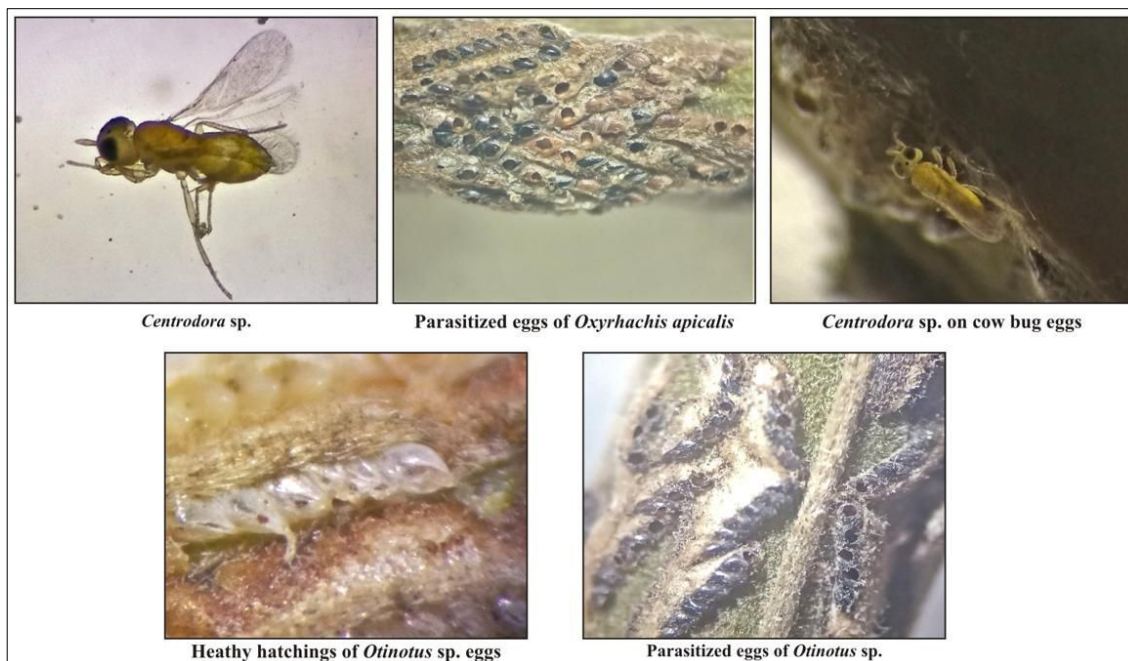


**Fig 2:** Parasitoid on cow bug eggs

### Conclusion

Two predatory spiders belong to genus *Argiope* were observed on cow bugs throughout the study period. The most potential and abundant natural enemy observed was the aphelinid parasitoid parasitizing the cow bug eggs is *Centrodora* sp. (Hymenoptera: Aphelinidae). The *Centrodora* sp. wasp, a solitary endoparasitoid had no species specificity and found parasitizing eggs of *Otinotus* sp. and *O. apicalis*. Parasitized eggs were differentiated from unparasitized as they took much longer time to hatch and upon hatching the parasitoid formed a distinct round emerging hole and the egg shape remained intact.

**Conflict of interest:** There is no conflict of interest.

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