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## Study of agrobiont spiders in Navsari agricultural university (NAU) campus in relation to their diversity and morphological characteristics

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### Abstract

The present experiment was conducted to study the agrobiont spiders in Navsari Agricultural University campus in relation to their diversity and morphological characteristics (Morphometrics of total body length, width of cephalothorax, length of four legs), at Department of Agricultural Entomology, N. M. College of Agriculture, Navsari Agricultural University, Navsari (Gujarat) India, during January 2017 to December 2017. Total 48 species of agrobiont spiders belongs to 34 genera, from 12 families were recorded from different localities of NAU campus. Among 48 species of agrobiont spiders, the total body length, width of cephalothorax and leg formula of largest species *i.e.* *A. aemula* and *Olios* sp. were  $21.59 \pm 0.23$  mm,  $5.33 \pm 0.20$  mm, 2/1/4/3 and  $18.50 \pm 0.18$  mm,  $7.43 \pm 0.19$  mm, 2/1/4/3 respectively, while *Cyclosa* sp. was the smallest in size with measurement of total body length ( $1.10 \pm 0.11$  mm), width of cephalothorax ( $0.38 \pm 0.05$ ) and leg formula (1/4/2/3).

**Keywords:** Agrobiont spiders, Morphometrics, diversity, Navsari

### 1. Introduction

Spider differ from other arthropods in that the usual body segments are fused into two tagmata, the cephalothorax and abdomen, and joined by a small, cylindrical pedicel. Unlike the insects, spiders do not have antennae. Spiders are divided into two suborders, Mesothelae and Opisthothelae. They are generalist predator, which can act against a broader range of insect pests. Order Araneae (Comprising > 40,000 species) ranks seventh in global diversity after the five largest insect orders (Coleoptera, Hymenoptera, Lepidoptera, Diptera and Hemiptera) (Dean and Sterling [5]). Spiders are divided into two principal groups of forages: "Web-weavers" that spin a catching web and "Hunters" that seize prey without the use of a web (Nyffeler *et al.* [10]). These animals disperse freely by "ballooning" through the atmosphere on silken threads (Produced from abdominal glands) (Dean and Sterling [5]). Worldwide 45,557 spider species described (Uniyal *et al.* [24]) and are estimated to number 60,000-170,000 species (Coddington and Levi [4]). In numbers, 1686 species of 438 genera belongs to 60 families are recorded from India (Keswani *et al.* [6]). Total 415 species belong to 169 genera of 40 families are recorded from Gujarat state (Yadav *et al.* [27]). Few author reported morphological character of spiders. So, to fill up the gap in knowledge about different species of spiders with their morphological characters (total body length, width of cephalothorax, length of four legs) in NAU campus, the present study was done. There is an increasing evidence that polyphagous predators, to which spiders belong, play an important role in the regulation of a number of insects (Whitecomb *et al.* [26], Kiritani [7], Mc Daniel and Sterling [8, 9]).

### 2. Objectives

To study the diversity and morphological characteristics of agrobiont spiders in Navsari Agricultural University campus.

### 3. Materials and Methods

Study on diversity and morphology of agrobiont spiders in NAU campus was carried out by the Department of Agricultural Entomology, N. M. College of Agriculture, Navsari Agricultural University, Navsari, Gujarat, India during January 2017 to December 2017.

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Sampling was done by hand picking and sweep netting. Samples were killed and preserved in 70% alcohol as per recommendation of Tikader [22] and Barrion & Litsinger [1]. Each specimen was examined under zoom, stereoscopic trinocular microscope having 10X eyepiece and 0.7X to 4.5X object lens. Photographs of species and their behavioural patterns were captured with the help of digital camera (Canon Power shot SX160IS). Live specimens from the field were photographed, so that natural colouration and specific behavioural postures can be documented. The taxonomy and nomenclature was followed as per the world spider catalogue given by Platnick [13] for confirming the identification. Apart from that few specimens were sent to Prof. Ramesh Thumar, Assistant Professor, Department of Zoology, B. P. Baria Science College, Navsari, Gujarat for confirmation of specimens. Simultaneously, collections of spiders were also done for measurement of their body length, width of cephalothorax and length of legs with the help of dissecting stereo-trinocular microscope having SCAPE software.

**3.1 Statistical analysis:** The experimental data was analysed statistically by using minimum, maximum values and average  $\pm$  standard deviation (SD) of the length of different body parts.

#### 4. Results

A Total 48 species of agrobiont spiders belongs to 34 genera, from 12 families were recorded from different localities of NAU campus (Table 1). Among 48 species of agrobiont spiders, the total body length, width of cephalothorax and leg formula of largest species *i.e.* *A. aemula* and *Olios* sp. were  $21.59 \pm 0.23$  mm,  $5.33 \pm 0.20$  mm, 2/1/4/3 and  $18.50 \pm 0.18$  mm,  $7.43 \pm 0.19$  mm, 2/1/4/3 respectively, while *Cyclosa* sp. was the smallest in size with measurement of total body length ( $1.10 \pm 0.11$  mm), width of cephalothorax ( $0.38 \pm 0.05$ ) and leg formula (1/4/2/3) (Table 2). The observed species are as follows:

**Class: Arachnida**

**Order: Araneae**

**I. Family: Araneidae**

##### 1. *Argiope anasuja* (Thorell, 1887)

**Description:** Cephalothorax is greyish yellow colour narrowing anteriorly and broad posteriorly covered with grey pubescence. Chelicerae is slender orange in colour. Abdomen is pentagonal, slightly wider than long, pointed posteriorly covered with hair and pubescence. Dorsally in the center is a horizontal black band on either side of which are yellowish white bands, close to the prosoma is a horizontal frilled greyish band, having a posterior black triangular shape. The legs have alternate dark and light black bands with bristles (Image 1).

**Measurements:** Total body length:  $9.31 \pm 0.06$  mm, Width of cephalothorax:  $4.21 \pm 0.07$  mm, Leg formula: 1/2/4/3 (Table 2).

##### 2. *Argiope pulchella* (Thorell, 1881)

**Description:** Cephalothorax is dark yellow and covered with thick layer of pubescence. Alternate white, yellow, black or red coloured parallel bands with spots present on abdomen. The abdomen is broad but ends with sharp tapering distally. Legs long, strong, alternately brown and yellow coloured and covered with hairs and spines (Image 2).

**Measurements:** Total body length:  $12.61 \pm 0.32$  mm, Width of cephalothorax:  $3.61 \pm 0.29$  mm, Leg formula: 1/4/3/2 (Table 2).

##### 3. *Argiope* sp.

**Description:** Cephalothorax is pale yellow with silver hairs, abdomen with silver, yellow, and black striped. Abdomen is more rounded (tapered rearward) than in other *Argiope* species, does not have notches and humps as in that species. Legs are spotted (Image 3).

**Measurements:** Total body length:  $11.83 \pm 0.20$  mm, Width of cephalothorax:  $4.17 \pm 0.23$  mm, Leg formula: 4/1/2/3 (Table 2).

##### 4. *Argiope aemula* (Walckenaer, 1841)

**Description:** Cephalothorax brownish with dirty white pubescence. Abdomen yellow with black stripes, oval shaped and truncated anteriorly. Ventral side brown coloured with yellow parallel lines. Legs are long with sharp spines. Third pair of legs is short than the other three pairs (Image 4).

**Measurements:** Total body length:  $21.59 \pm 0.23$  mm, Width of cephalothorax:  $5.33 \pm 0.20$  mm, Leg formula: 2/1/4/3 (Table 2).

##### 5. *Neoscona mukerjei* (Tikader, 1980)

**Description:** Cephalothorax elongated, yellowish brown in colour and clothed with pubescence and hairs. Chelicerae strong and yellow in colour. Abdomen grey, almost triangular in shape with posterior tapering end and covered with hairs and pubescence. Abdomen with banding pattern mid-longitudinally. Variation in colour and banding pattern is common in this species. Legs are yellow in colour, long and strong, covered with hairs and spines. Transverse bands are seen on distal ends of leg segments except coxa (Image 5).

**Measurements:** Total body length:  $6.73 \pm 0.35$  mm, Width of cephalothorax:  $2.01 \pm 0.11$  mm, Leg formula: 1/2/4/3 (Table 2).

##### 6. *Neoscona theisi* (Walckenaer, 1842)

**Description:** Cephalothorax is yellowish brown with dark brown middle line. Abdomen brownish with mid longitudinally chalk-whitish yellow marking. Legs are yellowish brown in colour (Image 6).

**Measurements:** Total body length:  $4.51 \pm 0.19$  mm, Width of cephalothorax:  $1.43 \pm 0.23$  mm, Leg formula: 4/1/2/3 (Table 2).

##### 7. *Neoscona bengalensis* (Tikader & Bal, 1981)

**Description:** Cephalothorax elongated, covered with thick hairs. Chelicerae very strong. Eight eyes present, anterior median eyes larger than posterior median eyes. Abdomen sub-triangular in shape and brown coloured, covered with white hairs. Legs sclerotized and covered with white hairs (Image 7).

**Measurements:** Total body length:  $12.23 \pm 0.18$  mm, Width of cephalothorax:  $4.35 \pm 0.16$  mm, Leg formula: 1/2/4/3 (Table 2).

##### 8. *Neoscona vigilans* (Blackwall, 1865)

**Description:** Cephalothorax longer than wide, narrowing at

the anterior side, brown, covered with hair. Abdomen slightly triangular, longer than wide, grayish brown with long gray hair. Dorsum marked with white and grayish brown patches and oblique black markings. Legs long and strong, yellowish with few transverse bands (Image 8).

**Measurements:** Total body length:  $7.04 \pm 0.20$  mm, Width of cephalothorax:  $2.93 \pm 0.11$  mm, Leg formula: 1/2/4/3 (Table 2).

#### 9. *Neoscona* sp.1

**Description:** Cephalothorax yellow-brown, brown or grey with a median band. Abdomen yellow-brown, brown or grey, which is covered with white hairs. Colour and markings very variable. Legs are dark with spines (Image 9).

**Measurements:** Total body length:  $6.60 \pm 0.33$  mm, Width of cephalothorax:  $2.75 \pm 0.29$  mm, Leg formula: 1/4/2/3 (Table 2).

#### 10. *Neoscona* sp.2

**Description:** *Neoscona* sp.2 can be distinguished from *Neoscona* species by rusty red color or golden orange color and the lack of pattern on the abdomen. The upper surface of the abdomen is brown and hairy. The legs display alternating light and dark brown bands (Image 10).

**Measurements:** Total body length:  $8.41 \pm 0.34$  mm, Width of cephalothorax:  $2.87 \pm 0.17$  mm, Leg formula: 1/2/4/3 (Table 2).

#### 11. *Pasilobus* sp.

**Description:** It is commonly called bird dung spider. Cephalothorax is wider than long, wider posteriorly, dark brown and covered with hair. Abdomen is large, wider than long, greyish with white and brownish patches. Dorsum has a pair of humps. Legs are short, dark brown and covered with hair (Image 11).

**Measurements:** Total body length:  $7.94 \pm 0.40$  mm, Width of cephalothorax:  $2.79 \pm 0.33$  mm, Leg formula: 1/2/4/3 (Table 2).

#### 12. *Cyclosa confraga* (Thorell, 1892)

**Description:** *C. confraga* is easily recognized by the way it strings together the dead bodies of insects and other debris and hangs it near the center of its web. It hides on this string of debris, and its natural coloration makes it extremely difficult to see until it moves, which is useful to defenses against other predators. Cephalothorax longer than wide, narrowing at the anterior side, brownish yellow and covered with hairs. Abdomen is elongated with three pairs of humps present on it, greyish with white and black patches on it. Legs are long, yellowish with brown patches present on the legs, covered with hairs (Image 12).

**Measurements:** Total body length:  $4.04 \pm 0.14$  mm, Width of cephalothorax:  $0.84 \pm 0.16$  mm, Leg formula: 2/1/4/3 (Table 2).

#### 13. *Cyclosa* sp.

**Description:** Cephalothorax is longer than wide, narrowing at the anterior side and brownish yellow coloured. Abdomen is greyish in colour and spherical in shape. Legs are long and hyaline (Image 13).

**Measurements:** Total body length:  $1.10 \pm 0.11$  mm, Width of cephalothorax:  $0.38 \pm 0.05$  mm, Leg formula: 1/4/2/3 (Table 2).

#### 14. *Cyrtophora cicatrosa* (Stoliczka, 1869)

**Description:** Cephalothorax and legs are yellowish with black markings; abdomen grayish with black spots and a patch distally. A black mid longitudinal and two lateral patches on carapace. Sternum blackish, roughly triangular, pointed behind with white mid longitudinal stripe. Abdomen with two pairs of small black conical humps (Image 14).

**Measurements:** Total body length:  $6.34 \pm 0.19$  mm, Width of cephalothorax:  $1.20 \pm 0.11$  mm, Leg formula: 1/2/3/4 (Table 2).

#### 15. *Eriovixia* sp.

**Description:** Cephalothorax is smaller than the abdomen. Cephalothorax is brownish and covered with cream colour hairs at anterior portion and posterior part with very less hairs. The abdomen is yellowish brown in colour and covered with small hairs. At the center of abdomen two white spots surrounded by ten white spots at margin of abdomen. Total 12 white spots can be seen on the abdomen. Legs moderately long, only the third pair of leg is shorter. Leg have banding pattern with brownish and yellow at joints of the legs (Image 15).

**Measurements:** Total body length:  $2.42 \pm 0.18$  mm, Width of cephalothorax:  $0.78 \pm 0.15$  mm, Leg formula: 1/2/4/3 (Table 2).

#### 16. *Larinia* sp.

**Description:** Cephalothorax is light yellowish colour with brown mid longitudinal line. Opisthosoma has bright longitudinal bands. Dorsally opisthosoma consists of three pairs of dark dots. Legs are completely bright in colour (Image 16).

**Measurements:** Total body length:  $7.12 \pm 0.22$  mm, Width of cephalothorax:  $1.98 \pm 0.10$  mm, Leg formula: 1/2/4/3 (Table 2).

### II. Family: Salticidae

#### 17. *Carrhotus viduus* (Koch, C. L., 1846)

**Description:** It is completely black colored spider. Cephalothorax is black coloured with two white stripes on either side. Abdomen is also black and have two white stripes either side. Legs are black and thick (Image 17).

**Measurements:** Total body length:  $7.64 \pm 0.23$  mm, Width of cephalothorax:  $2.65 \pm 0.09$  mm, Leg formula: 1/2/3/4 (Table 2).

#### 18. *Epeus indicus* (Proszynski, 1992)

**Description:** Cephalothorax is roughly spherical and light green in colour. Eight eyes are arranged in four rows, ocular area covered with white-brown setae and bright orange setae are present abundantly around the eyes. Abdomen is pointed, usually pale green to dull black colour with two rows of white spots present longitudinally. Legs are long, slender and banded in appearance (Image 18).

**Measurements:** Total body length:  $6.74 \pm 0.41$  mm, Width of cephalothorax:  $2.34 \pm 0.32$  mm, Leg formula: 1/3/4/2 (Table 2).

**19. *Plexippus paykulli* (Audouin, 1826)**

**Description:** Cephalothorax dorsally brown with black hairs, sides sandy with black margins, in lower half with white hairs. Abdomen sandy, with dorsal white median band which is widened T-like in the posterior third. Abdomen oval with a narrowing tip, pale beige (greyish-brown) colour. Legs long, covered with hairs and spines and with black small lines (Image 19).

**Measurements:** Total body length:  $7.10 \pm 0.12$  mm, Width of cephalothorax:  $2.86 \pm 0.17$  mm, Leg formula: 1/4/2/3 (Table 2).

**20. *Phintella vittata* (Koch, C. L., 1846)**

**Description:** Cephalothorax small, almost spherical with two broad black lines on bluish-white iridescent body. Eight eyes present, ocular region covered with iridescent setae. Abdomen almost rounded having alternate black bands on bluish- white iridescent body. A semi-circular black spot is present near the spinnerets. Legs are slender and small (Image 20).

**Measurements:** Total body length:  $2.94 \pm 0.14$  mm, Width of cephalothorax:  $1.06 \pm 0.07$  mm, Leg formula: 4/3/1/2 (Table 2).

**21. *Chrysilla volupe* (Karsch, 1879)**

**Description:** Its Cephalothorax is orange-red, with a narrow bluish-white, iridescent transverse stripe between the eyes. The long scutum of the Abdomen is dark brown and covered with dense, bronze-colored hairs. The long legs are brownish-yellow, with the first pair, and the last segments of the others brown (Image 21).

**Measurements:** Total body length:  $3.75 \pm 0.14$  mm, Width of cephalothorax:  $1.76 \pm 0.12$  mm, Leg formula: 1/4/3/2 (Table 2).

**22. Unknown sp.1 (Salticidae)**

**Description:** Cephalothorax generally wider or broader than the abdomen. It is brownish in colour with black markings on all over body. Legs are covered with light brown and dark brown hairs which shows banding like appearance (Image 22).

**Measurements:** Total body length:  $3.94 \pm 0.00$  mm, Width of cephalothorax:  $1.43 \pm 0.00$  mm, Leg formula: 4/2/3/1 (Table 2).

**23. *Pristobaeus* sp.**

**Description:** Cephalothorax brown, with two rows of whitish small hairs, reddish brown in between. Legs I dark brown, II to IV light brown, slightly darkly annulated. Abdomen brown-black, with fine, dashed, black lateral line, sometimes with broken black median line, between these lines grey to light brown (Image 23).

**Measurements:** Total body length:  $4.06 \pm 0.50$  mm, Width of cephalothorax:  $1.59 \pm 0.51$  mm, Leg formula: 4/1/3/2 (Table 2).

**24. *Evarcha falcate* (Clerck, 1757)**

**Description:** Cephalothorax is dark brown to black in colour and presence of light hairs. Abdomen is oval in shape, black in colour with mid longitudinal thick white band. Legs are dark brown to black in colour with hairs (Image 24).

**Measurements:** Total body length:  $7.98 \pm 0.00$  mm, Width of cephalothorax:  $2.78 \pm 0.00$  mm, Leg formula: 1/2/4/3 (Table 2).

**25. Unknown sp.2 (Salticidae)**

**Description:** Cephalothorax is dark brown to black in colour with two light band at posterior side of cephalothorax. Abdomen is black in colour with white marking, oval in shape and pointed posteriorly. Legs are light brown in colour with black band (Image 25).

**Measurements:** Total body length:  $6.52 \pm 0.20$  mm, Width of cephalothorax:  $2.42 \pm 0.18$  mm, Leg formula: 4/1/3/2 (Table 2).

**26. *Cosmophasis* sp.**

**Description:** The cephalothorax is a broad oval, longer than wide with half-moon shaped marking. The abdomen is oval with the anterior somewhat truncate. The abdomen is covered with black-bronze hairs with a white transverse marks anteriorly. Legs are long and slender (Image 26).

**Measurements:** Total body length:  $4.08 \pm 0.00$  mm, Width of cephalothorax:  $1.92 \pm 0.00$  mm, Leg formula: 4/3/1/2 (Table 2).

**27. *Telamonia dimidiata* (Simon, 1899)**

**Description:** Cephalothorax elongated, large, slender and pale cream coloured. Eight eyes present, anterior median are larger than the others. Ocular area with characteristic black patches along with brown hairs. Abdomen elongated and pointed posteriorly, cream coloured with two orange lines on dorsal surface. Legs are long and lighter in colour (Image 27).

**Measurements:** Total body length:  $8.59 \pm 0.21$  mm, Width of cephalothorax:  $3.37 \pm 0.15$  mm, Leg formula: 3/4/1/2 (Table 2).

**28. *Menemerus bivittatus* (Dufour, 1831)**

**Description:** Colour is grey dorsally, the cephalothorax edged with a thin white stripe laterally, the semifoliar grey abdomen is edged with broad black stripes on each side which meet posteriorly. Legs are covered with hairs and shows white and brown rings (Image 28).

**Measurements:** Total body length:  $3.58 \pm 0.16$  mm, Width of cephalothorax:  $1.09 \pm 0.09$  mm, Leg formula: 4/3/1/2 (Table 2).

**29. *Siler* sp.**

**Description:** Cephalothorax pattern comprising red between dorsal and lateral blue stripe. Abdomen densely covered with blue spots embedded in red patch, distally grey. Legs are light brown (Image 29).

**Measurements:** Total body length:  $3.07 \pm 0.00$  mm, Width of cephalothorax:  $1.05 \pm 0.00$  mm, Leg formula: 4/1/3/2 (Table 2).

**30. *Rhene* sp.**

**Description:** Pale yellowish colour abdomen, Cephalothorax is metallic brown in colour and it is wider than the length. Legs are dark brown colour. Brown eyes, with anterior row of eyes recurved (Image 30).

**Measurements:** Total body length:  $4.54 \pm 0.09$  mm, Width of cephalothorax:  $2.03 \pm 0.12$  mm, Leg formula: 1/2/4/3 (Table 2).

### III. Family: Oxyopidae

#### 31. *Oxyopes javanus* (Thorell, 1887)

**Description:** Dorsal surface of the cephalothorax with a pale V-shaped mark. Brownish patches present on the lateral side of cephalothorax. Heart shaped yellowish brown sternum present. A dark brown line extends from the anterior median eye to chelicerae. Chelicerae yellowish brown. Abdomen elongated with dark brown lateral sides and median white patch. Legs long, covered with spines and with black line on ventral sides (Image 31).

**Measurements:** Total body length:  $5.18 \pm 0.12$  mm, Width of cephalothorax:  $2.21 \pm 0.09$  mm, Leg formula: 1/4/2/3 (Table 2).

#### 32. *Oxyopes sunandae* (Tikader, 1970)

**Description:** Cephalothorax is yellowish in colour, longer than wide and convex. Two black stripes extending from anterior median eyes to near the base of fangs of chelicerae. Abdomen is reddish brown in colour, anterior with a mid-dorsal lance shaped yellowish-brown patch, laterally provided with light longitudinal lines. Legs are light colored with spines (Image 32).

**Measurements:** Total body length:  $6.58 \pm 0.21$  mm, Width of cephalothorax:  $2.48 \pm 0.16$  mm, Leg formula: 1/2/4/3 (Table 2).

#### 33. *Oxyopes* sp.

**Description:** Body colour yellowish to light brown with white pattern. Abdomen is characteristically pointed with dorsal pattern that extends on whole abdomen and cephalothorax while legs are yellowish brown with long spines (Image 33).

**Measurements:** Total body length:  $8.13 \pm 0.18$  mm, Width of cephalothorax:  $2.47 \pm 0.10$  mm, Leg formula: 2/1/4/3 (Table 2).

#### 34. *Oxyopes birmanicus* (Thorell, 1887)

**Description:** Cephalothorax slightly elongated and brown to yellow in colour. Ocular region brownish yellow in colour with two distinct longitudinal black lines running from anterior median eyes towards mandibles. Abdomen pale brown in colour, elongated with tapering posterior end and covered with hairs. Dorsal surface of abdomen with distinctive patterns. Legs are long and covered with distinct spines (Image 34).

**Measurements:** Total body length:  $6.61 \pm 0.13$  mm, Width of cephalothorax:  $2.48 \pm 0.12$  mm, Leg formula: 1/2/4/3 (Table 2).

### IV. Family: Clubionidae

#### 35. *Clubiona* sp.

**Description:** Cephalothorax yellowish, lateral margin slightly darker and anterior end narrowed. Abdomen longer than wide, somewhat oval, but posterior half narrowed. Dorsum brownish-grey without any dark markings or patches, uniformly covered with fine hairs. Legs pale yellowish, similar to cephalothorax in colour (Image 35).

**Measurements:** Total body length:  $12.33 \pm 0.12$  mm, Width of cephalothorax:  $3.22 \pm 0.12$  mm, Leg formula: 1/4/2/3 (Table 2).

#### 36. *Clubiona drassodes* (Cambridge, O. P., 1874)

**Description:** Cephalothorax slightly elongated, yellow in colour and covered with fine hairs. Eight eyes present, anterior row of eyes shorter than posterior row, posterior median eyes are larger than the other pairs. Abdomen elongated, oval with narrow posterior end, yellowish to brownish-grey in colour and dark brown pattern seen at the end of abdomen (Image 36).

**Measurements:** Total body length:  $9.52 \pm 0.11$  mm, Width of cephalothorax:  $2.64 \pm 0.11$  mm, Leg formula: 1/4/2/3 (Table 2).

#### 37. *Cheiracanthium punctorium* (Villers, 1789)

**Description:** Yellow sac spider (*C. punctorium*) are typically cream to light yellow in colour. A distinctive darker lance-shaped mark runs down the midline of the forward portion of the upper surface of the abdomen. Their chelicerae, tarsi, and pedipalps are dark brown. The front pair of legs in particular are longer and are used in capturing prey (Image 37).

**Measurements:** Total body length:  $8.29 \pm 0.19$  mm, Width of cephalothorax:  $2.29 \pm 0.22$  mm, Leg formula: 1/4/2/3 (Table 2).

### V. Family: Tetragnathidae

#### 38. *Tetragnatha mandibulata* (Walckenaer, 1842)

**Description:** *T. mandibulata* is commonly called long jawed spider. Cephalothorax yellowish brown in colour. Eight eyes are arranged in two rows. Abdomen yellowish brown, elongated with a posterior rounded tip. It is stick-like spiders with long legs and well-developed jaws (Image 38).

**Measurements:** Total body length:  $8.13 \pm 0.16$  mm, Width of cephalothorax:  $2.08 \pm 0.11$  mm, Leg formula: 1/4/2/3 (Table 2).

#### 39. *Tetragnatha* sp.

**Description:** Cephalothorax is dark brown to almost black. Chelicerae dark brown, basally with distinct tubercle. Abdomen is dark brown to almost black, which is laterally flanked with silver-white and medially also with silver spots. Legs are long and dark brown (Image 39).

**Measurements:** Total body length:  $7.85 \pm 0.14$  mm, Width of cephalothorax:  $1.76 \pm 0.16$  mm, Leg formula: 1/4/2/3 (Table 2).

### VI. Family: Sparassidae

#### 40. *Heteropoda venatoria* (Linnaeus, 1767)

**Description:** It is also known as the giant crabspider. Cephalothorax yellowish brown in colour. A distinct white line is seen above chelicerae and below eyes. Broad black band seen on the carapace. Eight eyes present, arranged in two rows. Large strong chelicerae present. Abdomen oval shaped and yellowish brown in colour. Legs are strong and covered with spines which is marked with black dots. While, Second pair of legs is the longest (Image 40).

**Measurements:** Total body length:  $16.53 \pm 0.11$  mm, Width of cephalothorax:  $5.74 \pm 0.10$  mm, Leg formula: 2/1/4/3 (Table 2).

**41. *Olios* sp.**

**Description:** It is large sized spider. *Olios* sp. as having light grey cephalothorax with a faint cross and pale buff-golden convex abdomen with median black-colored patch along the middle. Legs have distinctive barring pattern, each with three black-speckled white bands and four alternating black bands, black band on metatarsi being the larger (Image 41).

**Measurements:** Total body length:  $18.50 \pm 0.18$  mm, Width of cephalothorax:  $7.43 \pm 0.19$  mm, Leg formula: 2/1/4/3 (Table 2).

**VII. Family: Theridiidae****42. *Theridion* sp.**

**Description:** It is small sized spider. Longer cephalothorax than the width. Eyes are sub-equal in size. Abdomen is dark brown with black and white pattern and spherical in shape. Legs are long (Image 42).

**Measurements:** Total body length:  $1.56 \pm 0.14$  mm, Width of cephalothorax:  $0.58 \pm 0.13$  mm, Leg formula: 1/2/4/3 (Table 2).

**43. *Steatoda* sp.**

**Description:** Cephalothorax is light orange coloured without any markings. Abdomen is orange-brown, often with white line around anterior side and white markings. Legs are orange and thin with dark brown joints (Image 43).

**Measurements:** Total body length:  $2.14 \pm 0.14$  mm, Width of cephalothorax:  $0.65 \pm 0.16$  mm, Leg formula: 1/2/3/4 (Table 2).

**VIII. Family: Thomisidae****44. *Thomisus* sp.**

**Description:** Commonly it is known as crab spider due to its crab like appearance. Cephalothorax light brown in colour. Eyes round, black, ocular area chalk-white and a transverse yellow line from left lateral eyes to right laterals. Abdomen chalk-white, nearly round, slightly overlapping the posterior region of cephalothorax in front, broadest just behind the middle with two black spots. Legs are long and stout, I and II longer than III and IV legs (Image 44).

**Measurements:** Total body length:  $5.11 \pm 0.16$  mm, Width of cephalothorax:  $2.33 \pm 0.11$  mm, Leg formula: 1/2/4/3 (Table 2).

**IX. Family: Uloboridae****45. *Uloborus plumipes* (Lucas, 1846)**

**Description:** Posterior median eyes of moderate size and not directed forward but upward. Cephalothorax is longer than wide with two rows of eyes. Cephalothorax is densely haired, without pronounced longitudinal stripes. Legs covered with whitish hairs. Abdomen is light coloured with darker median line, densely haired and dorsally with two humps in anterior part (Image 45).

**Measurements:** Total body length:  $3.39 \pm 0.26$  mm, Width of cephalothorax:  $0.93 \pm 0.17$  mm, Leg formula: 1/4/2/3 (Table 2).

**X. Family: Lycosidae****46. *Lycosa* sp.**

**Description:** Species belonging to this group commonly called wolf spiders. Cephalothorax is light brown in colour and narrow at anterior side while broad at posterior side. Abdomen is dark brown in colour and blunt at posterior side. Legs are long, strong and light brown in colour (Image 46).

**Measurements:** Total body length:  $5.05 \pm 0.15$  mm, Width of cephalothorax:  $2.43 \pm 0.14$  mm, Leg formula: 4/1/2/3 (Table 2).

**XI. Family: Hersiliidae****47. *Hersilia savignyi* (Lucas, 1836)**

**Description:** Cephalothorax circular, flattened and broad. Anterior lateral eyes are present making an angle in between the anterior and the posterior median eyes. Abdomen almost circular, flattened and broad. Midlongitudinally a greyish black line covers the abdomen along with lateral white patches. Abdomen greyish in colour but often remains camouflaged with that of the background substrate. Posterior spinneret as long as the abdomen. Legs are long, slender, and annulated with dark rings. Third pair of leg is the shortest (Image 47).

**Measurements:** Total body length:  $8.19 \pm 0.21$  mm, Width of cephalothorax:  $3.31 \pm 0.14$  mm, Leg formula: 2/1/4/3 (Table 2).

**XII. Family: Scytodidae****48. *Scytodes thoricica* (Latreille, 1802)**

**Description:** Cephalothorax almost as large as abdomen. Cephalothorax is pale yellowish, with black pattern. Abdomen is pale yellowish, with pairs of black patches on midline, and small black blotches on the side. Legs are pale yellowish (Image 48).

**Measurements:** Total body length:  $4.28 \pm 0.12$  mm, Width of cephalothorax:  $2.10 \pm 0.14$  mm, Leg formula: 1/4/2/3 (Table 2).

**Table 1:** Species distribution of agrobiont spiders in NAU campus

Sr. No.	Family	Genera	No. of Species
1.	Araneidae	7	16
2.	Salticidae	14	14
3.	Oxyopidae	1	4
4.	Clubionidae	2	3
5.	Tetragnathidae	1	2
6.	Sparassidae	2	2
7.	Theridiidae	2	2
8.	Thomisidae	1	1
9.	Uloboridae	1	1
10.	Lycosidae	1	1
11.	Hersiliidae	1	1
12.	Scytodidae	1	1
Total		34	48



**Table 2:** Morphometric variation of different spider species

Sr. No.	Species of spiders	Body length (mm)	Cephalo- thorax width (mm)	Length of legs (mm)			
				1 <sup>st</sup> leg	2 <sup>nd</sup> leg	3 <sup>rd</sup> leg	4 <sup>th</sup> leg
		Av. $\pm$ SD	Av. $\pm$ SD	Av. $\pm$ SD	Av. $\pm$ SD	Av. $\pm$ SD	Av. $\pm$ SD
1.	<i>A. anasuja</i>	9.31 $\pm$ 0.06	4.21 $\pm$ 0.07	22.22 $\pm$ 0.05	21.48 $\pm$ 0.41	17.53 $\pm$ 0.33	20.66 $\pm$ 0.42
2.	<i>A. pulchella</i>	12.61 $\pm$ 0.32	3.61 $\pm$ 0.29	20.32 $\pm$ 0.38	10.49 $\pm$ 0.37	13.46 $\pm$ 0.27	19.32 $\pm$ 0.39
3.	<i>Argiope</i> sp.	11.83 $\pm$ 0.20	4.17 $\pm$ 0.23	22.11 $\pm$ 0.39	21.76 $\pm$ 0.31	17.36 $\pm$ 0.46	22.64 $\pm$ 0.29
4.	<i>A. aemula</i>	21.59 $\pm$ 0.23	5.33 $\pm$ 0.20	17.01 $\pm$ 0.30	18.44 $\pm$ 0.31	9.26 $\pm$ 0.23	13.37 $\pm$ 0.32
5.	<i>N. mukerjei</i>	6.73 $\pm$ 0.35	2.01 $\pm$ 0.11	8.36 $\pm$ 0.28	7.69 $\pm$ 0.28	5.33 $\pm$ 0.22	6.96 $\pm$ 0.13
6.	<i>N. theisi</i>	4.51 $\pm$ 0.19	1.43 $\pm$ 0.23	6.21 $\pm$ 0.19	5.87 $\pm$ 0.15	4.15 $\pm$ 0.23	6.66 $\pm$ 0.21
7.	<i>N. bengalensis</i>	12.23 $\pm$ 0.18	4.35 $\pm$ 0.16	18.45 $\pm$ 0.21	17.52 $\pm$ 0.38	10.69 $\pm$ 0.47	15.53 $\pm$ 0.39
8.	<i>N. vigilans</i>	7.04 $\pm$ 0.20	2.93 $\pm$ 0.11	8.50 $\pm$ 0.13	8.23 $\pm$ 0.10	5.60 $\pm$ 0.14	7.43 $\pm$ 0.15
9.	<i>Neoscona</i> sp.1	6.60 $\pm$ 0.33	2.75 $\pm$ 0.29	12.67 $\pm$ 0.14	10.80 $\pm$ 0.23	7.21 $\pm$ 0.22	11.26 $\pm$ 0.23
10.	<i>Neoscona</i> sp.2	8.41 $\pm$ 0.34	2.87 $\pm$ 0.17	12.21 $\pm$ 0.25	11.65 $\pm$ 0.33	6.18 $\pm$ 0.09	10.73 $\pm$ 0.20
11.	<i>Pasilobus</i> sp.	7.94 $\pm$ 0.40	2.79 $\pm$ 0.33	7.91 $\pm$ 0.28	7.70 $\pm$ 0.36	5.09 $\pm$ 0.19	6.81 $\pm$ 0.30
12.	<i>C. confraga</i>	4.04 $\pm$ 0.14	0.84 $\pm$ 0.16	3.14 $\pm$ 0.21	3.16 $\pm$ 0.13	2.00 $\pm$ 0.12	2.72 $\pm$ 0.12
13.	<i>Cyclosa</i> sp.	1.10 $\pm$ 0.11	0.38 $\pm$ 0.05	1.26 $\pm$ 0.14	1.14 $\pm$ 0.12	0.96 $\pm$ 0.08	1.20 $\pm$ 0.14
14.	<i>C. cicatrosa</i>	6.34 $\pm$ 0.19	1.20 $\pm$ 0.11	4.06 $\pm$ 0.15	3.37 $\pm$ 0.20	3.27 $\pm$ 0.16	2.44 $\pm$ 0.18
15.	<i>Eriovixia</i> sp.	2.42 $\pm$ 0.18	0.78 $\pm$ 0.15	2.73 $\pm$ 0.15	2.48 $\pm$ 0.17	1.80 $\pm$ 0.16	2.19 $\pm$ 0.13
16.	<i>Larinia</i> sp.	7.12 $\pm$ 0.22	1.98 $\pm$ 0.10	10.14 $\pm$ 0.25	9.35 $\pm$ 0.10	6.09 $\pm$ 0.12	9.32 $\pm$ 0.17
17.	<i>C. viduus</i>	7.64 $\pm$ 0.23	2.65 $\pm$ 0.09	8.94 $\pm$ 0.13	7.47 $\pm$ 0.14	7.05 $\pm$ 0.10	6.95 $\pm$ 0.12
18.	<i>E. indicus</i>	6.74 $\pm$ 0.41	2.34 $\pm$ 0.32	9.05 $\pm$ 0.24	6.17 $\pm$ 0.22	8.85 $\pm$ 0.20	8.17 $\pm$ 0.25
19.	<i>P. paykulli</i>	7.10 $\pm$ 0.12	2.86 $\pm$ 0.17	6.31 $\pm$ 0.15	5.92 $\pm$ 0.16	5.87 $\pm$ 0.18	5.99 $\pm$ 0.12
20.	<i>P. vittata</i>	2.94 $\pm$ 0.14	1.06 $\pm$ 0.07	2.40 $\pm$ 0.13	2.16 $\pm$ 0.11	2.95 $\pm$ 0.14	3.32 $\pm$ 0.09
21.	<i>C. volupe</i>	3.75 $\pm$ 0.14	1.76 $\pm$ 0.12	3.01 $\pm$ 0.09	2.76 $\pm$ 0.16	2.82 $\pm$ 0.14	2.92 $\pm$ 0.08
22.	Unknown sp.1 (Salticidae)	3.94 $\pm$ -	1.43 $\pm$ -	2.24 $\pm$ -	2.60 $\pm$ -	2.25 $\pm$ -	2.78 $\pm$ -
23.	<i>Pristobaeus</i> sp.	4.06 $\pm$ 0.50	1.59 $\pm$ 0.51	4.00 $\pm$ 0.37	3.74 $\pm$ 0.27	3.79 $\pm$ 0.24	4.11 $\pm$ 0.49
24.	<i>E. falcate</i>	7.98 $\pm$ -	2.78 $\pm$ -	5.22 $\pm$ -	5.20 $\pm$ -	5.11 $\pm$ -	5.17 $\pm$ -
25.	Unknown sp.2 (Salticidae)	6.52 $\pm$ 0.20	2.42 $\pm$ 0.18	6.41 $\pm$ 0.29	6.00 $\pm$ 0.16	6.15 $\pm$ 0.18	6.47 $\pm$ 0.13
26.	<i>Cosmophasis</i> sp.	4.08 $\pm$ -	1.92 $\pm$ -	3.96 $\pm$ -	3.50 $\pm$ -	4.66 $\pm$ -	4.93 $\pm$ -
27.	<i>T. dimidiata</i>	8.59 $\pm$ 0.21	3.37 $\pm$ 0.15	4.83 $\pm$ 0.11	4.63 $\pm$ 0.13	4.92 $\pm$ 0.10	4.89 $\pm$ 0.10
28.	<i>M. bivittatus</i>	3.58 $\pm$ 0.16	1.09 $\pm$ 0.09	2.35 $\pm$ 0.11	2.30 $\pm$ 0.12	2.39 $\pm$ 0.12	3.13 $\pm$ 0.08
29.	<i>Siler</i> sp.	3.07 $\pm$ -	1.05 $\pm$ -	2.87 $\pm$ -	2.42 $\pm$ -	2.78 $\pm$ -	3.50 $\pm$ -
30.	<i>Rhene</i> sp.	4.54 $\pm$ 0.09	2.03 $\pm$ 0.12	3.21 $\pm$ 0.11	3.18 $\pm$ 0.17	3.01 $\pm$ 0.09	3.14 $\pm$ 0.11
31.	<i>O. javanus</i>	5.18 $\pm$ 0.12	2.21 $\pm$ 0.09	8.84 $\pm$ 0.08	8.71 $\pm$ 0.12	6.47 $\pm$ 0.10	8.75 $\pm$ 0.07
32.	<i>O. sunandae</i>	6.58 $\pm$ 0.21	2.48 $\pm$ 0.16	14.37 $\pm$ 0.10	12.67 $\pm$ 0.10	10.03 $\pm$ 0.11	12.04 $\pm$ 0.10
33.	<i>Oxyopes</i> sp.	8.13 $\pm$ 0.18	2.47 $\pm$ 0.10	11.31 $\pm$ 0.12	13.55 $\pm$ 0.10	8.17 $\pm$ 0.15	10.85 $\pm$ 0.12
34.	<i>O. birmanicus</i>	6.61 $\pm$ 0.13	2.48 $\pm$ 0.12	15.09 $\pm$ 0.13	15.04 $\pm$ 0.11	9.86 $\pm$ 0.12	12.50 $\pm$ 0.11
35.	<i>Clubiona</i> sp.	12.33 $\pm$ 0.12	3.22 $\pm$ 0.12	15.61 $\pm$ 0.40	12.47 $\pm$ 0.12	8.55 $\pm$ 0.10	14.02 $\pm$ 0.12
36.	<i>C. drassodes</i>	9.52 $\pm$ 0.11	2.64 $\pm$ 0.11	13.60 $\pm$ 0.11	9.86 $\pm$ 0.08	8.36 $\pm$ 0.12	12.04 $\pm$ 0.12
37.	<i>C. punctorium</i>	8.29 $\pm$ 0.19	2.29 $\pm$ 0.22	10.87 $\pm$ 0.12	8.35 $\pm$ 0.13	6.66 $\pm$ 0.15	9.68 $\pm$ 0.13
38.	<i>T. mandibulata</i>	8.13 $\pm$ 0.16	2.08 $\pm$ 0.11	28.60 $\pm$ 0.36	18.47 $\pm$ 0.31	15.33 $\pm$ 0.14	19.24 $\pm$ 0.20
39.	<i>Tetragnatha</i> sp.	7.85 $\pm$ 0.14	1.76 $\pm$ 0.16	26.83 $\pm$ 0.20	15.47 $\pm$ 0.16	8.37 $\pm$ 0.22	16.06 $\pm$ 0.21
40.	<i>H. venatoria</i>	16.53 $\pm$ 0.11	5.74 $\pm$ 0.10	19.42 $\pm$ 0.11	20.52 $\pm$ 0.11	17.42 $\pm$ 0.19	18.88 $\pm$ 0.10
41.	<i>Olios</i> sp.	18.50 $\pm$ 0.18	7.43 $\pm$ 0.19	29.10 $\pm$ 0.21	31.58 $\pm$ 0.17	22.41 $\pm$ 0.13	24.56 $\pm$ 0.21
42.	<i>Theridion</i> sp.	1.56 $\pm$ 0.14	0.58 $\pm$ 0.13	3.17 $\pm$ 0.12	2.96 $\pm$ 0.08	1.33 $\pm$ 0.09	2.42 $\pm$ 0.13
43.	<i>Steatoda</i> sp.	2.14 $\pm$ 0.14	0.65 $\pm$ 0.16	2.35 $\pm$ 0.16	1.52 $\pm$ 0.16	1.42 $\pm$ 0.16	1.40 $\pm$ 0.18
44.	<i>Thomisus</i> sp.	5.11 $\pm$ 0.16	2.33 $\pm$ 0.11	8.78 $\pm$ 0.11	8.00 $\pm$ 0.15	3.79 $\pm$ 0.12	4.23 $\pm$ 0.13
45.	<i>U. plumipes</i>	3.39 $\pm$ 0.26	0.93 $\pm$ 0.17	5.14 $\pm$ 0.18	4.04 $\pm$ 0.17	3.43 $\pm$ 0.15	5.11 $\pm$ 0.15
46.	<i>Lycosa</i> sp.	5.05 $\pm$ 0.15	2.43 $\pm$ 0.14	7.27 $\pm$ 0.13	7.18 $\pm$ 0.10	6.80 $\pm$ 0.14	9.85 $\pm$ 0.11
47.	<i>H. savignyi</i>	8.19 $\pm$ 0.21	3.31 $\pm$ 0.14	18.02 $\pm$ 0.17	18.79 $\pm$ 0.13	10.69 $\pm$ 0.16	16.32 $\pm$ 0.12
48.	<i>S. thoricica</i>	4.28 $\pm$ 0.12	2.10 $\pm$ 0.14	9.96 $\pm$ 0.15	7.99 $\pm$ 0.13	6.37 $\pm$ 0.12	8.76 $\pm$ 0.16

Img 1: *A. anasuja*Img 2: *A. pulchella*Img 3: *Argiope* sp.



Img 4: *A. aemula*



Img 5: *N. mukerjei*



Img 6: *N. theisi*



Img 7: *N. bengalensis*



Img 8: *N. vigilans*



Img 9: *Neoscona* sp.1



Img 10: *Neoscona* sp.2



Img 11: *Pasilobus* sp.



Img 12: *C. confraga*



Img 13: *Cyclosa* sp.



Img 14: *C. cicatrosa*



Img 15: *Eriovixia* sp.



Img 16: *Larinia* sp.


















Img 17: *C. viduus*



Img 18: *E. indicus*



		
Img 19: <i>P. paykulli</i>	Img 20: <i>P. vittata</i>	Img 21: <i>C. volupe</i>
		
Img 22: Unknown sp.1	Img 23: <i>Pristobaeus</i> sp.	Img 24: <i>E. falcate</i>
		
Img 25: Unknown sp.2	Img 26: <i>Cosmophasis</i> sp.	Img 27: <i>T. dimidiata</i>
		
Img 28: <i>M. bivittatus</i>	Img 29: <i>Siler</i> sp.	Img 30: <i>Rhene</i> sp.
		
Img 31: <i>O. javanus</i>	Img 32: <i>O. sunandae</i>	Img 33: <i>Oxyopes</i> sp.





Img 34: *O. birmanicus*



Img 35: *Clubiona* sp.



Img 36: *C. drassodes*



Img 37: *C. punctorium*



Img 38: *T. mandibulata*



Img 39: *Tetragnatha* sp.



Img 40: *H. venatoria*



Img 41: *Olios* sp.



Img 42: *Theridion* sp.



Img 43: *Steatoda* sp.



Img 44: *Thomisus* sp.



Img 45: *U. plumipes*



Img 46: *Lycosa* sp.



Img 47: *H. savignyi*



Img 48: *S. thoricica*

## 5. Discussion

The present findings are in agreement with consulting the literature published by Tikader <sup>[19-22]</sup>, Tikader and Biswas <sup>[23]</sup> and Sebastian and Peter <sup>[15]</sup>. The present morphometric description of the various agrobiont spiders were more or less similar in accordance with Sugumaran <sup>[17]</sup>, Peng and Li <sup>[11]</sup>, Biswas and Ray <sup>[2]</sup>, Perveen and Jamal <sup>[12]</sup>, Sen *et al.* <sup>[16]</sup>, Suvak <sup>[18]</sup>, Caleb and Mathai <sup>[3]</sup>, Saha *et al.* <sup>[14]</sup> and Vijaya *et al.* <sup>[25]</sup>. The slight difference with present values may be due to difference in habitat, climatic condition and prey diversity. Total 415 species belong to 169 genera of 40 families are recorded from Gujarat state (Yadav *et al.*) <sup>[27]</sup>.

## 6. Conclusion

From the above mentioned results, it becomes clear that NAU campus consisting huge diversity of agrobiont spiders which gives 48 species among them *A. aemula* and *Olios* sp. were largest in size, while *Cyclosa* sp. was the smallest in size with measurement of total body length, width of cephalothorax and length of legs.

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