



RESEARCH ARTICLE

SEXUAL SIZE DIMORPHISM (SSD) AND MORPHOMETRIC ANALYSIS OF ARGIOPE ANASUJA
(SIGNATURE SPIDER) OF SOUTH BANGALORE, KARNATAKA

*¹Jalajakshi, S. and *²Vinutha, C.

¹Department of Genetics Vijaya College Basavanagudi Bangalore, India

²Department of Zoology Vijaya College Basavanagudi Bangalore, India

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ABSTRACT

The morphology of spider *Argiope anasuja* (Thorell 1887) has been described by many authors. Its distribution is from India, Pakistan to Maldives. In the present study the sexual dimorphism, morphometry, structure of female epigynum and male pedipalp has been described. The morphometric analysis revealed that females are four times larger than males. This sexual size dimorphism has evolved due to differences in adult life style and also selection, which focuses on early maturity, as explained and quoted by many researchers.

Key words:

Argiope anasuja,

Sexual Size Dimorphism,

Morphometry,

Pedipalp and Epigynum

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INTRODUCTION

The spiders are worldwide in distribution, our knowledge of Indian spider fauna is extremely fragmentary. Tikader published the first comprehensive list of Indian spiders in 1987. He has included nearly 1067 species belonging to 249 genera in 43 families. *Argiope* species are famous for their colourful opisthosomal patterns of the showy females and the strong sexual size and colour dimorphism (Levy1983). *Argiope* species are also known for their sexual cannibalism. Amongst the 42,055 species discovered till date (Platnick N.I. 1976, 1977), *Argiope anasuja* belongs to the family Araneidae consisting of 168 genus and 3006 species. The giant cross spider also known as 'Signature spider' has attractive eyes due to its fluorescent colors; and the standard peculiarity of X shaped arrangement of its limbs when at rest or in a stance waiting for the prey is solely enough to identify this species. *Argiope anasuja* bears eight legs arising from the cephalothorax and the abdomen separated by a delicate pedicel as described by Kulkarni S.S. and Deshpande V.Y. 2011.

MATERIALS AND METHODS

The selected study area is surrounding Turahalli forest, located in the south of Bangalore, off Kanakapura road nearly 8 km. from the Banashankari temple. It is a deciduous forest spread

across 514 acres of land, given its rich verdant texture by eucalyptus groves, other wild shrubs and trees. The forest area is blessed by flora and fauna which includes - jackals, hare, peacocks, monitor-lizards, mongoose, variety of migratory birds and large many species of spiders. In the present study, 6 females and 5 males were captured by hand collection method.

Temperature

The temperature ranges from a minimum 23^o C to 45^o C during summer and from 15^o C to 19^o C during winter. Males and females of *Argiope anasuja* were collected from this forest by hand collection method. The collected specimens were brought to lab and photographed using a digital camera. The specimens were stored in 70% alcohol. Identification has been done by key to identification to south Indian spiders. In the present study morphometric analysis, sexual dimorphism, structure of male pedipalp and female epigynum has been carried out using stereozoom microscope. (Labomed make)

Observation and Results

Morphological Description

Argiope anasuja female

General: Prosoma - 3.99 mm in length and 3.93 mm width.

Opisthosoma - 5.53 mm length and 6.02 mm width

Total body length - 9.52 mm,

Total length of - Leg1 - 23.70 mm, Leg2 - 23.45 mm, Leg3 - 14.79 mm, Leg4 - 21.60 mm.

*Corresponding authors: ¹Jalajakshi, S. and *²Vinutha, C.

¹Department of Genetics Vijaya College Basavanagudi Bangalore

²Department of Zoology Vijaya College Basavanagudi Bangalore

Prosoma: Greyish yellow colour slightly longer than wide, (3.99 mm length and 3.93 mm width) narrowing anteriorly and broad posteriorly covered with grey pubescence. Dorsally, black lines radiate from posterior median position towards anterior end. Three pairs of eyes arranged compactly in the anterior region of the carapace with two small median, just behind it a pair of large median and two lateral large eyes. Ventrally, the prosomal sternum is yellow in colour with striking black coxal segments of the legs a Chelicerae is slender orangish in colour, promargin with 8 teeth (1.63 mm in length and 1.37 mm in width). The legs have alternate dark and light black bands with bristles. The 1st leg measures 23.7 mm in length and 2nd pair 23.45 mm in length which are longer than the 3rd measuring 14.79 mm in length and the 4th pair measuring 21.60 mm in length.(Table 01)

Opisthosoma: Opisthosoma is pentagonal, slightly wider than long, measuring 5.53 mm in length and 6.02 mm in width 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. (Fig.4a)

The ventral sternum has two yellow characteristic stripes alternating with black vertical background. The central sternum has a light brownish patch extending as a thin line joining the spinnerets. The spinnerets are orangish brown in colour. (Fig 4b)

Epigynum: Measures 1.37 mm in length and 1.53 mm in width (Table-02). Epigynum is situated mid ventrally on the epigastric furrow. It is a slightly raised sclerotized plate with several cuticular infoldings. There is a pair of external large circular Epigynal orifices to receive the palps of the male during mating. (Fig 4c&4d)

The dorsal rim of the epigynal plate has numerous slender bristles. An oval shaped scape is found between the right and left epigynal orifices. A pair of ducts lead from the epigynum into a pair of internal vesicles known as sperm thecae. (Fig 4d) The structural morphology of epigynum varies from species to species which is a significant feature in the taxonomy of spiders (Sebastian 2009)

Table 3. Argiope anasuja: Female Body Morphometric Measurements

Character	Dorsal view	STD	Ventral view	STD
Prosoma Length (P.L)	3.99	±0.31	3.71	±0.93
Prosoma Breadth (P.B)	3.93	±0.53	3.36	±0.59
Opisthosoma Length (O.L)	5.53	±0.71	5.60	±0.76
Opisthosoma Breadth (O.B)	6.03	±1.22	6.39	±1.26
Total Body Length (T.B.L)	9.52	±0.97	9.30	±1.30
Total Body Breadth (T.B.B)	9.96	±1.28	9.75	±1.31

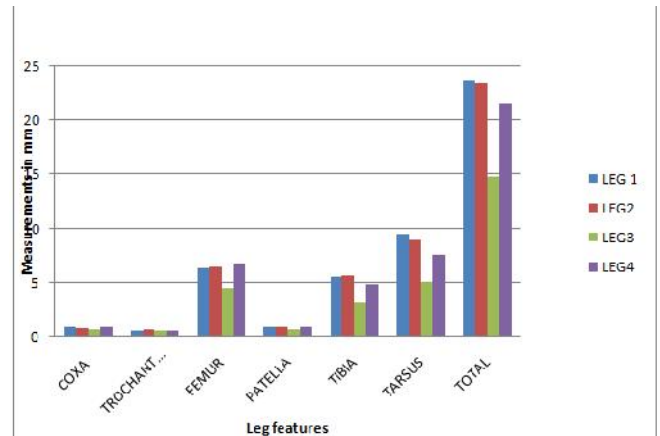


Figure 1. Argiope anasuja: Female Leg Morphometric Measurements (in mm)

Argiope anasuja Male

General

Prosoma - 1.19 mm length and 1.17 mm width.

Opisthosoma – 1.26 mm length and 0.99 mm width.

Total body length - 2.45 mm,

Total length of - Leg1- 6.95 mm, Leg2 - 7.09 mm, Leg3 - 4.06 mm, Leg4 - 4.87 mm.

Prosoma

Pale brown in colour, larger than opisthosoma measuring 1.19 mm in length and

1.17 mm in width Opisthosoma covered with dense hair without any markings as seen in female. Eye pattern is similar to that of female as described earlier.

Table 1. Argiope anasuja: Females Leg Morphometric Measurements in mm

	Leg 1	STD	Leg2	STD	Leg3	STD	Leg4	STD
Coxa	0.96	±0.24	0.78	±0.38	0.73	±0.23	0.86	±0.24
Trochanter	0.58	±0.18	0.63	±0.12	0.57	±0.19	0.6	±0.24
Femur	6.32	±0.87	6.47	±0.6	4.55	±0.56	6.82	±0.81
Patella	0.85	±0.94	0.94	±0.99	0.72	±0.79	0.87	±1.03
Tibia	5.51	±0.85	5.67	±0.71	3.16	±0.47	4.91	±0.77
Tarsus	9.49	±3.69	8.96	±2.47	5.07	±0.46	7.55	±0.82
Total	23.71	±5.71	23.45	±4.3	14.8	±1.71	21.6	±2.25

Table 2. Argiope anasuja; Morphometry of selected body parts of and

Sl.No	Length in mm	STD	Breadth in mm	STD
Mandible ()	1.41	±0.21	1.48	±0.86
Epigynum()	1.37	±0.35	1.53	±0.72
Pedipalp ()	1.27	±0.27	0.43	±0.02

Ventrally the sternum is rhomboidal, with yellow diamond marking posteriorly, covered with dense hair laterally. The legs have alternate dark and light brown bands with bristles. The 1st leg measuring 6.9 mm in length and 2nd leg measuring 7.09 mm in length which is longer than the 3rd leg measuring

Table 4. Argiope anasuja: Males Leg Morphometric Measurements in mm

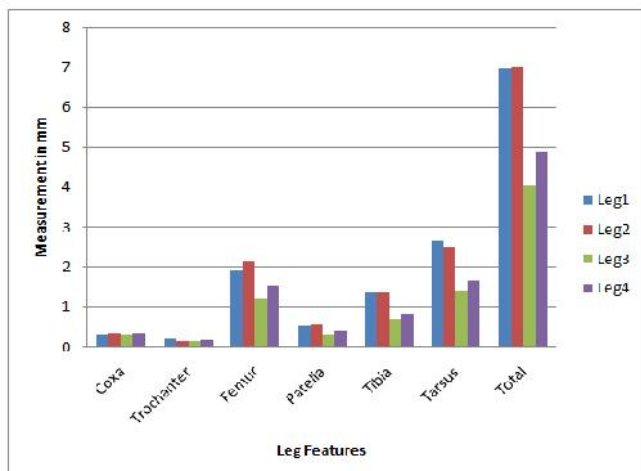
	Leg 1 in mm	STD	Leg 2 in mm	STD	Leg 3 in mm	STD	Leg 4 in mm	STD
Coxa	0.31	±0.12	0.32	±0.09	0.30	±0.15	0.34	±0.13
Trochanter	0.20	±0.09	0.15	±0.05	0.14	±0.05	0.16	±0.07
Femur	1.90	±0.48	2.12	±0.59	1.21	±0.66	1.52	±0.35
Patella	0.53	±0.15	0.55	±0.16	0.31	±0.19	0.38	±0.11
Tibia	1.37	±0.32	1.37	±0.32	0.68	±0.25	0.82	±0.15
Tarsus	2.65	±0.63	2.47	±0.56	1.41	±0.48	1.65	±0.38
Total	6.96	±1.71	6.99	±1.59	4.05	±1.67	4.87	±1.14

4.06 mm length and 4th leg measuring 4.87 mm length (Table 04, Fig 02)

Pedipalp: The sexually mature male spider of *Argiope anasuja* has a complex second pair of appendages called pedipalp present in the prosoma. Observing the complexity of the palp it can be categorized as entelegyne male spider. The coxa which is the basal segment articulates with the femur. Patella is a small lobe bearing a prominent spur at its apex. The tibia is very short. The tarsus consists of two parts, the cymbium and paracymbium. (Fig 5c&d)

Table 5. Argiope anasuja: Males Body Morphometric Measurements in mm

Character	Dorsal view	STD	Ventral view	STD
Prosoma Length (PL)	1.19	±0.35	0.98	±0.43
Prosoma Breadth (PB)	1.17	±0.29	0.74	±0.24
Opisthosoma Length (OL)	1.26	±0.41	1.13	±0.53
Opisthosoma Breadth (OB)	0.95	±0.24	0.92	±0.26
Total Body Length (TBL)	2.46	±0.74	2.11	±0.91
Total Body Breadth (TBB)	2.12	±0.52	1.65	±0.32

**Figure 2. Argiope anasuja Male Leg Morphometric Measurements in mm**

The cymbium is large spoon shaped forming a prominent base of the tarsus having 8 prominent bristles on the convex surface (or free surface). The paracymbium arises from the base of concavity of the cymbium and articulates with it by a movable joint. The cymbium at its inner margin contains a long coiled tube called the receptaculum seminis, the distal end of which extends like a coiled duct called embolus through which sperms are inseminated in to the spermathecae of female genitalia. The whole coiled structure of paracymbium is bulb like comprising of a basal subtegulum middle tegulum and a

terminal lobe at the apical division bearing a slender terminal apophysis.

Opisthosoma: Dorsally *Opisthosoma* is (1.26 mm in length and 0.95 mm in width) pale brown in colour covered densely with hairs without any markings, the posterior end is blunt. Ventrally, *Opisthosoma* is rhomboidal, wider in the center covered densely with hair, pale brownish black in colour. Two light brown patches laterally without hairs. Spinnerets are not as conspicuous as females and are orangish brown in colour. (Fig5a&b)

Table 6. Argiope anasuja: Variations in Morphology in Relation to Sex

Sl.no	Character	Female	Male
1.	Body size	Larger	Smaller
2.	Colour	Brilliantly Colored	Paler
3.	Pedipalp	Absent	Present (modified)
4.	Opisthosoma Shape and Size	Pentagonal broad anteriorly, pointed posteriorly larger than prosoma	Rhomboidal with blunt posterior end smaller than prosoma
5.	Epigynum	Present	Absent
6.	Leg Banding Pattern	Alternate black and white	Alternate pale and dark brown
7.	Spinnerets	Very conspicuous	Less conspicuous
8.	Hair Covering	Less dense	Heavily dense
9.	Shape of Prosomal Sternum	X-mass tree shaped	Rhomboidal shape
10.	Mandible	Well developed with 08 teeth	Poorly developed

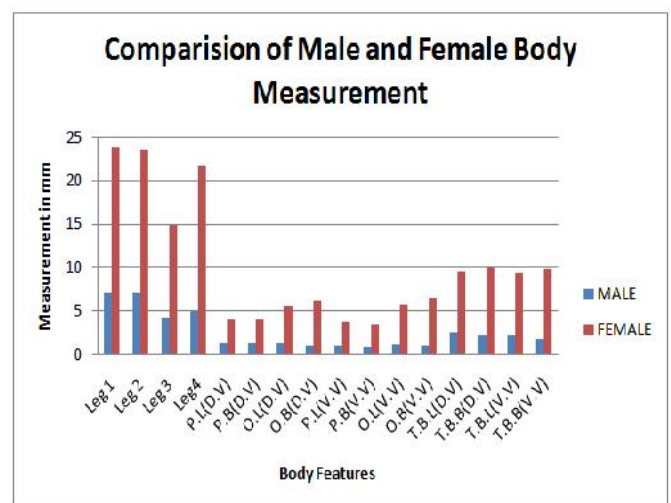
**Figure 3. Argiope anasuja: SSD of Male and Female in mm**

Table 7. Argiope anasuja Male and Female Morphometric Measurements in mm

SL.no	Features	Male	STD	Female	STD	SSD of in %	SSD of in %
1	Leg 1	6.96	±1.71	23.71	±5.71	22.6	77.3
2	Leg 2	6.99	±1.59	23.45	±4.30	22.9	77.0
3	Leg 3	4.05	±1.67	14.80	±1.71	21.4	78.5
4	Leg4	4.87	±1.14	21.60	±2.25	18.3	81.6
5	P.L(D.V)	1.19	±0.35	3.99	±0.31	22.9	77.0
6	P.B(D.V)	1.17	±0.29	3.93	±0.53	22.9	77.0
7	O.L(D.V)	1.26	±0.41	5.53	±0.71	18.5	81.4
8	O.B(D.V)	0.95	±0.24	6.03	±1.22	13.6	86.3
9	P.L(V.V)	0.98	±0.43	3.71	±0.93	20.8	79.1
10	P.B(V.V)	0.74	±0.24	3.36	±0.59	18.0	81.9
11	O.L(V.V)	1.13	±0.53	5.60	±0.76	16.7	84.2
12	O.B(V.V)	0.92	±0.26	6.39	±1.26	12.5	87.4
13	T.B.L(D.V)	2.46	±0.74	9.52	±0.97	18.9	73.3
14	T.B.B (D.V)	2.12	±0.52	9.96	±1.28	17.5	82.4
15	T.B.L(V.V)	2.11	±0.91	9.30	±1.30	18.4	81.5
16	T.B.B(V.V)	1.65	±0.32	9.75	±1.31	14.4	26.3



Figure 4a: Dorsal view ()



Figure 4b: Ventral view ()

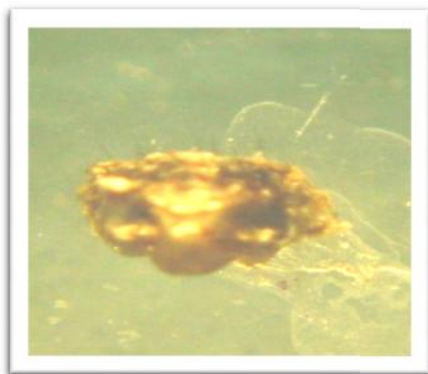


Figure 4c: Epigynum ()

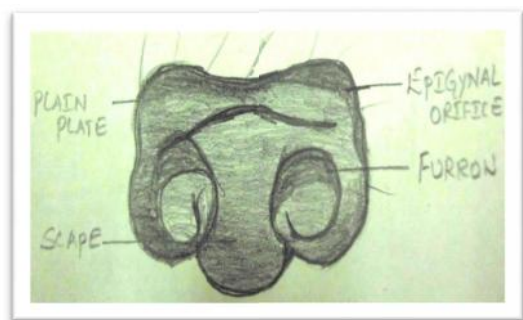


Figure 4d. Labelled structure of Epigynum ()



Figure 5a. Dorsal View ()



Figure 5b. Ventral view ()

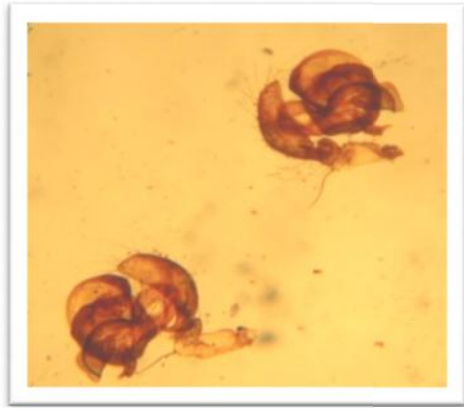


Figure 5c. Pedipalps ()

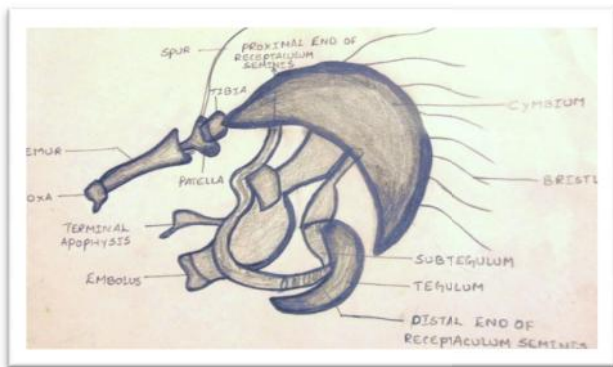


Figure 5d. Labelled Structure of a Pedipalp ()

DISCUSSION

The present study on Sexual Size Dimorphism, (SSD) and morphometric analysis of *Argiope anasuja* has revealed that the females are four times larger than males in their total body length measuring 9.42mm and males measured 2.46mm. About ten different sexual morphological features of both male and female spiders are tabulated. (Table 06) The reason as to, why males are smaller than females has been described by many authors. Levi, 1975: Robinson & Robinson, 1980: Vollrath, 1980: Downes, 1981: Elgar, Ghaffar & Read 1990; Main 1990: Elgar, 1991: Vollrath & Parker, 1992: Coddington, 1994: Head, 1995: Hormiga, Eberhard & Coddington, 1995: Prenter, Montgomery & Elwood, 1995). It has been identified that there is a reduction in male size in some orb weavers *Nephila* & *Argiope*. (Robinson & Robinson 1960: Vollrath 1980: Vollrath & Parker. 1992:)) Vollrath & Parker 1992 has proposed that a selection mechanism in which dwarfism in spiders has evolved due to differences in adult life styles characterized by foraging strategies, and an adaptive feature. Body size plays a central role in the life history of an organism and the potential fitness in many ways (Roff 2002)

Summary

The marked Sexual Size Dimorphism of *Argiope anasuja* which is visibly seen are detailed in (Fig 03, Table 07) & it has revealed that, of the 4 pairs of legs the 4th pair showed 63.3% variation and prosoma showed a range variation between 58.3% - 73.7%, while the opisthosoma with a range variation

between 58.3% - 74.9%. Of all the variations opisthosoma width showed the maximum variation of 74.9%. However the total body length of dorsal view showed 54.3% and the ventral view of 63.1% variation.

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