

## Morphometry and Principle Component Analysis (Pca) Of Oxyopes Species of South Bangalore, Karnataka

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**Abstract:** *Oxyopidea* commonly known as lynx spider for its ambush hunting, also as speedy runners and leapers, alert and with good vision. The morphometric measurements and sexual size dimorphism (SSD) of 10 males and 7 females were carried out. The male pedipalp and female epigynum were removed, mounted and detailed structure was described. The objective of the study focuses on finding out the remarkable difference of SSD of both male and female. The principle component analysis (PCA) was performed for 16 variables and found that visually even though not much difference in the sexual size dimorphism (SSD) between male and female, the principle component analysis has showed a significant difference in SSD on both. The 1<sup>st</sup> principle component accounts for 55.23 % of total variance(0.922 weightage) on total body breadth dorsal view as its dominant term and the 2<sup>nd</sup> principle component whose dominant term is the total body breadth ventral view with a total percentage variance of 22.585(0.652 weightage) Since the first two components together accounts for 77.818 of the total variance, each individual is represented as a point in the co-ordinate space of the associated amplitudes of the two principle components. The points filled as two obvious clusters confirming the succinct sexual dimorphic feature of the spiders.

**Keywords:** *Oxyopes* species, Morphometric measurements, Pedipalp, Epigynum & Principal Component Analysis (PCA)

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### I. Introduction

Lynx spider is the common name for any member of the family Oxyopidae. Most species make little use of webs, instead spending their lives as hunting spiders on plants Spiders of the family Oxyopidae have received very little attention in India. Pocock (1900,1901) described four and three new species of *Oxyopes* and *Peucetia* respectively. Oxyopidae in general rely on keen eyesight in stalking, chasing, or ambushing prey, and also in avoiding enemies. As with many other families of spiders, the arrangement of their eyes is typical of the family and is an important aid in identifying them.

The objective of the study focused on finding out the remarkable morphological sexual size difference between male and female spiders as members of the family.

#### Sexual Size Dimorphism (SSD)

The SSD can be defined as the mean difference in the morphometric measurement between adult males and females. The SSD occurs in almost all animal kingdom including invertebrates. Among invertebrates most of the genus under Nephilidae, Arachnidae, Lycosidae the size extremity is seen, where females are three times larger in size compare to males(male dwarfism).

The SSD plays an important role in evolutionary process. The phylogenetic analysis concludes that there are many selective agents which acts on the male dwarfism for its existence in nature.

#### Principle component analysis ( PCA)

Principle component analysis (PCA) is a statistical tool which transforms the complex data in to simplest form. It compress the dimensionality of the data set and identifies the new meaningful underlying variables. The technique also finds on linear transformation of data that retain the maximal amount of variance. The eigen values and eigen vectors of the covariance matrix can be founded. The largest eigen values correspond to the dimensions that have the strongest correlation in the data set. The graph can be executed by plotting a greatest variance of any projection of the data on the first axis (pca1) and the second greatest variance on the second axis (pca2).

## II. Materials And Methods:

Male and female *Oxyopes species* were collected by hand collection method from surroundings of turahalli forest. The specimen were brought to laboratory and stored in 70% alcohol. They were identified, by referring Journal of Arachnology “Identification to Indian Spiders” Seven females and ten male spiders morphometric measurements were done through calibrations under stereozoom microscope (Labomed). Sixteen variables were measured in mm. The specimens were photographed by using digital camera Nikon coolpix 6300. Further the Principle Component Analysis (PCA) was applied to compare the variables of both males and females.

### Observation:

#### Oxyopes species male

##### General:

Golden yellow with hexagonal shape eye pattern and were compact.

Dorsal View- Prosoma: 2.44mm in length & 1.9 mm in width.

Opisthosoma: 2.74 mm in length & 0.99 mm in width

Total Body Length (TBL): 5.18 mm

Total Length of: Leg 1- 11.49 mm, Leg 2- 10.64 mm, Leg 3- 8.75 mm & Leg4 – 10.48 mm

**Prosoma:** Broader and larger than opisthosoma which is long and narrow. Dorsally it is provided with fine pubescence. Eight eyes in compact hexagonal pattern. In the anterior row, the medians are smallest, anterior lateral bigger in size. Posterior row of eyes are nearly equidistant to each other larger in size. All the eyes are encircled by black patches. Clypeus long, black longitudinal band starts from anterior median eyes up to the fangs of chelicerae. In between the posterior rows of eyes are two thick black coloured bristles. **Fig.No-5a, Table No-01**

Ventrally chelicerae poorly developed, mandibles yellow, well developed. The sternum is diamond shape with fine pubescence and yellow in color. Legs long and strong with long brown thorny bristles and pubescence. **Fig.No 5b, Table No-01**

**Opisthosoma:** Dorsally longer than wide, narrow posteriorly and the abdomen is provided with dark orange yellowish and white patches. Ventral side slightly paler, with a small pale pedicel having two bright yellow patches which is laterally connecting to the prosoma. Two vertical silvery patch arising from the anterior to posterior end spinnerets. Spinnerets at the tip has tuft of stiff bristles. **Fig.No 5a & 5b. Table No-01**

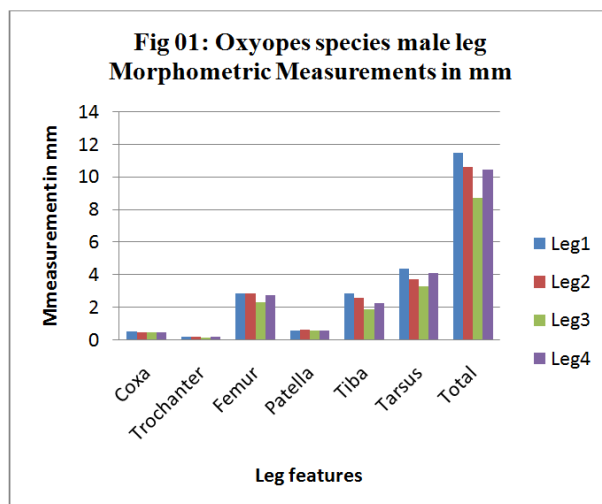
**Pedipalp:** The pedipalp is of entelegyne type and is yellow black in color. Femur is golden yellow, with two long spines dorsally and two short spines distally. Tibia is brownish yellow with long spines. Tarsus is modified in to a lantern shape comprising of dorsal black, dense hairy cymbium containing the coiled tube called receptaculum seminis. The paracymbium arises from the base of cymbium and is articulated by a movable joint. The proximal portion is enlarged and tapers distally. The terminal of the receptaculum seminis is the embolus on the ventral side. The whole coiled structure is bulb like called genital bulb. The genital bulb is divided in to basal subtegulum, middle tegulum and apical terminal lobe terminal apophysis bearing two small stiff bristles **Fig No.5c. Table No-05**

**Table 01:** Oxyopes species : Male Body Morphometric Measurements in mm (with standard deviation)

Character	Dorsal View (DV)	Std	Ventral View (VV)	Std
Prosoma Length(PL)	2.44	0.43	2.27	0.43
Prosoma Breadth(PB)	1.9	0.31	0.96	0.18
Opisthosoma Length(OL)	2.74	0.67	2.88	0.66
Opisthosoma Breadth(OB)	0.99	0.24	1.01	0.24
Total Body Length(TBL)	5.18	1.01	5.15	0.89
Total Body Breadth(TBB)	2.89	0.5	1.97	0.25

**Table 02:** Oxyopes species: Male Leg Morphometric Measurements in mm (with standard deviation)

Feature	Leg1	Std	Leg2	Std	Leg3	Std	Leg4	Std
Coxa	0.53	0.18	0.5	0.16	0.47	0.13	0.48	0.08
Trochanter	0.21	0.09	0.22	0.22	0.17	0.1	0.22	0.08
Femur	2.85	0.57	2.9	0.7	2.32	0.46	2.78	0.56
Patella	0.62	0.31	0.65	0.29	0.58	0.27	0.59	0.3
Tibia	2.87	0.86	2.63	0.82	1.91	0.55	2.26	0.77
Tarsus	4.41	1.42	3.74	1.46	3.3	0.93	4.15	1.45
<b>Total</b>	<b>11.49</b>	<b>2.93</b>	<b>10.64</b>	<b>3.64</b>	<b>8.75</b>	<b>2.43</b>	<b>10.48</b>	<b>3.24</b>



**Observation:**

**Oxyopes species female**

**General:**

Golden yellow with hexagonal shape eye pattern and are compact.

Dorsal View- Prosoma: 2.49 mm in length & 2.03 mm in width.

Opisthosoma: 4.51 mm in length & 3.98 mm in width

Total Body Length (TBL): 7.0 mm

Total Length of: Leg 1- 12.48 mm, Leg 2- 11.82 mm, Leg 3- 8.57 mm &

Leg4 – 11.4 mm

**Prosoma:** dorsally it is wider and shorter than opisthosoma. Eight eyes in compact hexagonal pattern. Lateral and lower median eyes are large and are of equal size, while inner median eyes are slightly larger than the anterior eyes. The inner median eyes have black patches. Clypeus long, black longitudinal band starts from anterior median eyes up to the fangs of chelicerae. In between the median eyes are two thick coloured bristles. From the posterior median eyes are the two streaks of orangish bristles which are broader at anterior end. Laterally three patches of black bristles are present. **Fig No 6a. Table No-03**

Ventrally sternum is heart shape with black bristles. Mandibles are well developed with jaw. At the base of the jaw there is a small black protrubence. Legs are long. The femur has two rows one row of blackish bristles and the other with brownish bristles. On each leg there are many long sharp thorny bristles. **Fig No 6b. Table No-03**

**Opisthosoma:** longer than wide, narrow posteriorly. Middle of abdomen is provided with dark orange-yellowish longitudinal band, starting from anterior end and up to the base of spinnerets, laterally provided with some black patches and in between the two mid lateral silvery white bands. **Fig No 6a. Table No-03**

Ventrally it is broader at the anterior and tapering posteriorly, slightly lighter than dorsal. Median longitudinal band with three rows of brownish black bristles arising from epigastric furrow up to the base of spinnerets. Just below the epigynum are three transverse rows of brownish black striations. The spinnerets are elongated and bear small brownish bristles. **Fig No 6b. Table No-03**

**Epigynum:**

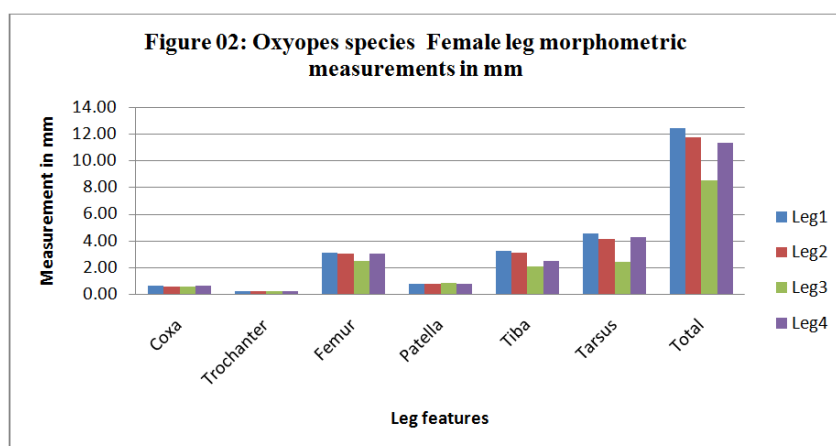
It is globular, anterior situated mid ventrally on the epigastric furrow. In between the cup shaped epigastric plate. These plates have bristles posteriorly which is similar to oxyopes shakilae. There is a pair of external openings/orifices to receive the palps of the male during mating. The plate is depressed or furrowed longitudinally and the depressed area is divided by a ridge like elevation. Forming two furrows or channels on either side lead in to the opening of the spermathecae of the corresponding side. This ridge like elevation is called guide which facilitates the copulation. The guide extends laterally on each side at its posterior and towards its spermathecal sacs. Internal genitalia comprises of anteriorly short spermathecal duct arising from the orifices which posteriorly arises as a pear shaped spermathecal sacs. In between the spermathecal sacs, there is a oval shape opening of the oviduct. **Fig No 6c. Table No-05**

**Table 03: Oxyopes Species : Female Body Morphometric Measurements in mm(with standard deviation)**

Character	Dorsal View (DV)	Std	Ventral View (VV)	Std
Prosoma Length (PL)	2.49	0.18	2.03	0.56
Prosoma Breadth(PB)	1.9	0.12	1.1	0.42
Opisthosoma Length(OL)	4.51	1.08	3.98	1.73
Opisthosoma Breadth(OB)	1.76	0.45	1.63	0.6
Total Body Length(TBL)	7.0	1.15	6.01	1.8
Total Body Breadth(TBB)	3.66	0.46	2.73	0.88

**Table 04: Oxyopes Species: Female Leg Morphometric Measurements in mm (with standard deviation)**

Feature	Leg1	Std	Leg2	Std	Leg3	Std	Leg4	Std
Coxa	0.61	0.13	0.57	0.11	0.54	0.11	0.62	0.07
Trochanter	0.23	0.14	0.20	0.10	0.19	0.07	0.22	0.04
Femur	3.10	0.46	3.01	0.47	2.48	0.55	3.01	0.43
Patella	0.76	0.11	0.79	0.05	0.84	0.37	0.77	0.08
Tibia	3.23	0.54	3.10	0.44	2.07	0.47	2.50	0.44
Tarsus	4.55	0.70	4.15	0.54	2.44	1.27	4.28	0.42
<b>Total</b>	<b>12.48</b>	<b>1.74</b>	<b>11.82</b>	<b>1.72</b>	<b>8.57</b>	<b>2.84</b>	<b>11.40</b>	<b>1.49</b>



**Table 05: Body features – Measurements in mm**

Body Feature	Measurement in mm	Std
<b>Female - Epigynum</b>		
Epigynum Length (EL)	0.55	0.20
Epigynum Breadth(EB)	0.59	0.19
<b>Male - Pedipalp</b>		
Pedipalp Length (PL)	2.79	0.74
Pedipalp Breadth(PB)	0.66	0.08

**Table 06: Oxyopes Species: Comparison of Morphometric Measurements in mm**

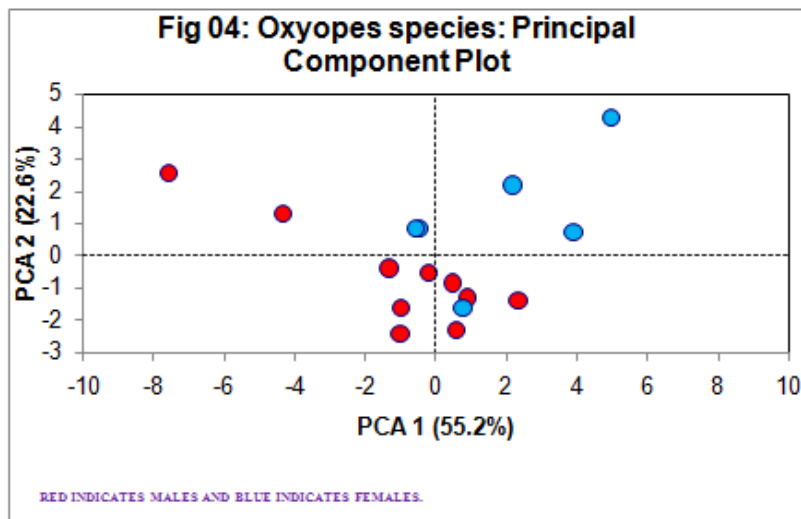
Sl.No	Features	Male	Std	Female	Std
1	Leg 1	11.49	2.93	12.48	1.74
2	Leg 2	10.64	3.64	11.82	1.72
3	Leg 3	8.75	2.43	8.57	2.84
4	Leg4	10.48	3.24	11.4	1.49
5	P.L(D.V)	2.44	0.43	2.49	0.18
6	P.B(D.V)	1.9	0.31	1.90	0.12
7	O.L(D.V)	2.74	0.67	4.51	1.08
8	O.B(D.V)	0.99	0.24	1.76	0.45
9	P.L(V.V)	2.27	0.43	2.03	0.56
10	P.B(V.V)	0.96	0.18	1.10	0.42
11	O.L(V.V)	2.88	0.66	3.98	1.73
12	O.B(V.V)	1.01	0.24	1.63	0.6
13	T.B.L(D.V)	5.18	1.01	7.00	1.15
14	T.B.B(D.V)	2.89	0.5	3.66	0.46
15	T.B.L(V.V)	5.15	0.89	6.01	1.8
16	T.B.B(V.V)	1.97	0.25	2.73	0.88

**Table 06: Oxyopes Species: PCA of 16 variables- Component Loadings**

Variable	PC 1	PC 2
LEG1	0.803	-0.507
LEG2	0.819	-0.474
LEG3	0.734	-0.482
LEG4	0.853	-0.463
PL(DV)	0.746	-0.577
PB(DV)	0.645	-0.602
OL(DV)	0.818	0.341
OB(DV)	0.801	0.492
PL(VV)	0.378	-0.474
PB(VV)	0.247	0.504
OL(VV)	0.676	0.508
OB(VV)	0.759	0.572
TBL(DV)	0.906	0.150
TBB(DV)	<b>0.922</b>	0.160
TBL(VV)	0.778	0.309
TBB(VV)	0.679	<b>0.652</b>
Explained Variance (Eigenvalues)		
Value	PC 1	PC 2
Eigenvalue	8.837	3.614
% of Var.	55.233	22.585
Cum. %	55.233	77.818

**Table 06: Oxyopes Species: Casewise PCA Scores**

Case	PCA 1	PCA 2
1	-7.564	2.546
2	-4.292	1.276
3	0.931	-1.326
4	2.352	-1.418
5	-0.994	-2.436
6	0.622	-2.315
7	-0.186	-0.548
8	-1.309	-0.405
9	-0.959	-1.629
10	0.506	-0.864
11	0.782	-1.624
12	3.926	0.692
13	-0.448	0.822
14	2.198	2.165
15	-0.550	0.817
16	4.987	4.246



### III. Results And Discussion:

The present study on the morphometric and principle component analysis (PCA) of oxyopes species revealed that visually even though not much difference in the sexual size dimorphism between male and female spiders but the principle component analysis has a significant difference in SSD on both. The PCA performed with the data on body measurements of 10 males and 6 females are presented. **Table No 07.** The 1<sup>st</sup> principle component accounts for 55.23 % of total variance(0.922 weightage) on total body breadth dorsal view as its dominant term and the 2<sup>nd</sup> principle component whose dominant term is the total body breadth ventral view with a %total variance of 22.585(weightage 0.652) **Table No 07.**

Since the first two components together accounts for 77.818 of the total variance, each individual is represented as a point in the co-ordinate space of the associated amplitudes of the two principle components. The points filled as two obvious clusters confirming the succinct sexual dimorphic feature of the spiders. **Fig No.03, Table No 08.**

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**Figure-05: Oxyopes Species Male**



Fig-05(a): Dorsal view

Fig-05(b): Ventral view



Fig-05(c): Pedipalp

**Figure-06:** Oxyopes Species Female



Fig-06(a): Dorsal view



Fig-06(b): Ventral view



Fig-06(c): Epigynum

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