

Morphometry and Principle Component Analysis (PCA) Of Red House Spider *Nesticodes Rufipes* 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.

*¹ijl_jala@yahoo.co.in*² vinuthacyril@gmail.com

Abstract: *Nesticodes rufipes* (Lucas 1846) commonly called as red house spider was collected and stored in 70% alcohol. The morphometric measurements and sexual dimorphism of both male and females were carried out. The male pedipalp and female epigynum were removed, mounted and detailed structure was described. The principle component analysis (PCA) was performed for 16 variables and found that female spider differed from male spider significantly in all variables. The first principle component accounts for 82% of total variance with first pair of legs length as its dominant term (weightage 0.52588299) and the 2nd principle component whose dominant term is the total body breadth measured in dorsal view with a percentage total variance of 94% (weightage 0.40512341). Since the first two components together account for 0.9384% of the total variance, each individual was represented as a point in the co-ordinate space, of the associated amplitudes of the two principle components. The points fell as two obvious clusters confirming the succinct sexual dimorphic feature of the spiders.

Keywords: *Nesticodes rufipes*, Morphometric measurements, Pedipalp, Epigynum & Principal Component Analysis (PCA)

I. Introduction:

Theridiidae (Sundevall 1853) is a large family of spiders, also known as the tangle web spiders, cob web spiders & comb footed spiders. The diverse family includes 86 genera and 2227 species (Platnick 2006). From India around 18 genera and 52 species have been reported. (Silwal, et al, 2005; Platnick N.I., 2011; Sebastian & Peter, 2009) Theridiids vary in general appearance and often show sexual dimorphism. Morphological descriptions and a key to genera of the family Theridiidae has been documented. (Levi & Levi 1962). Most of the theridiid spiders are cosmopolitan and pantropical in distribution.

Nesticodes rufipes is commonly known as red house spider because it builds a small, tangled web in dark corners inside houses or under rims of garden pots.

II. Materials and Methods:

Male and female *Nesticodes rufipes* were collected by hand collection method both from house as well as garden. The specimens were brought to laboratory and stored in 70% alcohol. They were identified, by referring Journal of Arachnology "Identification to Indian Spiders" Seven females and five male spiders morphometric measurements were done through calibrations under stereozoom microscope (Labomed). All 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:

Nesticodes rufipes female

General:

Females are dark brown slightly mottled, globular abdomen red brown legs.

Dorsal View- Prosoma: 2.19 mm in length & 1.75 mm in width.

Opisthosoma: 3.76 mm in length & 3.52 mm in width

Total Body Length 5.99 mm

Total Length of Leg 1- 13.00 mm, Leg 2- 10.24 mm, Leg 3- 7.71 mm &

Leg 4 - 10.80 mm

Prosoma: Golden brown in colour, triangular having blunt apex anteriorly and broad posteriorly covered with small stiff bristles dorsally while ventrally it is paler with scarty bristles. Three pairs of eyes arranged compactly with two small opaque median pair in the first row and two lateral slightly larger opaque and the central pair are transparent oval in shape.

Ventrally the four pairs of elongated legs arise laterally from the triangular prosoma. Chelicerae are slender globular brown in colour. Mandibles are stout measuring 1.62 mm in length. All the four pairs of legs have

uniform stump shaped trochanter character of theridiids being called “comb footed spider” (Fig4a) covered with numerous stiff bristles. The first pair of legs were the longest measuring 13.00 mm, the 2nd pair measuring 10.24 mm, 3rd pair measuring 7.71mm, & 4th pair measuring 10.80mm in length. (Table 01)

Opisthosoma: Is attached by a small flexible pedicel. It is pale golden brown in color measuring 1.75 mm at its widest region & 2.19 mm in length (Table 02) Dorsally there are two slight black patches separated by a central white zone. The entire abdomen dorsally is covered with small stiff bristles in large number compared to ventral side with scarty bristles two pairs of spinnerets are subultimate in position encircled with a black rings on the ventral side. (Fig4b)

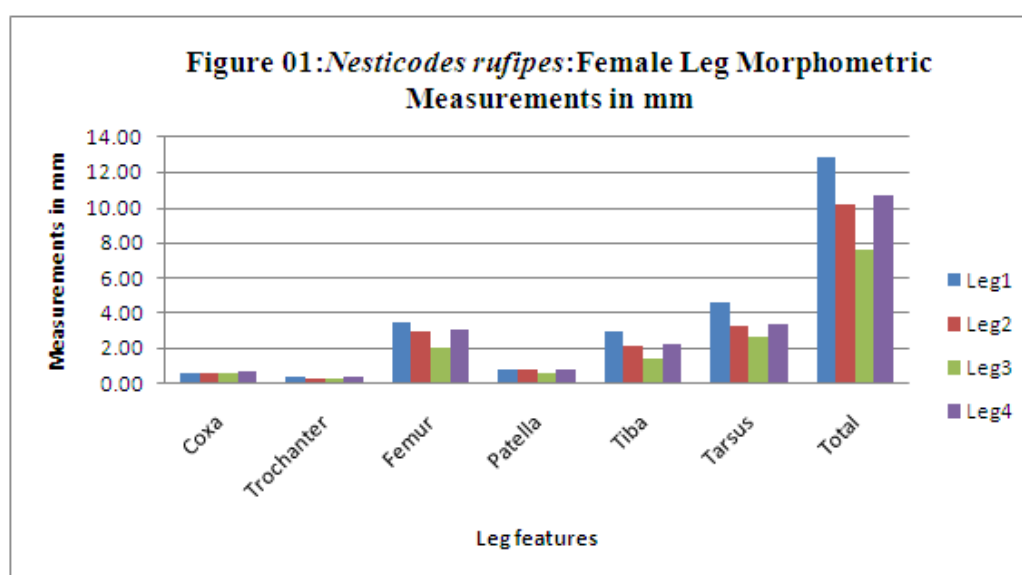
Epigynum: Measures 0.54 mm in diameter (Table 07). It is dark red circular in shape located anteriorly in the mid ventral region flanked in between two yellow triangular sclerotized plates. These plates bear thick, dense bristles (Fig4c). Below the sclerotized plates there is a depression called atrium. Atrium bears circular opening leading in to the adnexae (Roberts 1983). The female epigynum consists of two main parts namely viz external epigyne and internal adnexae, which are bilaterally symmetrical. The adnexae includes small ducts arising from the circular openings leading in to the seminal receptaculæ, from these the short fertilizing tubes lead inside the vagina. (Fig4d)

Table 01: Nesticodes rufipes: Females Leg Morphometric Measurements in mm

Feature	Leg1	Std	Leg2	Std	Leg3	Std	Leg4	Std
Coxa	0.62	±0.25	0.67	±0.19	0.62	±0.26	0.72	±0.27
Trochanter	0.42	±0.19	0.31	±0.05	0.30	±0.06	0.39	±0.11
Femur	3.52	±1.36	2.97	±1.16	2.07	±0.94	3.15	±1.06
Patella	0.85	±0.20	0.87	±0.40	0.62	±0.17	0.84	±0.37
Tibia	2.97	±1.16	2.13	±0.79	1.41	±0.49	2.25	±0.81
Tarsus	4.62	±1.65	3.29	±1.20	2.69	±0.97	3.45	±1.32
Total	13.00	±4.81	10.24	±3.79	7.71	±2.89	10.80	±3.94

Table 02: Nesticodes rufipes: Female Body Morphometric Measurements in mm

Character	Dorsal view	Std	Ventral view	Std
Prosoma Length(PL)	2.19	±0.66	1.95	±0.63
Prosoma Breadth(PB)	1.75	±0.49	1.13	±0.37
Opisthosoma Length(OL)	3.76	±0.44	3.58	±0.4
Opisthosoma Breadth(OB)	3.52	±0.43	3.46	±0.38
Total Body Length(TBL)	5.99	±0.95	5.59	±0.78
Total Body Breadth(TBB)	5.52	±0.46	4.62	±0.59



Nesticodes rufipes male

General:

Dorsal View- Prosoma: 1.46 mm in Length & 1.22 mm in Width.

Opisthosoma: 1.57 mm in Length & 1.28 mm in Width

Total Body Length: 3.04 mm

Total Length of: Leg 1- 9.49 mm, Leg 2- 7.53 mm, Leg 3- 5.15 mm &

Leg 4- 7.02 mm

Prosoma: Pale golden yellow in colour,triangular in shape larger than opisthosoma measuring 3.04 mm in length and 1.28 mmin width(Table-04)Prosoma has medially an elevated ridge with characteristic marking (Fig5a) with two stiff distinct bristles in the centre. Eye pattern is similar to that of female as described earlier.

Ventrally the sternum is smaller than dorsal carapace triangular in shape pale yellow in colour without any markings.(Fig5b). All the four pairs of legs have the unique stump shaped trochanter curved with numerous stiff bristles,the first pair being the longest of all the other pairsmeasuring 9.49mm in total length,2nd pair measuring 7.53mm,3rd pair measuring 5.15mm, &4th pair 7.02mm(Table 04)

Opisthosoma: Is oval shaped smaller in size compared to prosoma measuring 1.74mm in length and 1.41mm in breadth (Table05). Dorsally two lateral patches appearing black, because of the dense stiff bristles. Ventrally opisthosoma has two lateral yellow patches flanking the horizontal genital slit. Posteriorly two pairs of spinnerets are found above and cup shaped surrounded by rings. The number of bristles are fewer compared to those found on the dorsal surface.(Fig05)

Pedipalp:The sexually mature male spider ofNesticodes rufipes has a complex second pair of appendages called pedipalpi. The pedipalp is of entelegyne type measuring 1.36mmin length and 0.97mm in breadth(Table06). The coxa is broad articulating with the femur which hasa distinct femoral groove. The patella bears four prominent bristles at its apex. The tibia is very short forming the base of cymbium complex or embolus proper. The cymbium complex is elongated whip like structure turning clockwise in the left palp and in the right palp anticlockwise which is a character of all theridiids (Saaristo 1978). The paracymbium arises from the base of the cymbium ventrally which articulates bya movable joint. In between the cymbium and paracymbium internally has the alveolus forming two bulb like structures which continues as a coiled tube of receptaculumseminis. The terminal portion of the receptaculumseminis is the embolus. The entire structure is bulb like called the genital bulb. The bulb is divided in to three regions vizthe distal subtegulum, middle tegulum and terminal apophysis. The bulb also bears two prominent appendages the median apophysis and a hook like conductor or ejaculatory duct (Fig5c&5d)

Table 03: Nesticodes rufipes: Males Leg Morphometric Measurements in mm

Feature	Leg1	Std	Leg2	Std	Leg3	Std	Leg4	Std
Coxa	0.45	±0.09	0.41	±0.06	0.29	±0.05	0.39	±0.05
Trochanter	0.34	±0.15	0.26	±0.04	0.21	±0.05	0.24	±0.10
Femur	2.57	±0.39	2.28	±0.79	1.5	±0.26	1.94	±0.30
Patella	0.58	±0.14	0.53	±0.17	0.39	±0.11	0.53	±0.10
Tiba	2.36	±0.39	1.5	±0.35	1.05	±0.32	1.43	±0.27
Tarsus	3.19	±0.60	2.55	±0.43	1.7	±0.52	2.5	±0.32
Total	9.49	±1.26	7.53	±1.83	5.15	±1.32	7.02	±1.14

Table 04:Nesticodes rufipes: Male Body Morphometric Measurements in mm

Character	Dorsal view	Std	Ventral view	Std
Prosoma Length (PL)	1.46	±0.26	1.1	±0.21
Prosoma Breadth(PB)	1.22	±0.29	0.74	±0.12
Opisthosoma Length(OL)	1.57	±0.11	1.74	±0.19
Opisthosoma Breadth(OB)	1.28	±0.20	1.41	±0.40
Total Body Length(TBL)	3.04	±0.29	2.83	±0.27
Total Body Breadth(TBB)	2.50	±0.38	2.14	±0.36

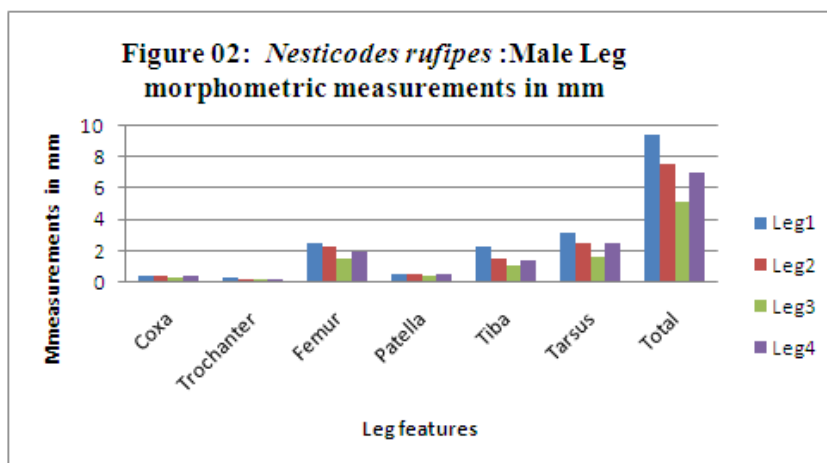


Table 05: Nesticodes rufipes: Male and Female Morphometric Measurements in mm

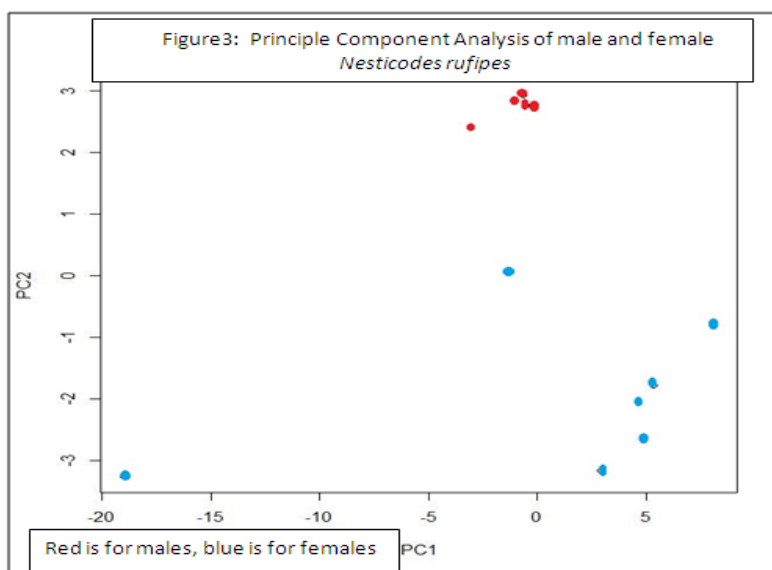
Sl. no	Features	Male		Female	Std
1	Leg 1	9.49	±1.26	13.00	±4.81
2	Leg 2	7.53	±1.83	10.24	±3.79
3	Leg 3	5.15	±1.32	7.71	±2.89
4	Leg 4	7.02	±1.14	10.80	±3.94
5	P.L(D.V)	1.46	±0.26	2.19	±0.66
6	P.B(D.V)	1.22	±0.29	1.75	±0.49
7	O.L(D.V)	1.57	±0.11	3.76	±0.44
8	O.B(D.V)	1.28	±0.2	3.52	±0.43
9	P.L(V.V)	1.10	±0.21	1.95	±0.63
10	P.B(V.V)	0.74	±0.12	1.13	±0.37
11	O.L(V.V)	1.74	±0.19	3.58	±0.40
12	O.B(V.V)	1.41	±0.40	3.46	±0.38
13	T.B.L(D.V)	3.04	±0.29	5.99	±0.95
14	T.B.B(D.V)	2.50	±0.38	5.52	±0.46
15	T.B.L(V.V)	2.83	±0.27	5.59	±0.78
16	T.B.B(V.V)	2.14	±0.36	4.62	±0.59

Table 06: Nesticodes rufipes: Morphometric measurements of selected body parts of male and female in mm

Body Feature	Measurements in mm	Std
Female		
Mandible Length (ML)	1.62	±0.41
Mandible Breadth (MB)	1.12	±0.30
Epigynum in diameter	0.54	±0.17
Male		
Mandible Length (ML)	0.94	±0.67
Mandible Breadth (MB)	1.47	±1.65
Pedipalp Length (PL)	1.36	±1.51
Pedipalp Breadth (PB)	0.97	±0.75

Table 07: PCA for Different Body Features

	PC1	PC2
LEG1	-0.52588299	-0.30785189
LEG2	-0.42716671	-0.30207069
LEG3	-0.31922476	-0.09038917
LEG4	-0.47782815	-0.12041582
PL(DV)	-0.08913371	-0.01877479
PB(DV)	-0.05022253	0.01800687
OL(DV)	-0.13029073	0.29076603
OB(DV)	-0.11883614	0.32385558
PL(VV)	-0.08437915	0.03958760
PB(VV)	-0.04901022	-0.01199780
OL(VV)	-0.09953772	0.27301851
OB(VV)	-0.11253585	0.29589837
TBL(DV)	-0.21953498	0.28060072
TBB(DV)	-0.16987099	0.40512341
TBL(VV)	-0.18413316	0.32945074
TBB(VV)	-0.16166624	0.29325870
Summary of PCA for pca1 & pca2		
Standard deviation:	6.8745	2.58591
Proportion of Variance in%	0.8221	0.1163
Cumulative %	0.8221	0.9384 Proportion



III. Result and Discussion:

Therididae is amongst the largest family of the order Araneidae including 2,297 species subdivided into 112 genera (Platnick 2010). The present study on the morphology of *Nesticodes rufipes* is very similar to that described by Saaristo (1978) of Seychelles, Finland. However, the morphometric analysis of male and female spiders differed both in size & body coloration, which might be due to geographical variations. The structure of both pedipalp of males and epigynum of female spiders were more complex in Indian spiders compared to that described by Finland species. (Fig 5c&d & 4c&d respectively)

There is marked sexual dimorphism visibly seen between the male and female *Nesticodes rufipes* (Table 05 & 06). The females differed from males significantly in all the 16 variables studied. The principle component analysis performed with the data on body measurements of seven females and five males are presented in table 03. The first principle component accounts for 82% of total variance with first pair of legs length as its dominant term (weightage 0.52588299) and the 2nd principle component whose dominant term is the total body breadth measured in dorsal view with a percentage total variance of 94% (weightage 0.40512341) (Table 07). Since the first two components together account for 93.84% 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 fell into two obvious clusters confirming the succinct sexual dimorphic feature of the spiders. (fig:3)

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Figure 04:Nesticodesrufipes female



Figure 4a: Dorsal View



Figure4b: Ventral view

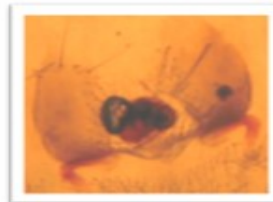


Figure4c: Epigynum

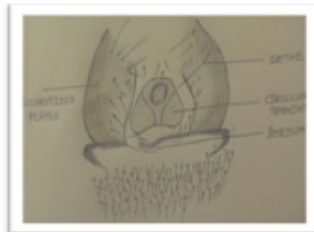


Figure4d: Labelled structure of Epigynum

Figure 5: Nesticodes rufipes male



Figure5a: Dorsal view



Figure5b: Ventral view



Figure5c: Pedipalp

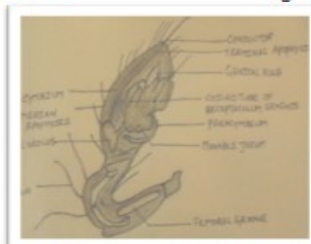


Figure5d: Labelled structure of Pedipalp