

# Spatial and temporal variability in webs of *Metepeira gressa* (Keyserling, 1892) (Araneae, Araneidae): a year field study

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## Resumen

*Variabilidad espacial y temporal en telas de Metepeira gressa (Araneae, Araneidae).*

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Se realizó un estudio de campo en Punta Espinillo (Montevideo, Uruguay), analizando las telas de hembras y juveniles de una población de *Metepeira gressa* (Keyserling, 1892). Los muestreos fueron mensuales durante un ciclo anual, registrándose la humedad y temperatura. Se determinaron 5 estadios de desarrollo y se analizaron los cambios de tamaño y distribución de la población durante un año. Se observó además, la ubicación de las telas en las plantas y la tolerancia territorial entre las telas. La distribución anual individual coincidió con el patrón de la familia Araneidae, siendo una especie estenocrona. Las construcciones de las arañas pertenecientes al mismo estadio no mostraron cambios coincidentes con los cambios estacionales. Se compararon las telas de las hembras con la realizada por estadios juveniles, encontrándose diferencias significativas en sus tamaños, pero no en el número de elementos (radios y espirales). Las telas de las hembras adultas mostraron una asimetría constante, refugio y un mayor ángulo de inclinación de la línea vertical, respecto a la tela de los juveniles. Además las telas de las hembras fueron puestas en la vegetación más elevadas que las telas de los juveniles en el estrato vertical. Se observó una fuerte asociación entre las telas y las plantas de *Eryngium* sp. y hasta tres arañas compartieron la misma planta.

**Palabras clave:** *Metepeira*, Telas de araña.

## Abstract

Webs of females and juveniles were analyzed monthly during one annual cycle in a population of *Metepeira gressa* (Keyserling 1892) in Punta Espinillo (Montevideo, Uruguay) in field conditions, with temperature and humidity registered. Five stages of development were found. Size, distribution and population changes during a year were analyzed. The egg-sacs was also registered. Territorial tolerance in the distance among webs was observed. The annual individual distribution showed the family pattern, being stenochronous species according Schaefer (1987). The buildings of spiders in the same stage did not show seasonal changes on the year. The webs of females versus juveniles showed statistical differences in their sizes. Webs of females showed constant asymmetry, a presence of retreat and a bigger angle of inclination to vertical line, respect the juvenile webs. Also the female webs was put in the vegetation higher than the webs of juveniles in a vertical stratum. A strong association between the webs and the plants

of *Eryngium* sp. and the occupation for until three spider sharing the same plant was observed.

**Key words:** *Metepeira*, webs.

## Introduction

Spiders build their webs in the environment following a characteristic species-specific pattern reflecting the selection pressure to increase the probability of insects interception probability. The distribution pattern follow the resources habitat distribution to avoid individual competency for select these sites (Enders 1974). Many studies were realized about the relationship between the spiders and the plants community, founding that many spiders have significant associations with vegetal species (Chew 1961, Riechert 1976).

The characteristics and placed of webs influence the predatory behavior due to the importance of relation structure-function of the web. The prey capture is not the only function of the web, all vital activity of the spiders happen in the web. The importance of web in the spider life is basic for the transmission of different kind of information (pheromones, vibrations). The spiders *Metepeira* species build a two-dimensional orb web with an additional structure, that communicates with the hub (radii confluence) by signal threads. The retreat is surrounded by a barrier-web (a group of irregular threads). The retreat has a double function: maintenance of spider and her egg-sacs allowing a safe sit-wait strategy to capture prey.

*Metepeira gressa* (Keyserling 1892) builds an orb asymmetrical web lightly inclined of the vertical line. The spiders sit in the retreat and wait while they were protected of predators and the weather condition (sun radiation, rain). The spatial structure (Viera 1983, 1989) is similar to the webs of *M. spinipes* F.O.P. Cambridge, 1903 y *M. labyrinthea* (Hentz, 1847) described by Peters (1955), Burgess & Witt (1976). Viera (1986, 1989, 1992) described qualitatively and quantitatively the web of *M. gressa* in laboratory conditions. The building behavior as an instinctive behavior that improve with ontogeny changes (Bristowe 1941). He observed that the webs of juveniles have less number of radii than the webs of females, the juveniles waited in the hub and the webs of females were more asymmetrical than the young webs. Viera (1989, 1992) observed *M. gressa* found in agree with Bristowe (1941) symmetrical young webs, but Viera did not found significant differences

in the number of radii, spirals and general structure, differing the webs only in their sizes. The juveniles of *Zygiella-x-notata* (Clerck 1758), *Metepeira incrassata* F.O.P. Cambridge, 1903 and *M. gressa* show webs different than the adult webs for the presence of symmetry and the absence of retreats. In this work, buildings of several life stages were studied looking for the potential influence of the ontogenical changes in the constructions in *Metepeira gressa*, considering the possible influence of non-biotic and biotic factors influence. The results founded during the annual cycle could allow us see the contrast with experiments in laboratory conditions and then the experimental influence.

## Material and methods

Seventy six webs of adults and 149 webs of juveniles during a year in Punta Espinillo (Montevideo) were analyzed monthly, using sections of 2 m wide and 10 m large. The relative humidity, temperature, the velocity of air and intensity of the light at the ground and 1 m high were registered. The samples were classified for the size and web characteristics. To know the phenology 870 samples were collected and observed by a pocket magnifier of 2x.

The high of the webs (distance from the ground to the bottom of the web), the minor and major diameter (wide and large) and the grade of inclination of the webs were measured. To improve the observation a black paper was put behind the web and sprayed water on the webs. Characteristics of the retreat during the development and egg-sacs number was also registered. To study the habitat selection we observed the phenology or population distribution and the distance between webs in the spiders which share the same plant of *Eryngium* sp.

The analyzed webs were selected *a priori* considering the complete ones. Samples of adult females and juveniles of the last stage were selected to register. Males were not used because they stop to build orb webs after the maturation molt, this fact was proved for Viera & Costa (1988). To compare the dates of webs of old stages of juveniles were analyzed together as a group *versus* webs of adult females based in previous studies of Viera (1989, 1992). All

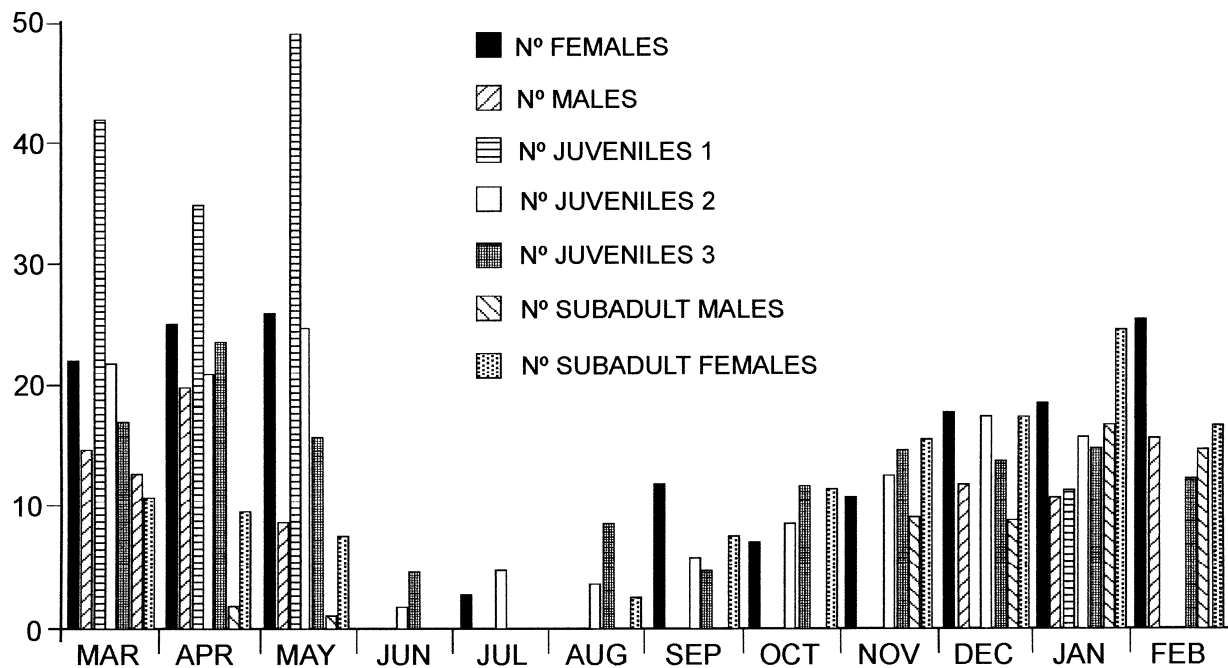


Fig. 1. Monthly variations of the population of *Metepeira gressa*.

Fig. 1. Variaciones mensuales de la población de *Metepeira gressa*.

the changes of population size through the all year were registered.

The test of comparison of means (Student t) with variance restrictions (F of Snedecor) to compare the webs of female and webs of juveniles groups and the non-parametric test of Mann- Withney & Wilcoxon (Siegel 1956) were used. The physical factors were correlated to web characteristics, using Spearman correlation. To Statistical analyzes we used pack PRESTA 6.1 (Abraira & Zaplana, 1989). The graphics was done with the program HPG and Quattro-Pro 5.9 (Astengo & Palma, 1993).

## Results

The influence of non-biotic data were not prove. Significant correlation (Spearman test) among web's inclination, web's high with the humidity, air velocity and light intensity did not observed. In twenty webs of juveniles of the last stage and 20 webs of adult females significant statistical differences were found (Table 1).

The samples were classified in five categories of development and the changes during the year are shown in the figure 1.

The first juvenile stage, the spiderlings stayed nearby the maternal web, they are small and grey, their webs have a major diameter until 2 cm. The second juvenile stage, they have their webs far of their maternal web, are bigger than the first stage and their

webs have a major diameter with 2-5 cm. The third juvenile stage, they have symmetrical webs with 5-8 cm of major diameter. The four stage is the sub-adult stage, the sub-adult females have slight epigynus, the abdomen is thin than the females and their webs are slightly asymmetrical with 8-10 cm of major diameter and smaller than the females webs and their coloration is similar to the adult spiders. The presence of retreat is no the same of the females, because their do not mimetic with the fruits of *Eryngium* sp. Sub-adult males show large pedipalpi, without spines. At the last stage the females have a conspicuous epigynus, global abdomen and build non symmetrical web, bigger than the other categories, with a retreat. Adult males did not used to the study of characteristics of the web, because they did not build orb-webs. They were found in threads in the periphery of female or sub-adult females webs. They have thin and long legs with erected and black spines in the metatarsus.

The webs of adult females showed asymmetry in all cases. The webs of juveniles showed a variability since perfect symmetry and slightly asymmetry, but in all cases the distance from the hub to the bottom was bigger than the distance from the hub to the top.

The mean comparison (Student test) between the number of sticky spiral to top and the number of sticky spiral to bottom was significant statistical different ( $p < 0.01$ ) in the webs of females. On the contrary was not different in webs of juveniles. The mean comparison between all spiral numbers and radii in the four sections of the webs of females and webs

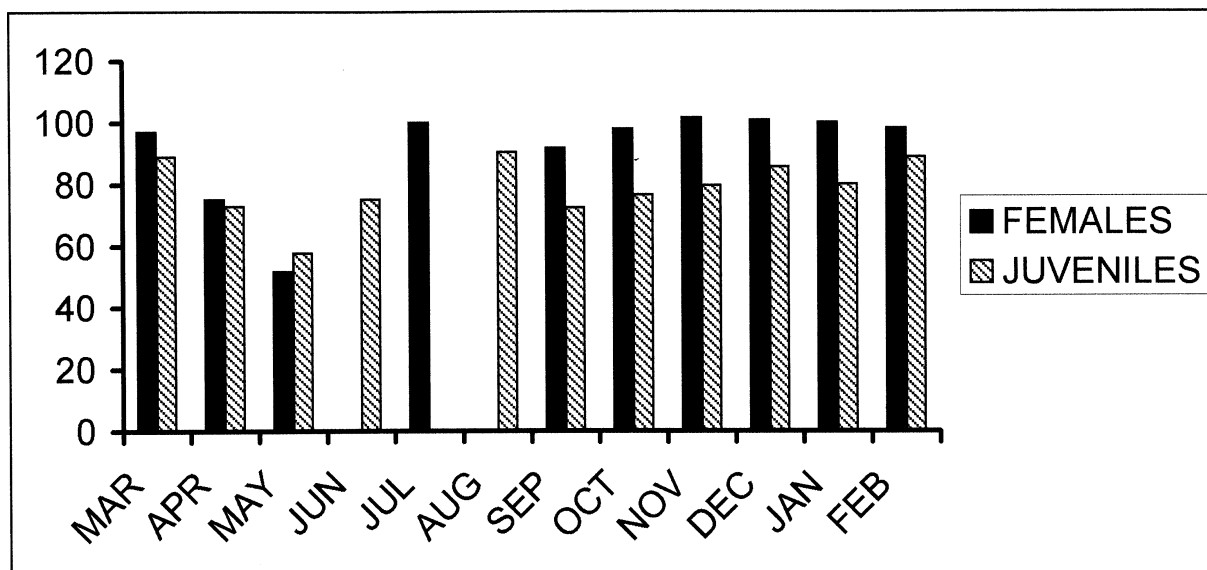


Fig. 2. Histogram of highs (cm) of female and juvenile webs  
Fig. 2. Histograma de alturas (cm) de telas de hembras y juveniles.

|            | females<br>(N=20) | VC   | juveniles<br>(N=20) | VC   | test M-W  |
|------------|-------------------|------|---------------------|------|-----------|
| web length | 10.99 ± 3.13      | 0.28 | 6.85 ± 1.36         | 0.32 | p < 0.002 |
| web wide   | 8.01 ± 1.32       | 0.16 | 5.84 ± 1.86         | 0.32 | p < 0.002 |

Table 1. Comparison values of web sizes using the Mann-Withney test (VC= variability coefficient).

Tabla 1. Valores comparativos de tamaños de telas usando el test de Mann-Withney (VC= coeficiente de variación).

of juveniles was not different. The comparison between spiral numbers and radii in webs of females and juveniles showed a positive correlation (Spearman test ( $p < 0.01$ )).

In rainy days was observed that the spiders cut threads of webs with the chelicerae and tarsii of the forelegs before the soil ingestion. The spiders did not build previous to the rain.

The occurrence of retreat of dense silk mimetic with the *Eryngium* sp. dry fruits was observed only in adults with egg-sac. The most females had only one ooteca except, three females with three ootecas of each and one female with four ootecas in the same retreat. The adult barrier-webs were bigger and stronger in the webs of females than the webs of juveniles.

The inclination was bigger in webs of females and was different to significant levels ( $t=1.75$ ) with a probability of  $0.1 > p > 0.05$ , than the webs of juveniles.

The distance from the first inner loop of the sticky spiral to the ground was major in webs of females, with a difference at limit of signification ( $t=1.98$ ;  $0.1 > p > 0.05$ ). (Table 2).

The spirals and the radii were registered (Table 3) and the mean values of webs of females were: radii  $35.1 \pm 7.55$ ; spirals  $81.06 \pm 19.64$  and in webs of juveniles was radii  $36.38 \pm 4.96$ ; spirals  $78.50 \pm 16.6$ .

The radii and spirals number for each section did not show significant differences between webs of adult and juveniles. In spite of this we found differences Wilcoxon ( $p=0.01$ ) between spiral numbers (section 1 and 2) and the spiral numbers (sections 3 and 4) in female webs showing a clear asymmetry in the females webs respect the juvenile webs.

The variation of the webs during the year showed that webs of females were built higher than the webs of juveniles, except in May. The webs of females were

|     | INCLINATION ANGLES |       |    |           |      |    | HIGH OF WEBS |       |    |           |       |    |
|-----|--------------------|-------|----|-----------|------|----|--------------|-------|----|-----------|-------|----|
|     | FEMALES            |       |    | JUVENILES |      |    | FEMALES      |       |    | JUVENILES |       |    |
|     | X                  | S     | N  | X         | S    | N  | X            | S     | N  | X         | S     | N  |
| MAR | 11.27              | 6.72  | 11 | 12.93     | 7.43 | 15 | 96.91        | 26.28 | 11 | 89.00     | 26.55 | 37 |
| APR | 14.14              | 10.38 | 7  | 13.00     | 6.37 | 12 | 75.14        | 29.19 | 7  | 72.91     | 28.04 | 22 |
| MAY | 15.00              | 9.17  | 3  | 12.40     | 7.30 | 5  | 51.67        | 45.24 | 3  | 57.57     | 31.11 | 7  |
| JUN | -                  | -     | 0  | 25.00     | 0    | 1  | -            | -     | 0  | 75.00     | 34.27 | 4  |
| JUL | 17.00              | 0     | 1  | -         | -    | 0  | 100.00       | 20.12 | 3  | -         | -     | 0  |
| AUG | -                  | -     | 0  | 10.33     | 6.11 | 3  | -            | -     | 0  | 90.50     | 13.60 | 4  |
| SEP | 13.00              | 7.71  | 5  | 16.83     | 5.71 | 6  | 91.80        | 19.83 | 5  | 72.50     | 25.36 | 6  |
| OCT | 15.00              | 11.88 | 6  | 10.20     | 5.63 | 5  | 97.86        | 19.12 | 7  | 76.60     | 24.59 | 5  |
| NOV | 9.25               | 5.30  | 8  | 10.43     | 5.65 | 7  | 101.44       | 19.42 | 9  | 79.50     | 23.56 | 8  |
| DIC | 15.00              | 9.14  | 6  | 14.50     | 6.91 | 8  | 100.71       | 16.60 | 7  | 85.56     | 23.11 | 9  |
| JAN | 9.38               | 9.35  | 8  | 12.20     | 6.14 | 5  | 100.00       | 18.99 | 10 | 80.00     | 20.76 | 6  |
| FEB | 18.20              | 5.07  | 5  | 12.00     | 6.53 | 7  | 98.17        | 11.18 | 6  | 88.67     | 14.59 | 9  |
| MAR | 16.43              | 5.09  | 7  | 14.70     | 6.70 | 10 | 94.13        | 11.09 | 8  | 84.16     | 24.72 | 32 |

Table 2. Inclination angles and high in adult and juveniles webs. Values of high (in cm) from the ground to the web bottom of females and juveniles.

Tabla 2. Ángulos de inclinación y alturas de telas de adultos y juveniles. Valores de altura (en cm) desde el suelo hasta el borde inferior de la tela de hembras y juveniles.

| FEMALES    |    |    |    |    | JUVENILES  |    |    |    |    |
|------------|----|----|----|----|------------|----|----|----|----|
| n° spirals |    |    |    |    | n° spirals |    |    |    |    |
| n° radii   | 1  | 2  | 3  | 4  | n° radii   | 1  | 2  | 3  | 4  |
| 33         | 14 | 14 | 18 | 18 | 35         | 15 | 16 | 18 | 15 |
| 38         | 19 | 19 | 19 | 30 | 33         | 19 | 18 | 20 | 18 |
| 40         | 15 | 22 | 22 | 24 | 30         | 22 | 21 | 15 | 20 |
| 42         | 15 | 25 | 25 | 29 | 32         | 18 | 14 | 18 | 15 |
| 45         | 15 | 17 | 27 | 28 | 41         | 25 | 22 | 22 | 20 |
| 43         | 21 | 15 | 26 | 27 | 28         | 18 | 16 | 15 | 17 |
| 41         | 22 | 25 | 31 | 28 | 36         | 21 | 25 | 25 | 19 |
| 40         | 16 | 17 | 33 | 30 | 40         | 33 | 32 | 28 | 32 |
| 45         | 20 | 14 | 31 | 32 | 45         | 20 | 31 | 25 | 22 |
| 42         | 13 | 15 | 24 | 19 | 43         | 22 | 24 | 20 | 24 |
| 27         | 14 | 22 | 26 | 26 | 38         | 18 | 17 | 20 | 17 |
| 26         | 21 | 11 | 25 | 26 | 42         | 20 | 18 | 17 | 15 |
| 30         | 19 | 20 | 14 | 31 | 39         | 18 | 16 | 20 | 20 |
| 24         | 7  | 12 | 13 | 13 | 32         | 16 | 15 | 17 | 15 |
| 36         | 18 | 16 | 17 | 15 | 35         | 18 | 16 | 17 | 15 |
| 29         | 17 | 15 | 19 | 16 | 33         | 16 | 14 | 15 | 17 |
| 25         | 15 | 12 | 20 | 13 |            |    |    |    |    |
| 26         | 7  | 9  | 10 | 12 |            |    |    |    |    |

Table 3. Radii and spirals number in four sections of the web of adults and juveniles.

Tabla 3. Número de radios y espirales en cuatro secciones de telas de adultos y juveniles.

|                 | MAR | APR | MAY | JUN | JUL | AUG | SET | OCT | NOV | DIC | JAN | FEB | MAR |
|-----------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 1/pl female     | 18  | 20  | 18  | 0   | 03  | 0   | 10  | 07  | 09  | 12  | 17  | 19  | 18  |
| 2/pl female     | 04  | 05  | 06  | 0   | 0   | 0   | 02  | 0   | 02  | 06  | 02  | 04  | 04  |
| 3/pl female     | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 02  | 03  |
| 1/pl sub male   | 05  | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 05  | 03  | 09  | 07  | 09  |
| 2/pl sub male   | 07  | 02  | 01  | 0   | 0   | 0   | 0   | 0   | 04  | 06  | 08  | 07  | 04  |
| 3/pl sub male   | 01  | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 01  | 03  |
| 1/pl sub female | 05  | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 05  | 03  | 09  | 07  | 09  |
| 2/pl sub female | 01  | 05  | 02  | 0   | 0   | 0   | 05  | 05  | 06  | 08  | 0   | 05  | 07  |
| 3/pl sub male   | 0   | 02  | 02  | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 09  | 03  | 0   |
| 1/pl juvenile 1 | 42  | 35  | 49  | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 12  | 0   | 0   |
| 2/pl juvenile 1 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 13  |
| 3/pl juvenile 1 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
| 1/pl juvenile 2 | 01  | 0   | 0   | 02  | 03  | 02  | 02  | 02  | 03  | 06  | 06  | 0   | 08  |
| 2/pl juvenile 2 | 18  | 17  | 17  | 0   | 02  | 02  | 04  | 07  | 10  | 12  | 10  | 0   | 11  |
| 3/pl juvenile 2 | 03  | 04  | 08  | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 03  |
| 1/pl juvenile 3 | 03  | 17  | 12  | 03  | 0   | 07  | 04  | 10  | 11  | 10  | 03  | 08  | 13  |
| 2/pl juvenile 3 | 06  | 04  | 04  | 02  | 0   | 02  | 01  | 02  | 04  | 04  | 0   | 02  | 02  |
| 3/pl juvenile 3 | 08  | 03  | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 12  | 03  | 06  |
| % plant         | 73  | 82  | 48  | 51  | 83  | 74  | 76  | 82  | 85  | 84  | 79  | 88  | 77  |

Table 4. Webs number for each plant of *Eryngium* and % occupation plants.Tabla 4. Número de telas por cada planta de *Eryngium* y % de plantas ocupadas.

built higher more frequently in females than in juveniles (Fig. 2).

Respect to the habitat selection and the specificity between spiders and plants of *Eryngium* sp., one to three webs were observed in the same plant. Table 4 shows the webs number for each plant during the study and the average of occupation plant.

The retreat consist in a dense structure of silk with a wall to divide the retreat in two spaces, the deeper for depositing eggs and the other to protect the spider. The color of the retreat mimetic with the *Eryngium* dry fruits.

The females with egg-sacs were frequent since November until May (summer- fall). The species lives in winter as a egg and the juveniles emerged in Spring. It is possible find samples of different stages at the long of the year, due to the females can put until three egg-sacs in their life. The presence of egg-sacs in November could be indicate the presence of males since October, but did not observed due to they do not build any webs. The males was observed since December until May when the juveniles of first stage increase their number . In June (beginning Winter) a few juveniles of stage 2 and 3 were sampled. In July

only 3 females and 5 juveniles of second stage were found. The number of individuals increased in Summer and Fall.

## Discussion

In *M. gressa* was observed that the web structure vary during the development in the asymmetry in the female webs while, in the juvenile webs was observed a constant symmetry in different stages of development, and a slightly gradual asymmetry in the last stage (subadult females) The web-buildings at the same stage of development did not show seasonal changes during the all year, according with Waldorf (1975). This fact could be influenced by the weather conditions during the all year had an adequate humidity and temperature with occurrence of different potential prey (temperate zone). In spite of this consideration, adult females did not occur in the winter and the rest of the population was quite decreased.

The assymetry of *M. gressa* agree with the fact found by Brown & Christensen (1982) in *Nephila* sp. (Linnaeus, 1767) that have a centric hub in juvenile

stages and the hub in the course of development increase the asymmetry and finally the adult webs were absolutely eccentric and the distance inter-radii and inter-spirals is bigger. Witt (1973) observed that relationship between the large of the legs and the web size was due to the legs like as an instrument of measure during the constructions and could explain the size differences. In this study did not find differences between spirals and radii numbers, but differences of mean sizes were found. In the observations at the field the web showed the same web pattern found before under laboratory conditions (Viera 1989, 1994) proving the fact that the possible influence of the study over the buildings was minimal.

Adult males were not used in this experiments because they did not build orb-webs. Also, this fact probably limited the observation to phenology study too. The statistical differences between webs of juveniles and adults about the high, coloration and retreat location should be influenced for physiology modifications in females like as oviposition as suggested by Witt & Reed (1965). The fact that adult females build webs more high than the juveniles could be explain for the presence of retreat mimicry with the *Eryngium* fruits. This retreat mimetic with dry fruits could avoid that insects and birds eat the spider and/or eggs with the fruits

Seven juveniles sit their webs in higher areas on the plants in May, when females did no observed, that suggest that may be the juveniles samples did not sit in higher areas to avoid the competence for food with females. In agree with Enders (1974) the different high of the webs to the substratum could allow the coexistence of individuals which exploited the same resource in a similar way. Also I think that different stages avoid the species specific competition with the high location and inclination of their webs.

About the influence over the buildings of environment factors, I observed that the spider need a minimum velocity of air to hold the initial line-thread. Also I observed the spiders did not build webs in *Eryngium* areas under strong wind, indicating that exists minimum and maximum values of velocity air to allow the building process. The population was homogeneous, but the fact that females were kept three or four egg-sacs could indicate at least two life cycle through the year.

In this experiments a high specificity between *Eryngium* sp. y *M. gressa*, was observed, indeed specimens of *M. gressa* were no found in other plants in the same area. The association between plants and spider was already observed by Chew (1961) and Riechert (1976). The distribution of *Eryngium* plants could affect the webs distribution, but the estimation

per m<sup>2</sup> showed a superior spider density (number of plants/ spider numbers). The spiders did not occupied all the potential places, but this factor is not enough to explain the spider distribution founded. The spatial distribution was regular taking into account the distance among webs. This suggest the existence of interactions among spiders sharing a territory. In this species I observed a certain range of tolerance among individuals sharing the same plant, with a minimum distance among webs. This tolerance approach *M. gressa* to other social species of the same genera (Uetz 1990), like *M. spinipes* F.O.P. Cambridge, 1903 and *M. labyrinthea* (Hentz, 1847) being the first step to the necessary tolerance to live in groups.

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