

# Activity fluctuations of *Pardosa lugubris* (Walckenaer), Araneae Lycosidae, during the breeding-season

by

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## INTRODUCTION

Pit-fall traps have been widely used for investigations into the activity of Lycosid spiders. Using this technique TRETZEL (1954), HEYDEMANN (1960), WIEBES (1960) and DUFFEY (1962) developed phenological curves for some species of the genus *Pardosa*. Generally these curves are given for males, females and juveniles separately. A general idea of population activity can be obtained in this way but more precise interpretation is difficult, especially as most data are based on weekly or monthly catches. In the field it had already been noticed that during the reproduction period the activity varies appreciably from one spider to another (VLIJM c.s., 1963). There was not only a difference in the activity of males and females, but also some evidence was found that the activity of females without cocoons was higher than the activity of females with cocoons. It seemed to be of interest to concentrate on the quantitative aspects of activity in an attempt to correlate these with the stage of the animals. A method was developed to measure activities of spiders of the genus *Pardosa*. *Pardosa lugubris* (Walckenaer) was used as an experimental animal.

## MATERIALS AND METHODS

The experiments were conducted in a container measuring 1.80 m by 0.87 m by 0.20 m, filled with a mixture of sand and loam. A smooth plastic wall was placed inside the rectangular container in such a way that the shape of the arena approached that of an ellipse. Lights with built-in reflectors were installed over the container, to illuminate the arena from 08.30—17.00. During this period the surface temperature was 30—35° C and a normal humidity of the substrate was maintained by pouring water in the corners of the container at regular intervals. A picture of the test room is given in fig. 1.

The spiders were caught in the field as sub-adult animals approximately two weeks before the start of the experiment. The sexes, which can easily be distinguished in the sub-adult stage, were separated. The animals became adult on 12 March 1964. They were fed on *Drosophila melanogaster* (var. *vestigial*). The test animals, 20 adult males and 20 adult females, were placed in the arena three days after the last moult. An identification mark was placed on each individual animal beforehand by painting a band of different colours on the metatarsus of the second leg. During the first few days the animals were observed continuously and special notice was taken of the time and duration of copulation. The test animals did not show any abnormal behaviour in comparison to those observed in the field.

The location of all animals was marked on a plan of the container every half

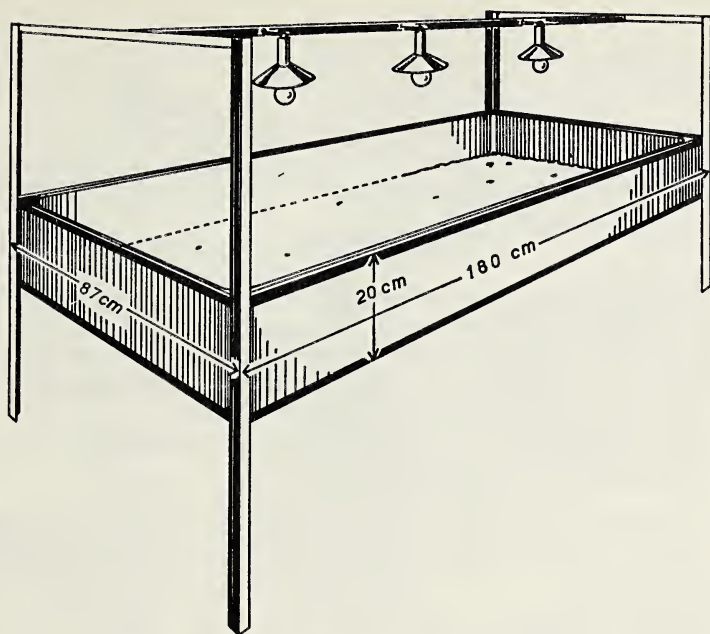


Fig. 1: The test room.

hour during a period of eight hours, resulting in 16 observed points per day. By connecting, in chronological order, the observed points of one day for each specimen a broken line is obtained, the total length of which we shall call for the purpose of this study "the daily activity". In order to examine the homogeneity of the daily activity-measurements the Wilcoxon test was used, indicated by P (probability with a unilateral critical zone).

#### THE BEHAVIOUR OF THE ANIMALS IN THE TEST ROOM

During the period 15 to 20 March, the animals were observed continuously during the day time. During this time most of the copulations took place. The exact time of 16 of these could be established: 95, 100, 116, 125, 165, 175, 186, 188, 189, 205, 210, 233, 235, 240, 260 and 300 minutes. These are rather long periods, compared with some other species of the genus *Pardosa* e.g. *Pardosa amentata*, for which 20—60 minutes is usual (VLIJM c.s. 1963). During copulation the female was relatively motionless. It was observed in many cases that towards the end of the copulation the female started walking through the arena with the male on its back. After copulation a short period of high activity occurred.

In general the females which had recently moulted were rather restless. This was partly due to the chasing away of courting males, but especially to their well developed feeding activity.

A few days before the cocoon was constructed, appetite and activity gradually diminished. An increased level of activity, often of short duration, on the last day before the construction of the cocoon, was closely connected with the urge to seek

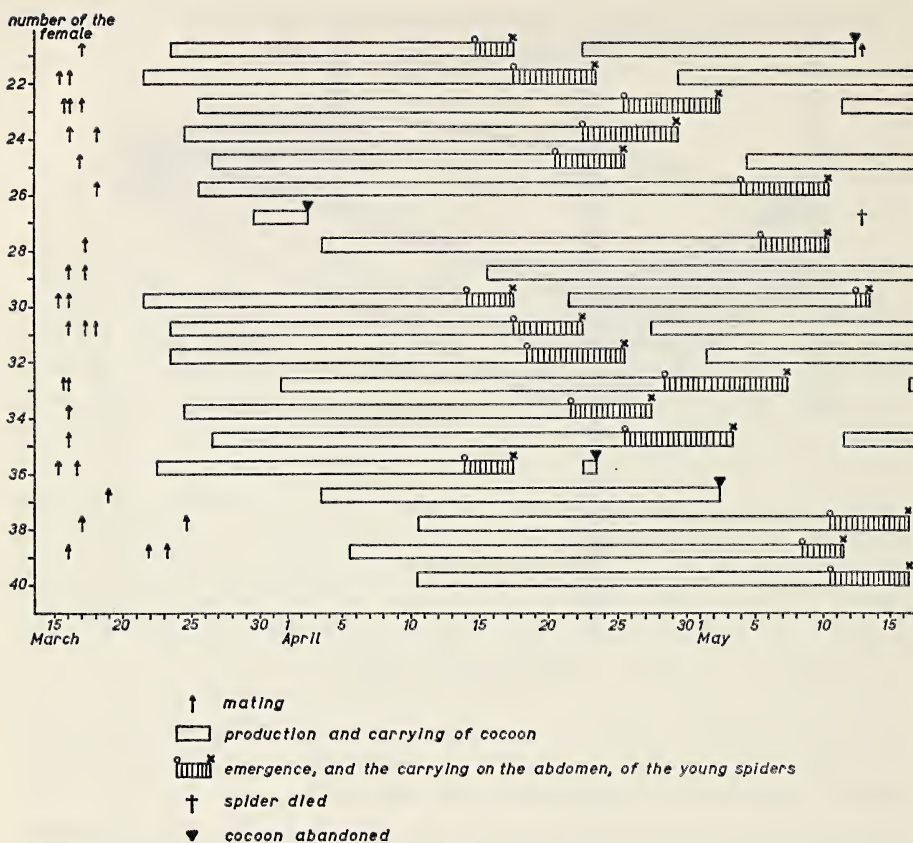


Fig. 2: Diagram of the reproductive period.

a suitable site in which to spin it. The spinning of the cocoons took place only at night. It appears (fig. 2) that the formation of a cocoon can occur as early as nine days after moulting, but in some cases may be delayed for a month.

During the cocoon period, which was approximately 3 to 5 weeks, the females usually lay down with the legs spread out, and thorax and abdomen sunk in a hollow. In this period the females were very tolerant towards each other and little food was consumed.

At the end of the cocoon period the silk cover was opened. The female did not move so that the pulli could mount its back. Depending on the number of spiderlings and their activity this stage took  $1\frac{1}{2}$ —2 days. As soon as the empty cocoon had been abandoned, the female, covered with young spiders, became increasingly active, often preferring to move along the wall of the arena. During this period, which lasted from 3 to 8 days, the females rarely fed. During these days of high activity of the female, the young spiders individually left the abdomen. After the last young spider had left the mother, a sudden change took place and the spider started eating again. In most cases a second cocoon was formed within a week, and, in almost all cases, was fertile. The second as well as the third cocoons were



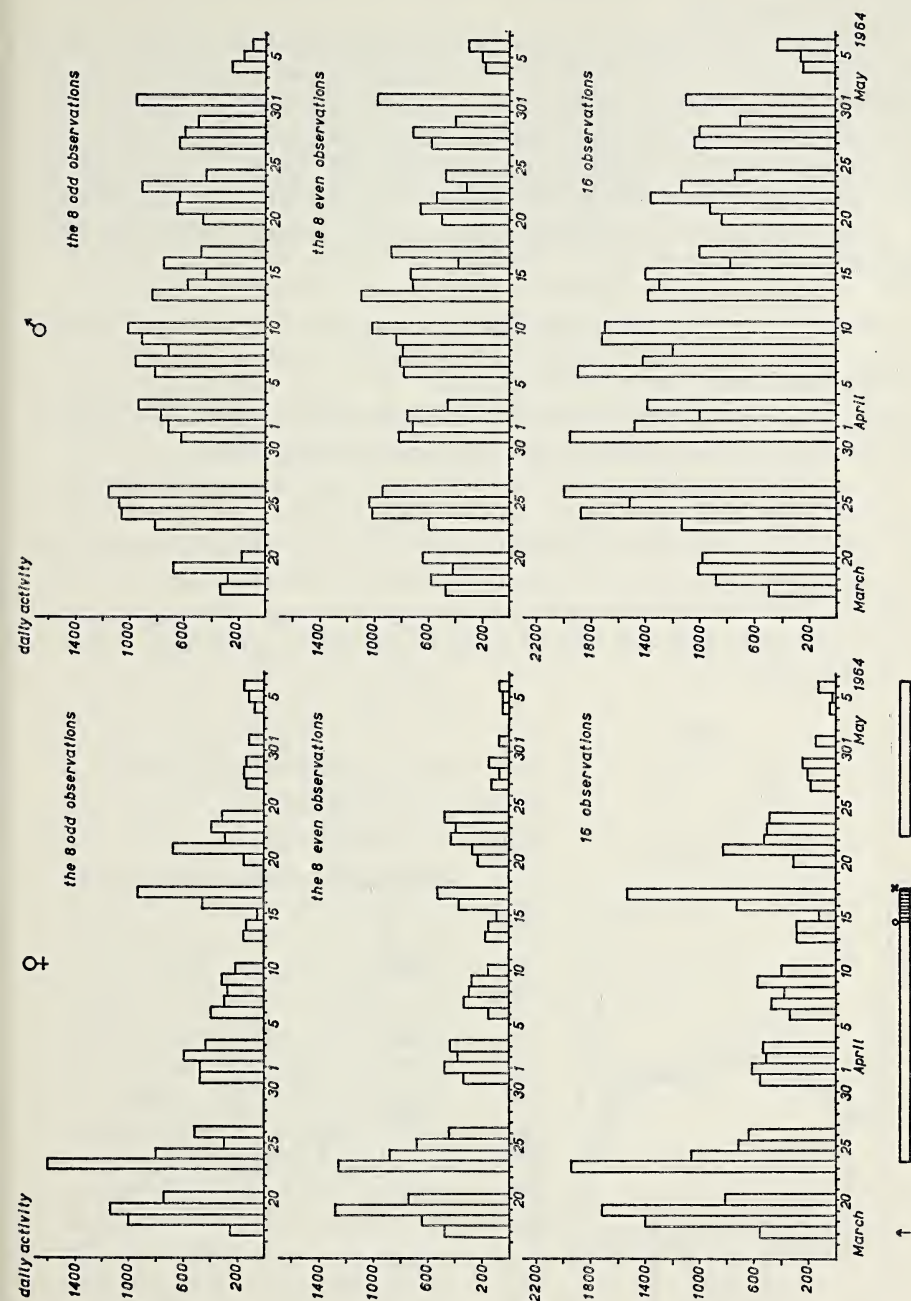


Fig. 3: The three measured daily activities for a representative male and female.

produced generally without further copulation. The third cocoon was usually prematurely abandoned.

The males showed both search and courtship behaviour before as well as during the cocoon period. After copulation a new spermweb was prepared and sperm-induction occurred. As soon as they reached maturity they had little appetite. Half of the males died within a month (end of April) and the remainder within two months (end of May). Almost all females lived until September and some till the end of October. This seems to be normal as also in the field males decrease in numbers just after the copulation period, whereas females survive for some months.

## RESULTS AND DISCUSSION

### 1. The method of observation.

We have already described the use of the term "daily activity". It is evident that the more active an animal is, the less accurate is this method.

The 16 observed points per day recorded every half-hour were divided into groups of "even" and "odd" observations, of 8 points each. So, two activity curves were obtained for each specimen using 8 points and a total activity curve using all 16 points. These three types of curves were calculated for all experimental animals. In general they show the same result although there was some individual variation. The three measured daily activities are demonstrated for a representative male and female (fig. 3).

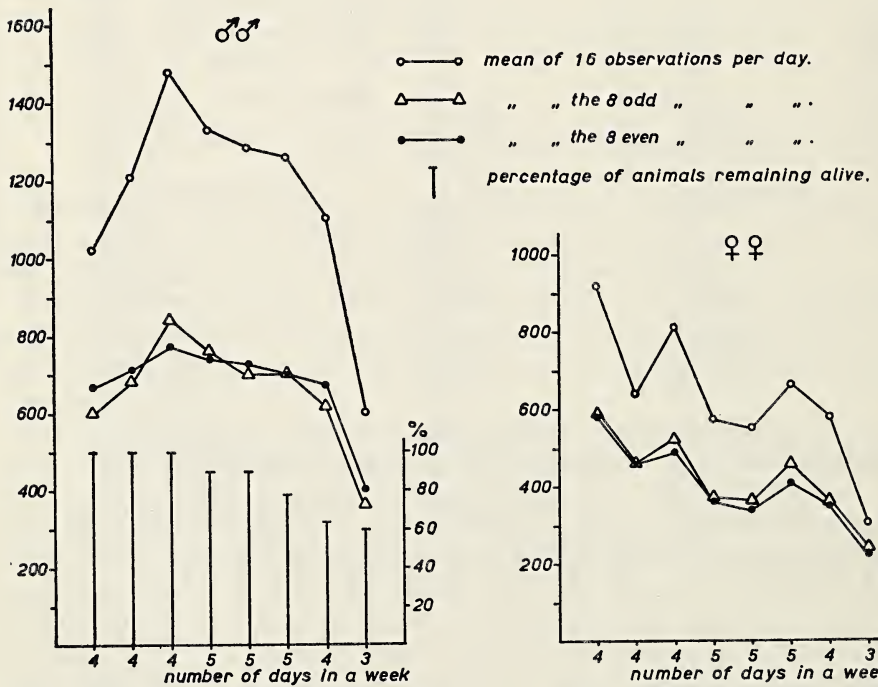


Fig. 4 (left): The mean weekly activity of 20 males.

Fig. 5 (right): The mean weekly activity of 20 females.

In order to show the general trend of activity, figs. 4 and 5 demonstrate the average weekly activity of the 20 males and 20 females. The percentage of living males is also shown in fig. 4, because their number decreased due to death during the experiment. It can be seen that the "even" and "odd" activity curves of the males correspond reasonably well and that they follow a similar pattern as the 16 point curve. In the case of the females, where the level of activity is much lower, the three curves show an even greater similarity. Generally it can be postulated, on the basis of figs. 3, 4 and 5, that with 8 observations a day, this method gives reliable results.

The accuracy of this method was examined further, by using SPEARMAN's test to calculate the accuracy of the activity fluctuations of the "odd" and "even" activity diagrams for each specimen and then correlating this with the level of activity. The test indicates that, taking 8 hourly observations per day, reasonable accuracy is achieved at an activity level of 600—900 (as was the case in the males), ( $P < 0,05$  for 75% of the males) and that at an activity level of 250—550 (as was the case in the females) this method is fully accurate ( $P < 0,05$  for 100% of the females).

## 2. The fluctuations of the level of activity.

The fluctuations in the level of activity (fig. 3) indicated in the previous section, will now be further analysed and correlated with the behaviour of the animals.

In the females a difference in activity before and after the production of the cocoon was observed. In order to check this, the average activity for each specimen was calculated for the 1st, 2nd, 3rd, 4th and 5th day before and after the cocoon was made. Although the graph (fig. 6) gives a slight indication of a higher level of activity before the production of the cocoon, this does not appear to be statistically significant ( $0,1 < P < 0,2$ ). The increasing activity of the males, which gradually appeared in the second and third week of the experiment (fig. 4) may have had a disturbing effect on the activity of those females already carrying cocoons.

In this connection earlier data from *Pardosa amentata* (Cl.) are important.

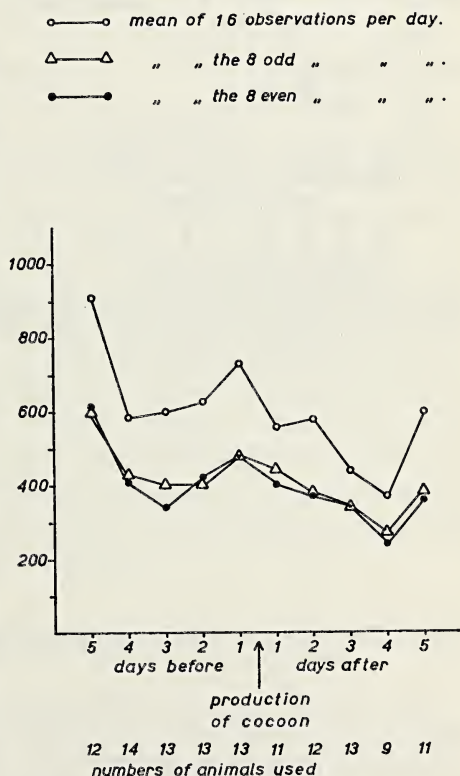


Fig. 6: The activity of females before and after the production of the cocoon.



The activity of these animals, whose activity curve is generally comparable to *P. lugubris*, was determined in two experiments, in one of which the males were removed from the container after the copulation period. In these experiments a total of five observations were made, once every two hours. Following the method demonstrated in fig. 6 the daily averages for both experiments with *P. amentata* were marked in fig. 7. Two conclusions may be drawn from these graphs. The level of activity of the females in the experiment with males is higher than that of the experiment without males. Furthermore, after statistical adjustment, it appears that only in the experiment without males there does occur a clear activity peak for females prior to the production of the cocoon ( $P > 0,2$  resp.  $P < 0,0001$ ).

It may be concluded from these data that for both *P. lugubris* and *P. amentata* the females show a higher activity before the production of the cocoon, because of a great need for food, than just after cocoon production, and that the relatively high activity of the females during the first part of the cocoon period, both in *P. lugubris* and *P. amentata*, is brought about by the disturbing effect of the extremely active males (see later).

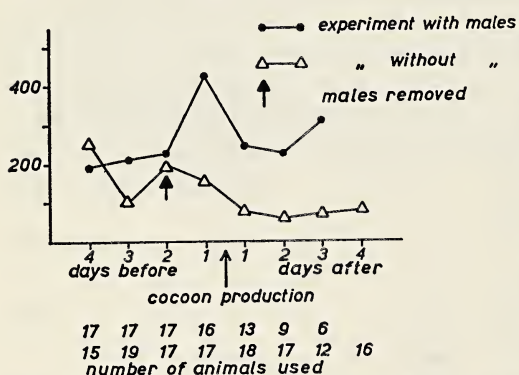


Fig. 7: The daily averages of activity of females of *P. amentata* (the graphs are based on 5 observations per day).

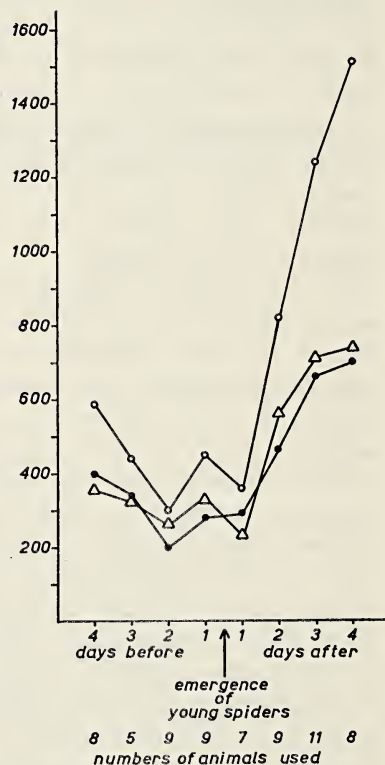


Fig. 8: The activity of females before and after emergence of young spiders.

The activity of females with young is demonstrated in fig. 8. On the second day after the tearing open of the cocoon an increase in activity occurred which continues to develop strongly. The level of activity before the emergence of young spiders in comparison with the days after, is significantly different ( $P < 0,0001$ ). The low average of activity on the first day after the tearing open of the cocoon

is explained by the immobile position of the females during the time that the pulli mount the abdomen. It is assumed that the increased level of activity of the females with pulli may be important in helping the species to disperse.

The average activity of males was low during the period in which copulations occurred (fig. 4), which in this experiment was restricted to 15—19 March (fig. 2). Activity was low then because during the first week after moulting the males usually courted in front of a female for long periods of time, so that there was little movement. In the second and third week after moulting the activity increased rapidly due to a sharp change in behaviour of the males. The intensity of the display decreased gradually and the behaviour pattern finally changed to a feverish searching for females. In the case of these experiments, this high searching activity was purposeless as all females had been fertilized and carried cocoons. The change observed in behaviour is probably very important in natural conditions, as by means of this the chance for isolated females to be fertilized increases. This could be demonstrated in the field for other species e.g. *P. monticola* and *P. nigriceps* (c.f. VLIJM and KESSLER-GESCHIERE, 1966).

Afterwards the activity of the males decreased again (fig. 4), due to the gradual approach of complete exhaustion, and the loss of legs, followed by death. Beneath the curve in fig. 4 it can be seen that during this time the number of males had already declined to 60%.

### Summary

1. A method is described for measuring the activity of terrestrial living spiders on a quantitative basis, using *Pardosa lugubris* (Walckenaer) as a test animal.
2. Female spiders showed a high feeding activity before cocoon production but this decreased during the cocoon carrying period.
3. When carrying young spiders, the activity of the females increased strongly. It is thought that this may be of importance in helping the species to disperse.
4. The level of the activity of the males during the reproductive period was higher than that of the females. After copulation the activity of the males increased coupled with a marked change in courtship behaviour. At the end of the reproductive period the activity of the males decreased as death approached.
5. It is suggested that the above-mentioned differences in the activity between the sexes, as well as those caused by reproductive stages should be taken into account in conclusions based on pitfall trapping.

### Acknowledgements

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## Zweefvliegen in de Leidse Hortus (Dipt., Syrph.)

door

S. J. VAN OOSTSTROOM

Om een indruk te verkrijgen van de in de Leidse Hortus voorkomende zweefvliegen-fauna werd door mij gedurende een deel der oorlogsjaren (1940—1943) regelmatig daar verzameld, terwijl tegelijkertijd notities werden gemaakt over de frequentie der waargenomen soorten.

Veel materiaal werd in dezelfde tijd ook bijeengebracht door een groepje Leidse biologen. Vooral de heer A. D. J. MEEUSE verschaftte mij talrijke exemplaren, doch ook de heren A. G. L. ADELBERT, A. C. PERDECK en W. VERVOORT hielpen mee om het overzicht vollediger te maken.

Door allerlei andere werkzaamheden werd daarna echter mijn Syrphiden-studie op de achtergrond gedrongen, zodat van publicatie niets kwam. Eerst nu, na ruim 20 jaar, heb ik het werken aan mijn destijds bijeengebrachte collectie weer eens opgevat en ik wil nu niet nalaten de verzamelde gegevens alsnog het licht te doen zien. In totaal bevat de lijst 58 soorten en 3 variëteiten.

De vermelde exemplaren bevinden zich alle in mijn bezit; onderstaande opgaven zijn vrijwel geheel erop gebaseerd; hier en daar kon ik wat de vliegtijd betreft een kleine aanvulling toevoegen op grond van een aantal door de heer C. O. VAN REGTEREN ALTENA in dezelfde jaren verzamelde dieren, die zich bevinden in de collectie van het Rijksmuseum van Natuurlijke Historie te Leiden.

De Leidse Hortus, ruim 2,5 ha groot, wordt voor een groot deel door de bebouwing der stad ingesloten; slechts aan de zijde van de Witte Singel treedt deze bebouwing wat terug. Naar het mij voorkomt mag worden aangenomen, dat veel van de in de Hortus voorkomende Syrphiden daar hun gehele levenscyclus volbrengen; een groot aantal soorten wordt immers regelmatig ieder jaar weer opnieuw aangetroffen. Natuurlijk zullen ook wel dieren van elders „aanvliegen”; ik vermoed echter, dat hun aantal slechts gering is vergeleken met die welke werkelijk in de Hortus „gevestigd” zijn.

De achter de namen in de hier volgende lijst voorkomende Romeinse cijfers geven de maanden aan waarin de dieren werden gevangen of waargenomen.