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Arachnol. Mitt. 13:29-40 Basel, Juli 1997

On the biology of *Dipoena torva* (Araneae: Theridiidae)

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Abstract: On the biology of *Dipoena torva* (Araneae: Theridiidae). Data are given concerning stratification, phenology, feeding and mating behaviour of the theridiid spider *Dipoena torva* (THORELL, 1875). The species was found predominantly at heights of around 10 metres on the stems of oaks and pines in Berlin, Germany. The sex ratio was more or less 1:1. Adult spiders were active during summer whereas juveniles were only found before and after the main activity period of adults. This species seems to be active during the daytime. The main food consists of ants. The mating behaviour is described. The occurrence of *D. torva* is a result of certain biotic and abiotic factors such as the abundance of ants, the understorey and structural factors.

Key words: *Dipoena torva*, life history, stratification, pine trees, oaks, Berlin, Germany

INTRODUCTION

The vertical distribution of spiders in a single habitat has been studied little up to now (BRAUN 1992, SIMON 1995). Thus, knowledge about spider species not dwelling on the ground is underdeveloped. This may be the reason why little is known about the biology of *Dipoena torva* (THORELL, 1875). There are only a few records of this species from Europe. MILLER (1967) mentioned *D. torva* collected by BERTKAU in a park in Bonn, Germany, and by WIEHLE beaten from spruce and sifted from litter "in Germany" (for both records no dates or better records of the sample sites were available). Two specimens of this species found on pine tree trunks in southern Finland are described by PALMGREN (1972, 1977). Two other records from northern Great Britain, also collected from pine tree trunks, are mentioned by LOCKET et al. (1974). Eleven years later, ROBERTS (1985) gave some more records from southern England, Ireland and Scotland. For Switzerland, MAURER & HÄNGGI (1990) mention only one record: from the southern part of the country recorded by SCHENKEL (1925). According to this source, the habitat of *D. torva* should be light *Larix*-forests and xerothermic areas. For central Europe HEIMER & NENTWIG (1991) note *D. torva* as very rare.

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In the area of Berlin, where this investigation was carried out, *D. torva* was not known to occur until colour traps placed in the crowns of pine trees were examined by U.KIELHORN. Two males were identified at that time (PLATEN pers. comm., see also PLATEN et al. 1991). Thus, up to now little has been discovered about the biology of this species. In this paper I will give some results on the phenology, the habitat, and the behaviour of *D. torva*.

STUDY AREAS

The ecological investigations were carried out in the Grunewald and the Spandau forests in Berlin (Germany). On average, the air temperatures in Berlin are about 1-2°C higher than the surrounding countryside, and during summer maximum temperatures may even be up to 9°C higher (after HORBERT 1983 in SUKOPP 1990).

The site in Grunewald was a mixed stand of pine trees (*Pinus sylvestris* L.) that were about 140 years old, as well as 40-year-old oaks (*Quercus robur* L.) and moutain ash (*Sorbus aucuparia* L.). Pine trees reached heights of about 26 to 31 m. Oaks and ashtrees grew as a second layer more or less like bushes with a maximum height of 12 m. The ground was sparsely covered with grass (*Avenella flexuosa* (L.) Trin.) and moss.

In Spandau, two different stands were examined. One was a 150-year-old pine tree stand (maximum height 35 m) with a herb layer of heather and grass. The other one was a 200-year-old oak tree stand (*Quercus petrea* Liebl.) (maximum height 40 m), with a lot of bushes (*Prunus padus* L.) which reached a height of 6 m.

MATERIAL AND METHODS

In Grunewald, the stratification of spiders was investigated over a period of three years from April 1991 to March 1994 (SIMON 1995). Stem-eclectors (BEHRE 1989) were used at four different heights (1.5 m, 5 m, 10 m & 13 m). Each height represented a certain region of the stem with differences in bark texture: at 1.5 m, near the soil surface, the bark was roughly fissured; at 5 m, the bark was still very scaled but the influences of the soil fauna and the soil surface microclimate were reduced; at 10 m scaly and smooth bark structures were adjacent; at 13 m only smooth bark was left; and finally above 13 m the crown emerged. The pine trees had the same diameter in every trapping height to avoid the influence of stem girth (SIMON 1991).

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In the crowns of four pines, trapping was done using branch-eclectors (BARSIG & SIMON 1995, SIMON 1995). Six traps were installed in each crown.

All traps mentioned above were sampled every two weeks.

In the two other stands, six oak trees and six pine trees were examined using stem-eclectors at two heights (5 m and 8 m) during 1992 and 1993 (THÖMEN 1994, PFÜTZE 1994). These eclectors were constructed as temporal selective traps. Four trapping containers each sampled during a period of 6 h from 09:00 - 15:00, 15:00 - 21:00, 21:00 - 03:00 or 03:00 - 09:00. These traps were emptied every week.

In order to observe the mating behaviour of *D. torva*, two males and two females were caught alive in Grunewald. Each female was kept in a transparent plastic box (18 x 18 x 5 cm). After web-building, one male was added carefully. After mating, the males were removed again and after one day the procedure was repeated.

RESULTS

Spatial aspects

In the five investigated heights of the pine trees in Grunewald, 43 males, 58 females and 36 juvenile specimens of *Dipoena torva* were caught in the three years. Most of the individuals were found at the height of 10 m. The number of individuals, juveniles as well as adult males and females, decreased in all three years from that height to the tree top and down to the bottom (fig. 1a, b, c).

The juveniles of this species are not easy to classify. There are relatively few definite records, as many may have been identified only as „theridiids". Nevertheless, the results reveal that the juveniles have their main habitat, like the adults, at the height of 10 m (fig. 1c). This is probably caused by the females depositing their coccoons predominantly at this height.

During the entire time of this investigation, it was not possible to observe any kind of stratum change during the activity period of the spiders (fig. 2). This phenomenon described by ALBERT (1982) for spiders living on the bark of young beech (e. g. *Drapetisca socialis*) has also not been observed in most other spider species living on old pines (SIMON 1995).

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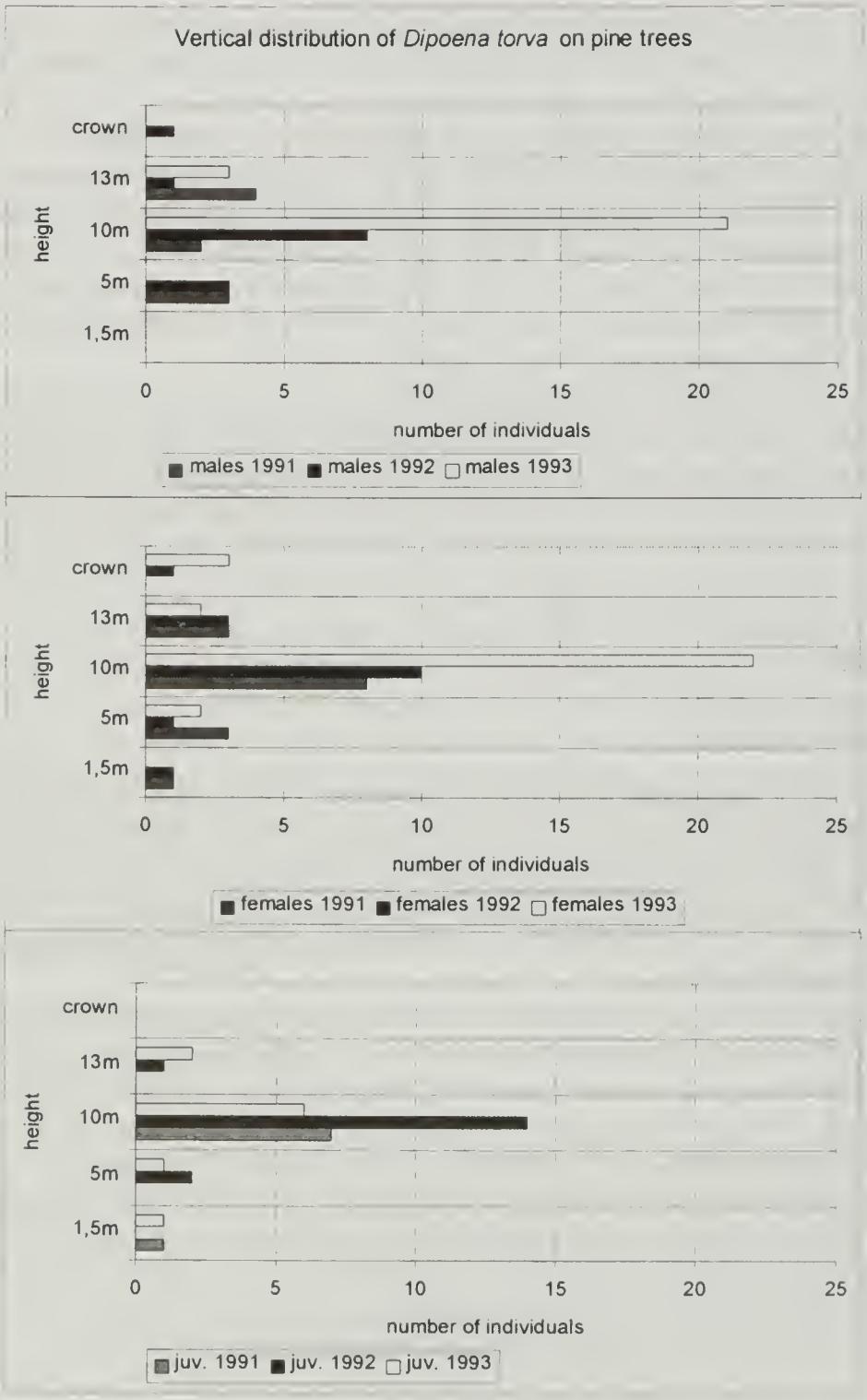

Fig. 1: Vertical distribution of *D. torva* on pine trees. a) males; b) females; c) juveniles.

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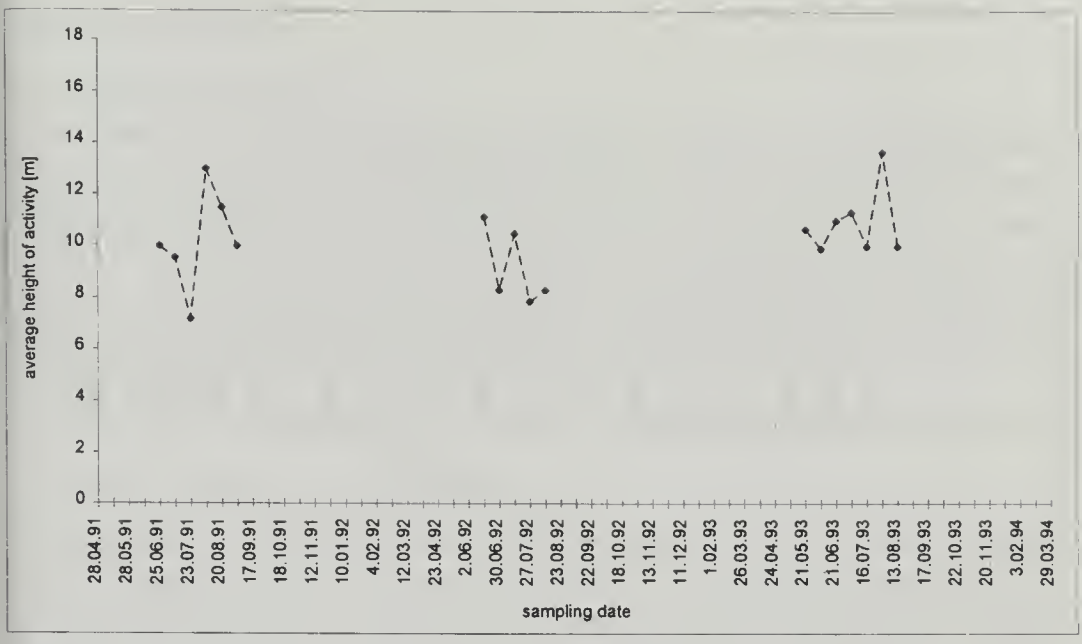

Fig. 2: Average height of activity of *Dipoena torva* at pine trees.

In Spandau, no specimens of *D. torva* were found on the tree trunks of the pines, either at 5 or at 8 m height (THÖMEN 1994). However, 160 specimens of *D. torva* were found on oaks (PFÜTZE 1994). About two thirds of the individuals were caught at a height of 5 m and the remainder at 8 m. Only slightly more spiders were caught in south-facing stem eclectors than in north-facing ones (table 1).

Table 1: Number of individuals of *Dipoena torva* in two different heights on stems of oaks in Berlin-Spandau

	trap exposited to north	**trap exposited to south**
5 meters	42	68
8 meters	24	23

Over two years, an average of 26 individuals were caught on each of six oaks in Spandau. This is about the same number as in Grunewald on the pine tree with the trap installed 10 m above ground. From these results it is evident that there is only a small population of *D. torva* on each tree.

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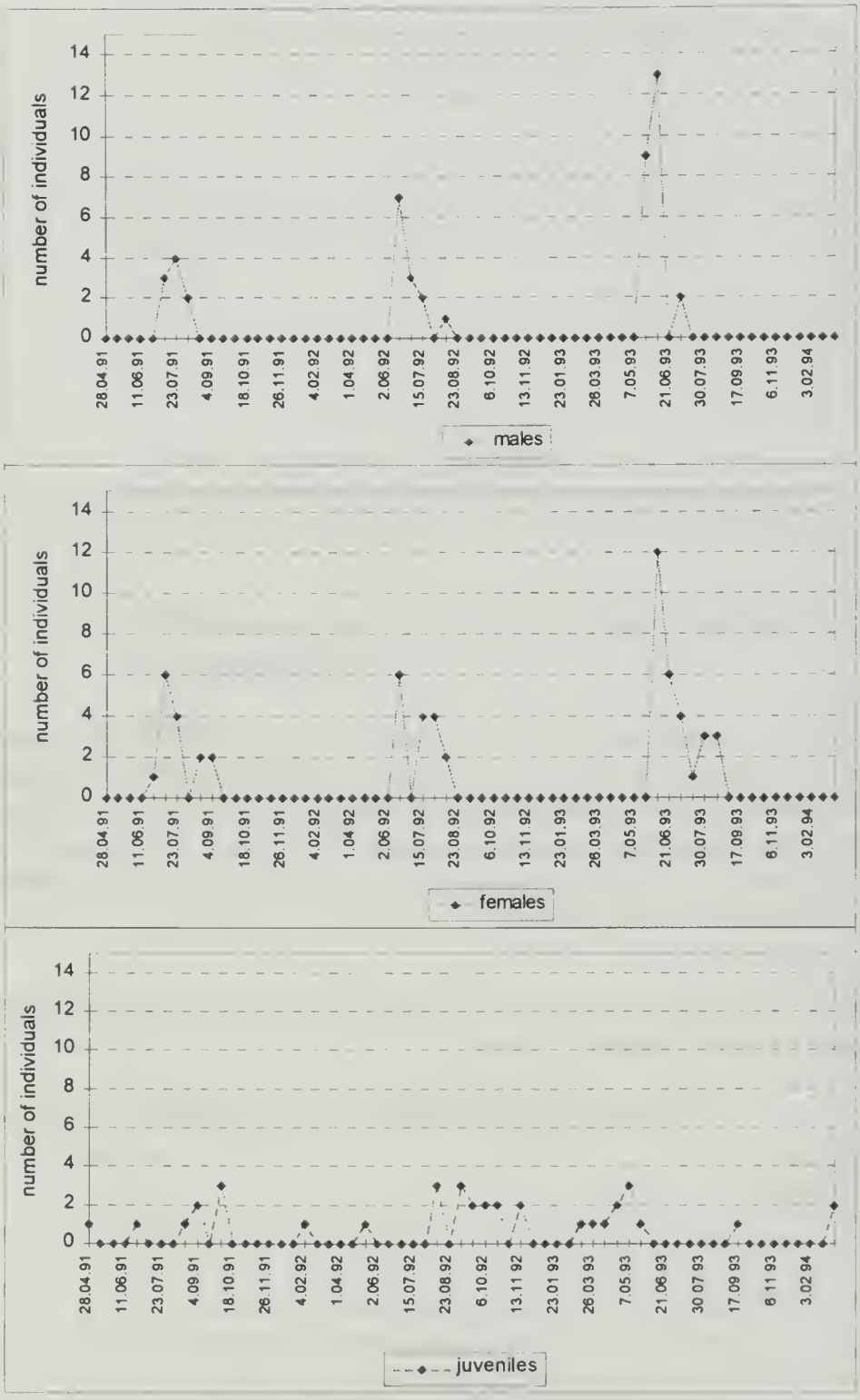

Fig. 3: Phenology of males (a), females (b) and juveniles (c) of *Dipoena torva* on pine trees.

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Temporal aspects

a) Phenology of adults

The seasonal activity of the species was quite similar in all three years of the investigation in Grunewald (fig. 3). In 1991, the first adults occurred in mid-July, in 1992 in mid-June, and in 1993 at the end of May. The first specimens of *D. torva* in the samples during 1993 at Spandau occurred at the end of May. This coincided with the results from Grunewald. The last adult specimens, almost exclusively females, were trapped in August or September of each year.

The highest abundance occurred at the beginning of the activity period.

Two phenomena are worth mentioning:

First, the initial record of *D. torva* was a little earlier in successive years, and second, the number of individuals increased during successive years.

The first fact may be due to the climate with warm winters in 1991/1992 and 1992/1993. The second may be an effect of the traps giving shelter to the developing juveniles. Particularly in the preferred height of 10 m, this may have caused a rise in abundance.

There were differences in the activity of the sexes. In every year the males were active only in the first half of the activity period. The females were active for a longer period.

b) Phenology of juveniles

The information on the phenology of the juveniles over the sampling period is incomplete due to the difficulty of identification. In 1992, many immature spiders were found in the traps from late August until the next adult period. No specimens were found during periods of low temperatures in winter from late November to early March (see fig. 3).

c) Circadian activity

In the stem eclectors in Spandau, *D. torva* showed a higher degree of activity during the day than during the night (fig. 4). Most specimens were caught in the morning, fewer in the afternoon and only very few by night. Both males and females were active during the day.

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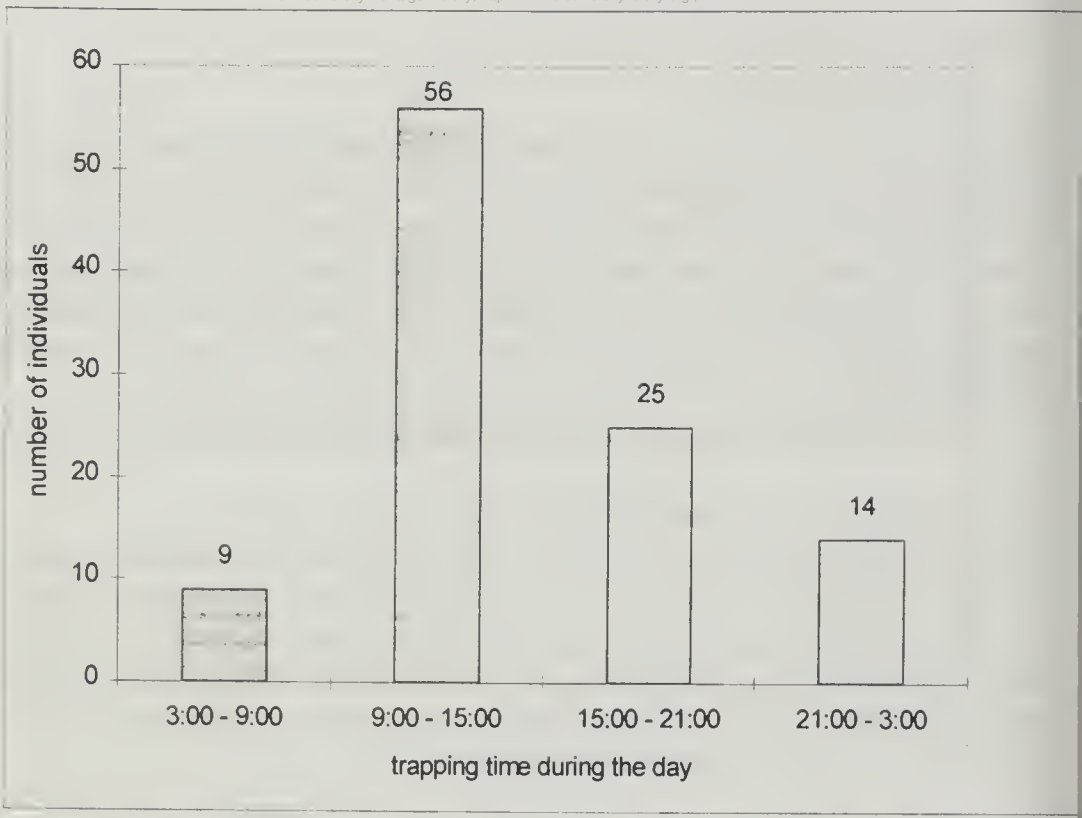

Fig. 4: Diurnal activity pattern of adults of *Dipoena torva* on oaks, revealed by time-sorting stem eclectors (PFÜTZE 1994, THÖMEN 1994)

Behavioural aspects

a) Feeding

D. torva was observed feeding in the field five times. In each case, the prey was an ant. It was hanging at the end of a silky thread with its head stuck to the silk. The spider was positioned at the end of the thread sucking at the bases of the ant´s antennae. This is obviously an effective method for a small predator to capture prey as defensive as ants.

b) Web

The web built by the females in the laboratory was an irregular three-dimensional web, spun from the top of the plastic box to lower parts. Only a few threads were attached to the ground. The part of the web the spider was sitting in had more dense silk threads. The whole web was longish with only a few, long silky threads in one direction. In general, it looked more or less like a typical web of a theridiid spider.

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c) Mating behaviour

After web-building by the female in the transparent plastic box, a male was added at the opposite corner. The male reached the female's web by going transversely on a silk thread leading to the retreat. When close to the female the male began to knock with his pedipalps on the inner web. There was no obvious reaction from the female. After 10-15 minutes the male reached the female, inserted one of his bulbi very rapidly and withdrew very quickly. After a short pause the male initiated courtship again by beating the silk threads, approached the female once more and inserted the other bulbus. After this second copulation, the male withdrew and was removed after being inactive for a while. The female was not observed attacking the male. The time from the beginning of courtship to the first insertion was about 20 minutes.

d) Cocoon and egg number

Within one day of copulation one of the females built a whitish, dense cocoon attached to one corner of the web. From this, 17 spiderlings hatched. Unfortunately, the female and all the spiderlings died because of too dry conditions. To raise *D. torva* it is important to provide spiderlings with sufficiently humid conditions. The other female died for unknown reasons.

DISCUSSION

Dipoena torva appears to be an arboreal species with a distinct habitat on trees. THÖMEN (1994) did not find any individuals although the investigated pines were of the same age as the ones in Grunewald. It is possible that the structure or the shade of bushes in the understorey is necessary for *D. torva* to occur.

Despite extensive net sweeping in the surrounding understorey, only a few female *D. torva* were found. Two were observed sitting under the leaves of *Prunus serotina*. Thus, spiders of this species live mainly along tall tree stems and sometimes occur on the foliage of surrounding plants.

Another factor that may influence the distribution of *D. torva* is the activity of ants. In Grunewald, the tree with the most specimens was frequented by *Formica polyctena* which had a nest nearby and attended numerous aphids (fam. Lachnidae) in the canopy. On the other hand, the number of *D. torva* doesn't seem to depend on the number of ants on the bark. On a tree with a low number of these spiders, many ants were active. It thus appears that although the presence of ants might be necessary for *D. torva* to occur, the abundance of this spider cannot be explained sufficiently by the abundance of ants.

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ROBERTS (1985) mentions that probably all species of the genus *Dipoena* feed mainly on ants. For the very small *D. torva* it is neither possible to catch an ant by strength nor by a harmful bite. *D. torva* has only small chelicerae with only a narrow aperture width. The species has evolved an effective way of neutralizing the defence of ants by attaching them to the ends of silky threads. Consequently, the note given by ROBERTS, that „web building seems to have been abandoned by the genera *Euryopis* and *Dipoena*..." is not correct at least for *D. torva*.

The circadian activity pattern could reflect the period of web-construction or the period of high prey capture. A sympatric theridiid, *Theridion mystaceum* L.KOCH, 1870, of the same size and with a similar web, is active at night (PFÜTZE 1994). This is perhaps a result of competition for web-sites between these or other species. This should be investigated in future, e. g. by removing one of the two species.

Dipoena torva has its main habitat at a height of about 10 m on tree trunks. This is out of reach of most investigators and might explain why the spider has been recorded so infrequently. This illustrates the importance of using an adequate method to study so-called rare species.

ZUSAMMENFASSUNG

Zur Biologie von *Dipoena torva* (Araneae: Theridiidae)

Es werden Daten zur Phänologie, der Stratifikation sowie dem Beutefang- und Fortpflanzungsverhalten der Theridiidae *Dipoena torva* (THORELL 1875) vorgestellt. Die Art wurde hauptsächlich in 10 Meter Höhe an den Stämmen alter Kiefern und Eichen in Berlin gefunden, Männchen und Weibchen etwa in gleicher Anzahl. Die Adulten sind sommeraktiv, Juvenile bzw. Subadulte werden vor und nach der Hauptaktivitätszeit der Adulten gefangen. Die Art ist tagaktiv. Nahrungsgrundlage scheinen bevorzugt Ameisen zu sein. Das Paarungsverhalten wird kurz beschrieben. Das Vorkommen der Art wird vor dem Hintergrund biotischer und abiotischer Faktoren diskutiert.

Thanks to B.KÖNIG, J.HENSCHEL, U.GRAFE and S.OAKELEY for correcting the English version of the article; to D.THÖMEN and J.PFÜTZE for their teamwork; to all of them and A.MEIßNER and S.KÜRPICK for fruitful discussions.

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Zeitschrift/Journal: Arachnologische Mitteilungen

Jahr/Year: 1997

Band/Volume: 13

Autor(en)/Author(s): Simon Ulrich

Artikel/Article: On the biology of Dipoena torva (Araneae: Theridiidae) 29-40