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The cocoon of *Argiope bruennichi* (Scopoli, 1772)—a SEM-study

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***Argiope bruennichi*, Arachnida, Araneae, Araneidae, spider, cocoon, micro structure, insulation, Scanning Electron Microscope (SEM)**

Abstract. *Argiope bruennichi,* an originally Mediterranean representative of orb-weavers (Arachnida: Araneae: Araneidae), nowadays occurs more often north of the Alps than in the years before. Its cocoon is of importance to protect the spiderlings from several environmental influences. Thus the microstructure was a subject of a SEM-course (Scanning Electron Microscope) at the institute to get an optical impression in consideration of the different functions of the cocoon, stated by a few authors.

INTRODUCTION

Argiope bruennichi has been widespread in Austria, and especially in Upper Austria since 1992 (Pfitzner, 1994). The climatic change seems to be favourable to the northward expansion of this conspicuous spider, whose life span lasts only one season. In addition the construction of the cocoon, wherein about 250 spiderlings hibernate as agile nymphs, probably is of importance to withstand icy periods during winter (Köhler & Schäller, 1987). Aspects such as controlling desiccation, which could not be shown for the cocoons of the American *Argiope aurantia* by Hieber (1992), protection from predators and parasites (Köhler & Schäller, 1987) and from fungi attack (Hieber, 1992: *A. aurantia*) are also suggested as playing a major role. However that may be, without the protection by the cocoon colonisation of habitats in Central Europe would have to take place every year, because adults die in autumn.

MATERIAL AND METHODS

The material was collected in winter 1993/94 in an one-year-old hedge plantation near Schwand im Innkreis (Upper Austria). The cocoons were found in groups of about three, with approximately 30 x 25 mm in size, suspended in sparse gramineous vegetation 0.3–0.8 m above the ground by a cloud of fine lines.

One cocoon, in which the eggs had hatched in autumn and the spiderlings had moulted to nymphs, was prepared for analysis of micro structure with Cambridge Stereoscan 250. The material itself did not have to be dried and thus was only coated first with carbon and then with gold.

RESULTS AND DISCUSSION

The photo-series in Bellmann (1984), which shows the construction of the cocoon that lasts about four to five hours (Becker, 1983; Bierwirth, 1991), illustrates the

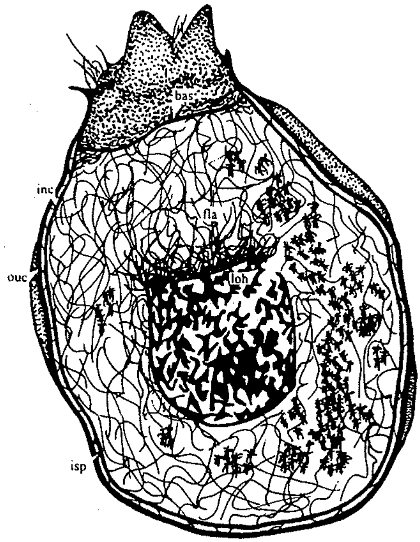

Fig. 1. Longitudinal section: (schematic after Schremmer, 1989 and own observations). Cocoon about five weeks after construction: The eggs had hatched. The spiderlings left the egg sac through the loop-hole (loh) and moulted. They stay in this part of the cocoon until spring: base (bas), inner cover (inc), inner space (isp), propped up outer cover (ouc), flocculent layer (fla).

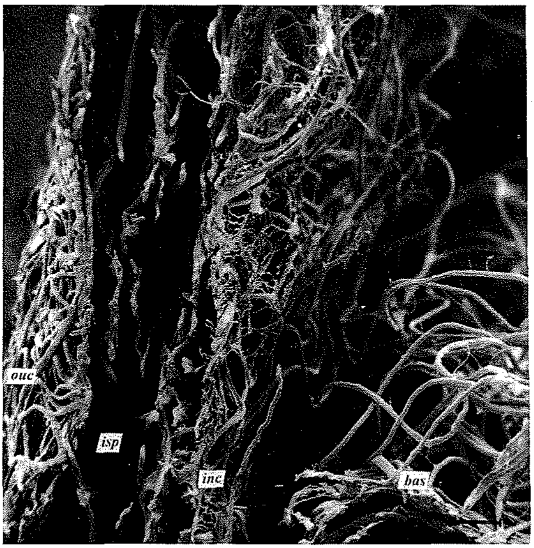

Fig. 2. The interspace (isp) between the outer (ouc) and the inner cover (inc), the base (bas) at the bottom (220 x). The inner cover (0.1 mm) has more threads of small diameter and places with sticking substances than the outer cover (0.1 mm). The interspace is wider than 0.1 mm.

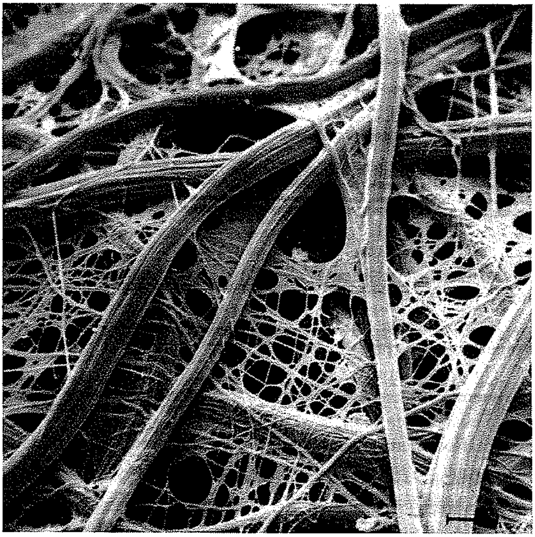

Fig. 3. The upper side of the base (1150 x). The strength can be explained by the combination of different types of crossing threads with sticking substances.

Fig. 4. Platform where the eggs are stuck to (980 x).

complexity of threads used by *Argiope bruennichi*. The SEM-pictures give an insight into the different types of silk with which the cocoon is made.

The parchment-like cover is a strong web made of many different types of crossing threads (0.5–10 µm). Both the cover and the flocculent silk layer between the egg mass and the cocoon shell (Fig. 1) protect from several environmental influences.

First a base is produced (Fig. 1). After appending reddish and loose threads the spider sticks the eggs to a silk platform (Fig. 4), covers them with silk and produces a flocculent layer of reddish and loose threads at last. The base (Figs 2 and 3) is very similar to the inner cover (Fig. 2) concerning the types of threads. The latter seems to have an important insulating function. The propped up outer cover however is a web of strong threads (Fig. 2). Thus it seems to have a more stabilising than insulating function, and probably protects from evertebrate predators and parasites. Referring to this the statement by Diller (1991), who assumes *Gelis gallica* (Hymenoptera: Ichneumonidae)—*Thaumatogelis gallicus* (Seyrig, 1928) after a revision by Schwarz (1995)—to be a parasite in the cocoons of *A. bruennichi*, seems to be of interest concerning further investigations.

The optical impressions can make one jump to conclusions. Becker (1983), for instance, mentioned an insulating function for cocoons of *A. bruennichi*, but had not investigated this effect. The fact is that Hieber (1985) found out, that the large egg-mass and cocoon cover of *A. aurantia* function to control temperature fluctuations through thermal inertia and the creation of a dead-air space, respectively. On the other side mean hatching and molting rates, and spiderling survival for *A. aurantia* are unaffected by cocoon removal at any humidity, although they vary with humidity (Hieber, 1992).

The reddish and loose silk, the so-called flocculent layer (Fig. 1), in which the egg sac is embedded, seems to be multifunctional: climbing threads resp. moulting platforms, food—recycling of proteins (Russenberger, 1975), and insulation (Russenberger, 1975; Schremmer, 1989). However, the results by Hieber (1985) concerning *A. aurantia* cocoons under laboratory conditions indicate that it is the shell of the cocoon, and not the silk layer, which creates the dead-air space that acts as insulation.

Still there are more questions than answers and further work on cocoons is needed. The current studies have looked at water loss from cocoons under constant humidity conditions and in quiet air. Thus field experiments under realistic conditions, in consideration of the natural parameters (force of the wind, rain etc.), should be done.

At last it should be cleared up that the spiderlings are able to leave the cocoon in spring without its explosion conditional on heat as stated in Fabre (1989) and sometimes quotated (e.g. Russenberger, 1975). One can see the loop-hole(s) especially in the platform of the cocoons even without a pocket-lens. By the way, it would also be interesting if the silk is bitten out, enzymically dissolved or only widened.

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