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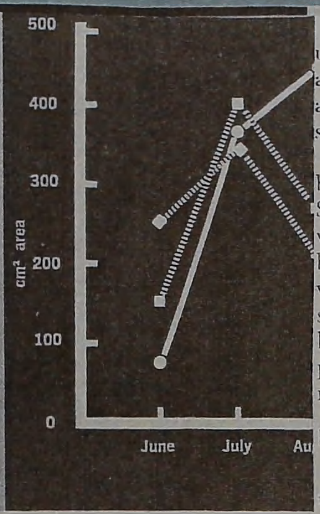
To the left is the normal web of Araneus diadematus Cl. The graph at the right shows the changes which occur in web design as the spider grows. Note that after an early increase, the web area remains constant. In contrast, the number of radii and spiral turns declines.



Experiments on webs are providing interesting insights into spider behavior and glandular physiology.

ONCE A DAY, for half-hour periods in the early morning, the female spider *Araneus diadematus* Cl. spins a web. The old web is eaten.

The old web is eaten, that is, unless it is removed. To the spiders in the laboratory of Dr. Peter N. Witt this is precisely what happens. Dr. Witt, associate professor of pharmacology at the State University of New York, removes the webs and studies them. His experimental techniques have provided some interesting results.

A. diadematus Cl. is one of the many species of spiders called *orb weavers*. A normal orb web is shown at the beginning of this article.

The orb-shaped web is an economical one to produce. The spider covers the greatest area with as little material and work as possible. The larger the area, of course, the greater the probability of capturing flying prey.

These considerations led Dr. Witt to wonder if the limiting factor in web building might be the amount of thread material produced. His experiments were designed to answer the question: How are web proportions related to the amount of building material available?

Experimental Technique

Dr. Witt recorded experimental data on two kinds of experiments. In one, the *motor behavior*, or sequence of movements followed by the web-spinning spider, was observed. In the other, the patterns of the web itself, as well as the amounts of protein material which went into its construction, were determined.

The spiders were kept in aluminum cages under controlled temperature, light, and humidity. Every day, they were driven out of their webs. The empty webs were then prepared for photography by spraying with glossy white Krylon paint. They were spread over a dark box and illuminated from the side. The photographs were taken with a high contrast 35 mm film.

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unable to adjust and repair the damage. This, in itself, indicates a lack of any "reasoning" on the part of the spider.

It is also quite evident that web building is independent of learning. Spiders raised in narrow glass tubes, without a chance to "practice" web building, construct a perfect web when released. Furthermore, young spiders never see another spider web before building their own. The entire process appears to be a "mechanical," rather than a learned one.

Protein Content

What about the second phase of the experiment . . . that of determining the amounts of protein material going into each web?

All proteins contain the element nitrogen. Therefore, by assuming that all the webs of this species of spider consist of similar proteins, the nitrogen content of the web can be taken as a direct measure of protein content.

Each web was cut free from its supports and collected on a nitrogen-low filter paper. After being chemically digested, the nitrogen content was determined using an instrument known as a *spectrophotometer*.

Before each web was digested, its diameter, number of radii, and spiral turns were counted and measured. From these data, the thread length was calculated. Assuming that all the thread in one web is of uniform thickness, the quotient of the nitrogen figure and thread length provides a measure for thread thickness. Thread thickness, in turn, gives a measure of the amount of material per unit length.

The results of this work are shown in the illustrations on these pages. After a certain time, the amount of web material used (as measured by nitrogen analysis) remained the same. The area of the webs also remained the same. However, ***later webs were built with shorter and thicker thread.*** Thus they had wider meshes.

It was noted that the spider's body mass had increased considerably. ***Could the spider be building a stronger web to support its increased mass?***

It was reasoned that a spider with a greater mass faced two alternatives. Having a limited amount of thread at its disposal, it could either (a) build a smaller web, or (b) build a wider meshed web of full size, with shorter and thicker threads. The second alternative had been followed.

It was decided to test the increased-mass hypothesis. The reasoning was as follows: ***IF*** the mass increase of the spider causes thread thickness and mesh width changes, ***THEN*** increasing the spider's mass with a piece of lead should result in an even thicker thread with even wider meshes. The illustration below shows the experimental results.

Some Conclusions

As a result of these and other experiments, Dr. Witt has proposed an explanation. There must be some signal which communicates to the central nervous system the amount of silk which is ready in the gland for thread production. Body mass determines thread thickness. The combination of amount of silk available and body mass, therefore, indirectly determines the length of thread the spider can spin.

The length of the spider's web also influences web size. From all these data, the mesh width of the future web can be established in advance. By doing the radii first and determining the angle between them, the spider automatically predetermines the web pattern. In the end, it will have covered the largest possible area with a web still strong enough to support its own body.

Thus we see here a close interrelationship between biochemical processes and motor behavior. The speed of protein synthesis determines the filling of the silk glands. This, in turn, regulates the motor behavior of the spider in building the proper web pattern.

—*JEFFREY J. W. BAKER*
BIOLOGY EDITOR

Webs built by the same spider at three different age information given in the graph above. Age at spinn web B, four weeks; web C, five months.

A

B

The mass of this spider has been increased by about 22 per cent by the addition of a lead weight (arrow). The results on web patterns are shown below to the right. Protein values for the experimental web were almost doubled. When the weight was removed, the protein content returned to the control level.

	A	B
Mass of spider	42.4mg.	plus 22% 51.6mg
Number of radii	42	35
Number of spiral turns	42	30

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Coming Next Issue: Hermaphroditism.