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The Effect of LSD-25 on Spider Web Formation

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The authors of the present communication have worked together for four years, using the spider as an experimental animal (Groh and Lemieux, 1965; Groh and Lemieux, 1965a; Groh and Groh, in press; Groh, Lemieux and St.-Jean, 1966). Previously, one of the authors worked on this project for a period of six years. During the latter four years several drugs, including Thorazine, Haloperidol, Taraxan, Librium, and Surmontil, were tested to determine the changes they cause in the normal geometry of the spider's web.

The orb web spinning spider is an animal which cannot survive in nature without its web (the orb web or triangular web is newly built nearly every night), so it is reasonable to suppose that web building is an integral function of the central nervous system, and can be considered as a permanent extension of it.

In giving psychopharmacological substances to spiders we were always surprised by the relatively high amount in micrograms usually needed to produce changes in the geometry of the spider's web. In contrast to this, LSD-25 had a registerable action on the geometry when only fractions

of micrograms were given.[1] We have also reported the dramatic action on the working behavior of this animal after giving it only a few milligrams of the blood serum of an untreated schizophrenic patient in catatonia (Groh, Lemieux and St.-Jean, 1966). Inevitably, in this blood serum, there will be several dozen unknown components, not one of which can be present in a higher amount than a fraction of a microgram.

From research material consisting of several thousand tests repeatedly performed, we will report here only material concerning these areas:

1. The effect on spider web formation of a single dose of LSD-25.
2. The effect on spider web formation of doses of LSD-25 given for several weeks.

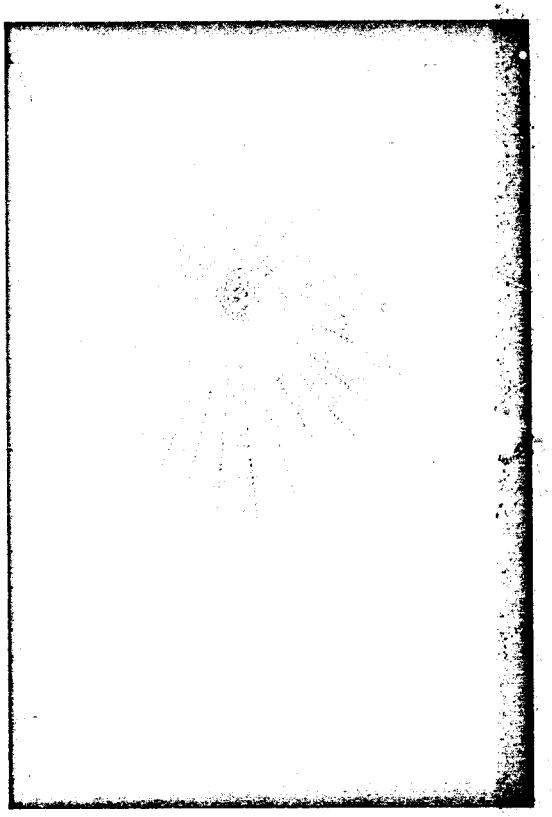

FIGURE 1. Normal web of the Aranea Diademata spider. Note the pathway by which the spider left her web.

[1] It should also be mentioned that the life span of our animals is from six to ten months, so that by giving LSD-25 for several weeks, for instance, the animal is drugged during an appreciable percentage of its lifetime.

3. The relationship between the effect of prolonged doses of LSD-25 and the effect of the single dose of blood serum from an untreated schizophrenic patient in catatonia.

The animals used for these experiments were the Aranea Diademata and the Hyptiotes Paradoxus.[2] The Aranea Diadematas were all collected on the Island of Montreal. We point out this fact because we found that these animals had different behaviors in the laboratory if they came from

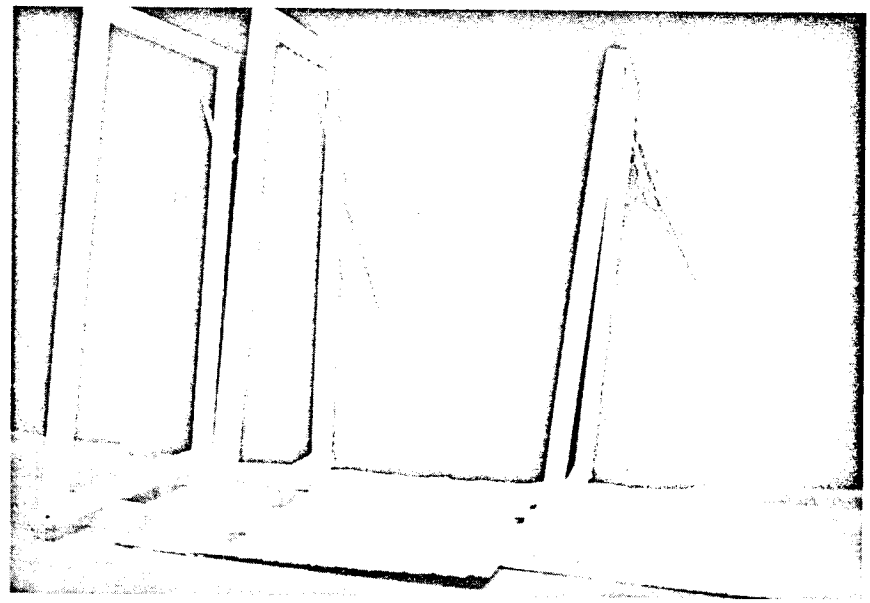

FIGURE 2. Webs of the Aranea Diademata. On the left, a normal two-dimensional web. In the middle, the web shows the effect of a single lower dose of LSD-25. The web becomes bigger, more regular, and has a three-dimensional shape (see Figure 4 for a similar planar view at this stage). At the right, upon administration of a smaller dose for 14 days, the normal pattern may disappear while the three-dimensional structure remains pronounced.

[2] Since the spider as a research animal was introduced in medical science, LSD-25 has often been administered in a single dose experimentally (Peters and Witt, 1949; Witt, 1951; Witt *et al.*, 1961). These authors used to give LSD-25 to the European and American Zilla X Notata spider. They gave it in two different dosages, either 0.1–0.3 micrograms and/or 0.03–0.05 micrograms. We have to point out that we found the Canadian Zilla spider to be a very bad—almost useless—laboratory research animal. We could only collect it in a single place in Northern New Brunswick, and we found that this animal, living probably in its most northern environment, could not be used for laboratory researches. This does not imply that Zilla spiders found in other more southerly regions in Europe and America are useless.

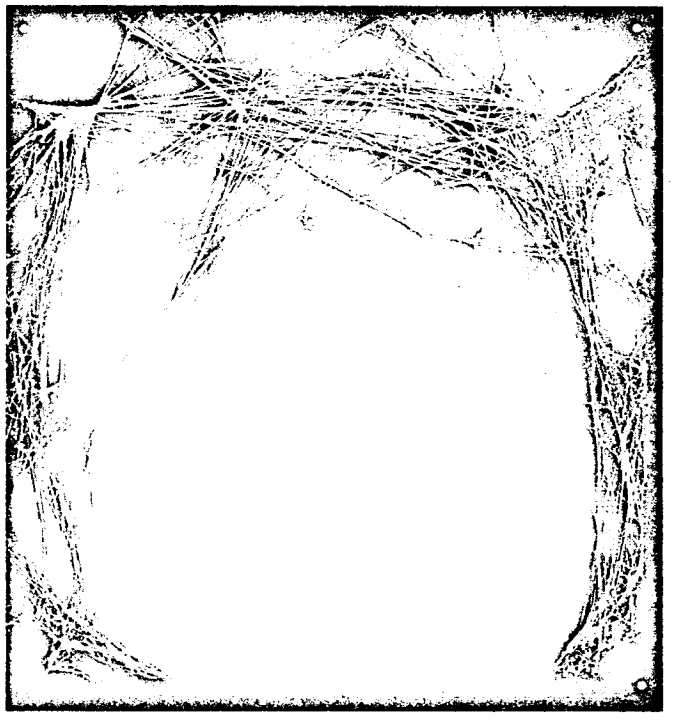

FIGURE 3. Thirty-six webs of the Aranea Diademata, after prolonged smaller doses of LSD-25, colored and fixed to the same paper.

different geographical regions. The ones collected in the Niagara Peninsula behaved and reacted in a slightly different manner from the ones collected on Montreal Island.

We also used Aranea Diadematas or their offspring hatched in the laboratory, originally from Lugano, Switzerland or from the Gulf of Naples, and there we also found considerable differences in behavior. As far as possible we used twin spiders, that is to say those from the same hatching.

The normal web of the Aranea Diademata is an orb web and the animal lives in the center when she has finished building her web. A normal web is shown in Figure 1. This web is repeated with great regularity every night if the spider is not overfed. Note the pathway by which the spider left her web. (After catching her out of the web, the web was colored with white enamel spray and fixed on black paper. This method possibly gives less perfect photographs in black and white, but permits us to conserve a great many webs in their original forms.)

Witt (1951) found that with the bigger single doses of LSD-25, the following changes occur: (1) smaller surface of the web; (2) vertically

longer webs in 88.7% of the cases; (3) decreased regularity of the woven web angles. The smaller single doses of 0.3 and 0.5 micrograms gave these characteristic changes: (1) decrease in web building frequency to 74% [the normal web building frequency with our Aranea Diademata spiders was 88.3%—that is, about 9 nights out of 10]; (2) increased surface of the web; (3) generally increased regularity in web building, the normal small mistakes being no longer present.

Bercel (1960) confirms that after low doses of LSD-25, the web abnormality is the lowest, and there exists, in fact, a statistically increased regularity. He describes also a markedly abnormal web response which he calls rudimentary "R" responses. The "R" responses for this author consist in the first few strands being often built in a Y-shape. After giving LSD-25 to his Zilla animals, he found 5.5% of his webs with "R" responses. Bercel did not tell us about the future behavior of these animals, and he only gave a single dose of LSD-25.

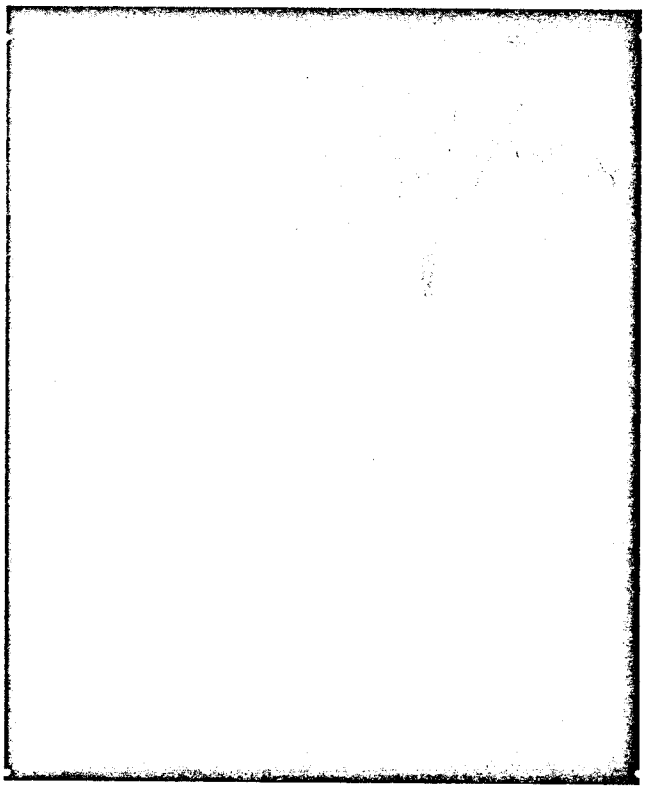

FIGURE 4. Web of the Aranea Diademata after a single smaller dose of LSD-25; the web becomes bigger and more regular.

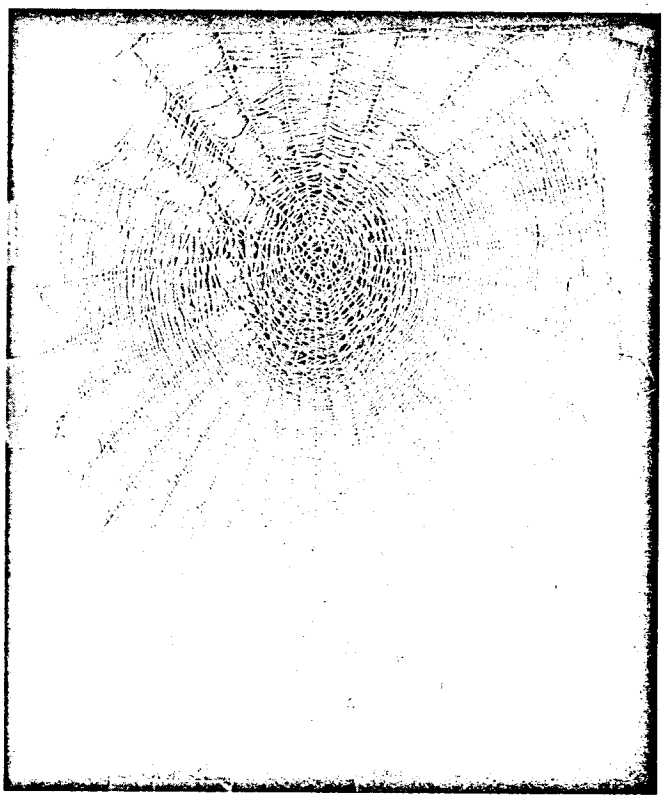

FIGURE 5. After smaller doses of LSD-25 repeated for 5 weeks, the web of the Aranea Diademata often remains bigger, and the center may show similarities to the web built after absorption of blood serum from a catatonic schizophrenic patient; these changes are generally permanent.

In our researches we gave LSD-25 in slightly higher single doses, because our animals were heavier than the Zilla used by the previous authors. Our higher dose, given 282 times, was 0.4–0.6 micrograms. Our day-by-day repeated lower dose, given 234 times, was either 0.04 or 0.06 micrograms. (The spider absorbs the drug and the blood serum without difficulty by mouth if some sugar is added. LSD-25, unlike other substances in our investigations, was given only by mouth, not by intra-abdominal injections.)

In giving the single dose, all of Witt's observations were confirmed. 26.1% of the animals getting the higher dose discontinued web building. It should be mentioned that a great number of these animals were never completely normalized after several weeks. Several of them had to be fed by hand to survive at all. Repeated higher doses produced such a

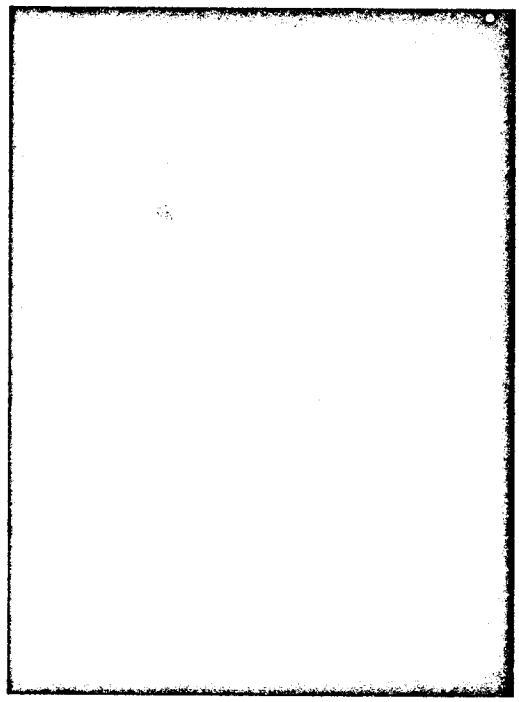

FIGURE 8. Permanent changes in web of Aranea Diademata after prolonged smaller doses of LSD-25. Here there are some characteristics similar to those resulting from absorption of blood serum from a catatonic schizophrenic patient.

high percentage of permanently abnormal web building spiders, that we had to discontinue this line of research for technical reasons.

Observing the web building production of the Aranea spiders, we should mention that there were vague similarities with often repeated smaller doses. By observing them one by one, we could not find any common pattern in the results. To find some results with a common denominator, we repeated all these tests with a series of 84 Aranea Diademata spiders from the same hatching. We have already introduced this working system in previous publications, particularly for the study of schizophrenia. This method is difficult to realize in laboratory conditions, but once again we found it useful for our study of the effects of LSD-25 on spider web formation.

Fourteen spiders of the 84 (16.6%) never again became normal after one single higher dose of LSD-25. (The remaining 70 spiders reacted as published by Witt, and became normal in a maximum of four days.) The webs again showed the greatest dissimilarities. Several of these dis-

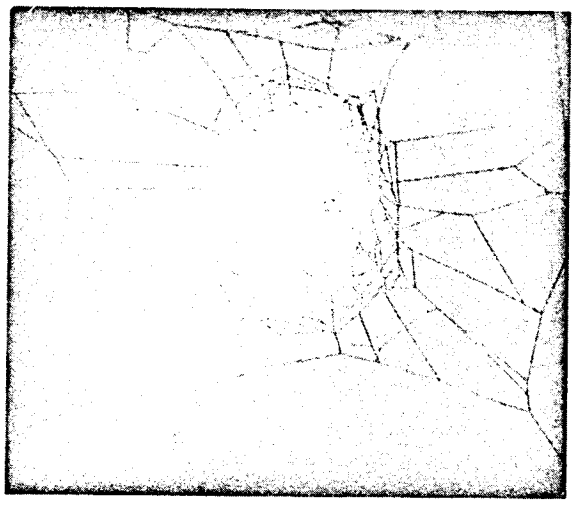

FIGURE 6. Web built by Aranea Diademata after absorption of blood serum from a catatonic schizophrenic patient.

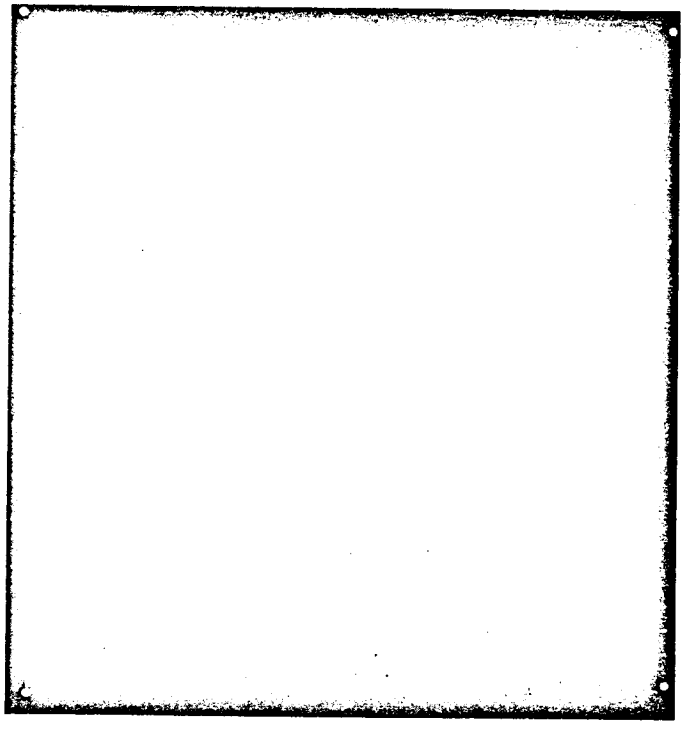

FIGURE 7. Permanent changes in web of Aranea Diademata after prolonged smaller doses of LSD-25. Here the web misses a sector.

similarities have something in common with the Y-shaped "R" response of Bercel (1960). Some are shown in the accompanying photographs, particularly the ones with similarities to webs built after giving the spider drops of blood serum from patients with untreated catatonic schizophrenia.

The animals remaining normal on repeated lower dosages of LSD-25 (0.04–0.06 micrograms) continued to remain normal after two weeks of observation without any further drug being given. All these spiders lived in wooden frames as shown in Figure 2. In this illustration we see three different webs. On the left is the normal web of the Aranea Diademata. The web in the middle shows the effect of a single lower dose of LSD-25. The web becomes bigger, more regular, has a higher number of radii and takes, as opposed to the first one, a three-dimensional shape.

The third web, at the right, shows the web of the animal after we gave it the smaller dose for 14 consecutive days. Nothing is left of the normal structure of the Aranea Diademata's web, but the three-dimensional structure is particularly pronounced. This spider, though not given further doses of LSD-25 and fed by hand, never again became normal.

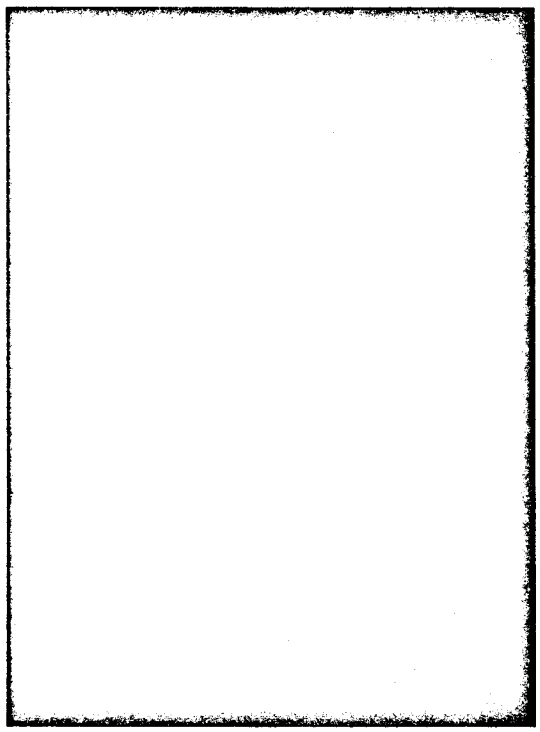

FIGURE 9. Web of the normal Hyptiotes Paradoxus spider, composed of three triangles.

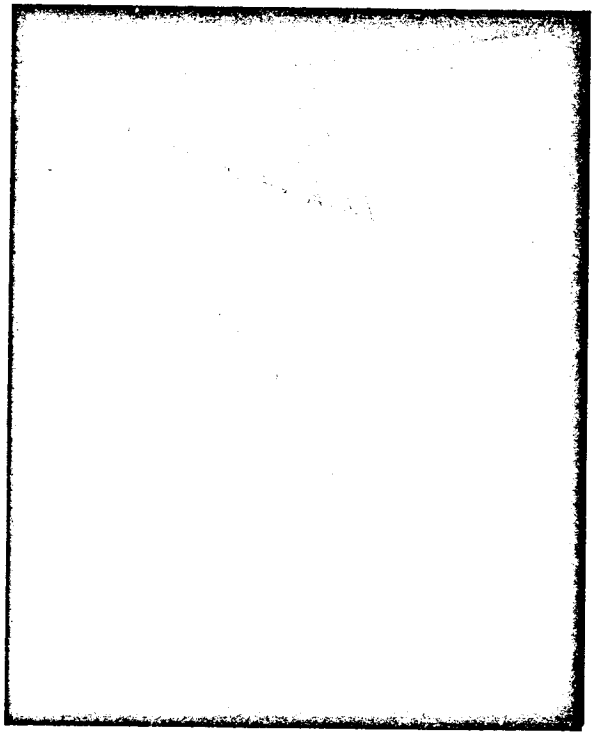

FIGURE 10. After a single lower dose of LSD-25, the Hyptiotes web becomes bigger, more regular, and the upper triangle has two more transversal lines.

She rebuilt her three-dimensional web every three or four days, 36 consecutive times. In spite of the technical difficulties of fixing on the same paper 36 of these disorganized three-dimensional webs, we could get the picture shown in Figure 3. Despite the chaotic disorganization of every one of the 36 webs, it is still possible to observe certain permanent crossing points and a vague approximation to the general outline of a web.

None of these 36 consecutively fixed webs has any relationship to the spider's working after it absorbed serum from the blood of schizophrenic patients. But that is not always the case.

Compare Figure 1, the normal web, with Figure 4, which was built after a single small dose of LSD-25. The latter is far more regular than the former. This regularity, and the fact that it was built three-dimensionally, are not clearly seen in the photograph because of the difficulties of fixing the web on a two-dimensional plane. Figure 5 shows the web of the same animal five weeks later, after receiving nearly every day its smaller dose of LSD-25.

The animal has grown larger. This is, of course, one of the reasons that the web is bigger in size. After this period of time and these amounts of

LSD-25, the center of the web shows some similarity to the webs built by spiders absorbing blood serum of an untreated catatonic schizophrenic patient. Figure 6 shows a spider's web of the same species as built 24 hours after the spider was given the blood serum of a catatonic schizophrenic patient.

It is hard to find similar characteristics after repeated smaller doses of LSD-25. The web shown as Figure 7 misses a sector. The animal was able to build the same web during all his drugged life. He was afraid to live in the middle of his web as his species normally does. He chose to live in the right hand corner connected by a single thread to the center of his web which by its vibrations transmitted to him the fact that a prey was caught. Possibly the animal could not give the needed tension and elasticity to his web. This may be one reason he destroyed the left upper corner. (The web, incidentally, has similarities to the one built by the Zilla, a completely different species.)

The web in Figure 8 was built by an animal which received a smaller permanent dose for most of its life. All the characteristics of this web

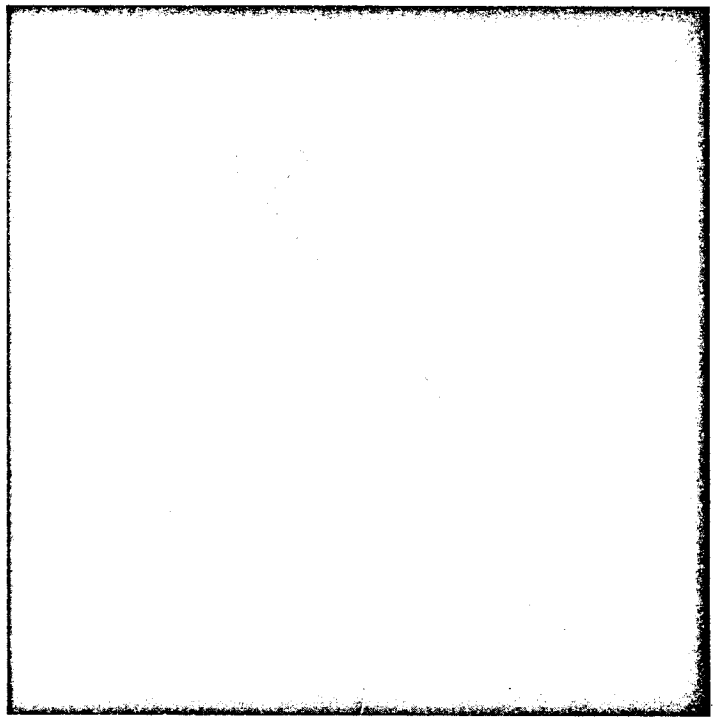

FIGURE 11. After the absorption of 8 consecutive small doses of LSD-25 the lower corner has some similarities with the terminal phases of the "schizophrenic" web of the Hyptiotes.

remain about the same without changes. This web has similarities to that built by an Aranea spider which had absorbed the blood serum of a catatonic schizophrenic patient several days before. It therefore shows characteristics of the terminal phases of the action of the blood serum of the patient on a spider.

As it was seen from the drugged Aranea Diademata, production of an additional dimension in the working behavior of the spider can occur; thus we studied a spider species building a triangular web, composed of three sub-triangles. This animal is the Hyptiotes Paradoxus, which we collected in the Mont Tremblant region about 100 miles north of Montreal. Here there is no opportunity of building a three-dimensional web, since the web is suspended at only three points. We are presently studying the effects of LSD-25 to find out what takes the place of three-dimensional building. For the time being we can only publish three illustrations concerning this research.

In Figure 9 we see the normal Hyptiotes web composed of three triangles. In Figure 10, after a single lower dose of LSD-25, the web becomes bigger. Notice that the upper triangle has two more transversal lines, and it is more regular. In Figure 11, we see the web built by the animal after getting 8 small doses of LSD-25. Particularly noticeable is the fact that the lower corner has some similarities with the terminal phases of the "schizophrenic" web of the same animal, details of which have been published by us (Groh, Lemieux and St.-Jean, 1966).

There is, of course, a considerable distance on the evolutionary scale between spiders and man. Nevertheless, we have found two kinds of changes in spiders' webs resulting from LSD-25 ingestion which seem to correspond to the effects the drug produces in man.

First, the individual who takes a psychodysleptic drug very often declares that he has the impression of seeing his inner world enlarge and take on a new dimension.

Second, some studies suggest that the habitual users of LSD-25, after a certain time, show a diminishing of their psychic and emotional capacities, bringing on a state of indifference with an inappropriate behavior pattern and ideo-affective dissociation.

How far should we go in comparing the effects of these substances on man and spider? Without wishing to suggest that the effect of LSD-25 on the human brain is identical to that which it produces on the spider's nervous system,[3] the aggregate symptoms which curiously resemble schizophrenic psychosis may give the reader food for thought.

[3] Bullock (1947) found acetylcholine and cholinesterase in the nerve endings of insects including the Tubularia which has a far less developed central nervous system than the spider. The cell breathing of insects uses the same biochemical mech-

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anism as man, a cytochrome system. The presence of haemocyanin in the spider's blood permits us to think of a similar catalysation mechanism. Witt and Niss (1961) have also found the presence of MAO in the spider; Witt and Charles Reed will shortly publish a deeper study of this particular phenomenon.