When mature, *Salvia divinorum* seeds (technically mericarps or nutlets) are 1.8–2 mm long, 0.12 mm wide, somewhat pyriform, minutely tuberculate, and dark brown (Reisfield 1993). At one time it was believed that *Salvia divinorum* did not produce viable seed, and the only manner in which it could be reproduced was by cuttings (Emsco 1972; Schultes 1972; Heydrich 1974; Mayer 1977; Foster 1984). While this belief is now known to be in error, it is true that *S. divinorum* only rarely sets seed. Those wishing to grow *S. divinorum* from seed face three obstacles: a low seed set, a low germination rate, and a low survival rate.

The first inklings that *Salvia divinorum* did indeed produce viable seed came from the 1973 book *Growing the Hallucinogens*, wherein the author stated that, “This salvia is generally grown from cuttings, but I know of one instance in which it was grown from seed” (Gruber 1973).

Then in 1980 while working on his Ph.D. dissertation, Leander J. Valdés III performed breeding experiments in which he cross-pollinated 14 *Salvia divinorum* flowers (using the “Cerro Quemado” clone and a “Wasken/Hormann” clone). 4 flowers were pollinated successfully, and 8 seeds were produced (not 4 as has mistakenly been stated, Oct 1996). A photo of these 8 seeds was published in 1987, the first time that *S. divinorum* seeds had appeared in print (Valdés et al. 1987). These 8 seeds represent a 14.3% seed set, since each flower has the potential to produce 4 seeds. Unfortunately, these seeds were killed by overheating in a growth chamber, and their viability couldn’t be ascertained (Valdés 1983).

Aaron Reisfield was the next person reported to attempt pollination experiments. Self-pollinated plants with 108 flowers produced 11 seeds—a 2.5% seed set, and his cross-pollination of 100 flowers produced 24 seeds—a 3.2% seed set (Reisfield 1993). Clearly it is difficult to get *Salvia divinorum* to produce seed. It has been noted that since the anthers and the pistils of a single flower appear to mature at different times (a way for a flower to prevent self-pollination), that this must be accounted for when hand-pollinating flowers; both the anther and the pistil must be ripe (Valdés 1999). This may be partially responsible for the substantially lower seed set that *S. divinorum* displays.

*Salvia divinorum* is not a particularly easy plant to grow from seed. Although there have been several successes, there have also been many failures. One of the main reasons for this is the relatively low seed set (around 10%). While the plant grows quite readily from cuttings, the seed is often less easy to come by. *Salvia divinorum* is a species that is quite popular among growers due to its interesting appearance and the psychoactive effects of its产生的化合物。然而，有人错误地认为它是仅仅通过种子繁育的，而未能注意到其广泛的使用和收集。

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The BOTANICAL PRESERVATION CORPS presents the second annual Salvia divinorum conference

SKA PASTORA, LEAVES OF THE SHEPHERDESS: SALVIA DIVINORUM & SALVINOIN-A

December 9–12 at BREITENBUSH HOT SPRINGS, Oregon. $350.00, including meals and lodging. To register, call (503) 854-3314.

Salvia divinorum is easily grown, perfectly legal, and presents challenges and promises in ethnomedicine, chemistry, psychotherapy, neurology, and shamanism. Consider these mysteries:

- Salvia divinorum has not been found in the wild, rarely yields viable seeds, and Mazatec shamans say it came from “elsewhere.”

- Chewed or smoked leaves induce a visionary state unlike that of any known psychoactive plant.

- Salvinorin-A is active in microgram amounts, is not an alkaloid, is structurally different from all known psychoactive compounds, and acts at unknown receptor sites.

Several leading researchers offer a lively four-day weekend of exploration, education, and speculation on the potentials of the Salvia divinorum human relationships.

Bret Brosser, anthropologist, is studying with a Mazatec shamanistic family and will share insights into the traditional use of Salvia divinorum.

Kat Harrison, ethnomedicinal artist, is learning about the spirits of Salvia divinorum and tobacco in the Sierra Mazateca of Oaxaca.

Ralph Metzner, psychologist, professor at CALIFORNIA INSTITUTE OF INTEGRAL STUDIES, author of The Unfolding Self, The Well of Remembrance, and Green Psychology, will speak on Salvia divinorum and shamanic divination.

Bob Montgomery, ethnobotanist and founder of the BOTANICAL PRESERVATION CORPS, has been studying the pharmacology, cultivation, and distribution of Salvia divinorum for ten years.

Jonathan Ott, chemist, ethnobotanist, and author of several leading books on entheogens, offers extensive experience from the lab and the field.

Dale Pendell, poet, ethnobotanist, and author of Pharmako/Poeia: Plant Powers, Potions, and Herbcraft, will muse on the voice of this distinctive and amazing plant teacher.

Daniel Siebert, ethnobotanist, has developed improved methods for ingesting Salvia divinorum and was the first person to ingest salvinorin-A.

Nika Turelli, healer, will speak about Salvia divinorum in practical healing work.

BREITENBUSH HOT SPRINGS is a small and very beautiful resort in the mountains of central Oregon. Beifuß believes that those seedlings are having a more limited root system than a cutting of similar size would have. The remaining two seedlings are a sickly yellow-green and much less vigorous, having only grown to about 1 inch tall after one-and-a-half months (See Figure 7). Beifuß believes that this is due to this seed-grown plant having a more limited root system than a cutting of similar size would have. The remaining two seedlings (germinated at a later date) are a sickly yellow-green and much less vigorous, having only grown to about 1 inch tall after one-and-a-half months (see Figure 6). Beifuß does not think that these will pull through.

After sacrificing one of the seeds sent to us to be photographed with a scanning electron microscope (see Figures 4 and 5), I was left with 6 seeds to attempt germination on. I decide to see if giberelli acid-3 (GA-3) would help my success rate with germination. (See Seed Germination: Theory and Practice, second edition by Norbert C. Deno for more on the use of GA-3; this is an excellent book that I recommend to anyone who is trying to germinate difficult seeds.) On seed set that REISFIELD obtained when compared to Valdés (but it could also be argued that Valdés’ sample was statistically small). Reisfield was able to get a few of these seeds to germinate, and he described these seedlings growth as “vigorously” (Reisfield 1993).

In January 1994 Daniel Siebert collected 70 seeds from “Was-son/Hofmann” clones residing at the BOTANICAL DIMENSIONS’ garden in Hawaii. Hand pollination had not been attempted on these plants, which means that the seeds were generated in conditions that might be considered as being similar to “the wild.” Of 70 seeds, Siebert was able to get 12 or 13 to germinate (17.1% to 18.6% germination rate), and only 6 to survived to maturity. (Clones of these seed-grown plants are available for sale from Siebert’s web-based Salvia divinorum business.) Unlike Reisfield’s seedlings growth, Siebert described his own seedlings growth as “very weakly,” and he has commented that “[t]he seed raised clones seem a bit less vigorous than some of the Oaxacan material” (Siebert 1999a; Siebert 1999b).

More recently in 1999, BRENT LINDBERG—a commercial Salvia divinorum farmer in Hawaii (growing about 800 of the so-called “palatable” clones) collected 305 seeds from his plants. The plants that produced these seeds were growing in pots under 70% shade, with approximately 60 inches of rain per year. They first started to flower in November, and they were cut back at this time to promote better leaf growth, but by December there were so many in flower that Linberg decided to stop cutting them back. The seeds were first spotted in January, when Linberg was hand-pollinating flowers; Linberg does not think that his hand-pollination was responsible for any of these seeds (presumably since he saw them early-on in his attempts at hand-pollination). Nevertheless, he did not notice any insects near the flowers, other than a few ants. The seeds were collected over a 2 month period; by February 13 Linberg had 162 seeds, and he harvested the rest after this. Only about 80% of the seed had reached maturity. Germination of 100 of these seeds was attempted, with 31 germinating (a 31% germination rate), and 10 surviving to maturity. The seeds were germinated in potting soil mixed with peat moss, and Linberg believes that these seedlings that died (when they just had their first small leaves) did so due to overly moist conditions (they dissolved from being too wet). The first seed germinated after 10 days, and the last seed took over 30 days to germinate. The surviving seedlings are growing with equal vigor, comparable to that of a cutting of the same size. As of August, these seedlings were 1–2 feet tall. They are kept outdoors in pots under 70% shade cloth (Beifuß 1999).

Several others were also sent seeds from Linberg’s harvest.

In early April, Siebert attempted to germinate 20 of these seeds, of which 3 sprouted (a 15% germination rate), but only 2 survived. The first seed germinated at about 10 days, and the last at about 18 days. The 2 surviving seedlings are growing vigorously. The seeds were planted directly into commer-
August 16, 1999 I attempted germination in paper towels using GA-3 and following the advice in the aforementioned book. In 8 days, 1 of these seeds germinated, and by 20 days a second seed germinated. The first germinated sprout seems to be growing well, albeit slowly; the second sprout hasn’t yet pushed through the soil. Although additional seeds may still germinate, as it stands this is 33.3% germination rate. With such a small number of seeds, it is tough to say for certain whether or not the GA-3 treatment had any positive or negative effect on germination.

It has been proposed that the various collected plants brought into cultivation in the USA might all be genetically identical, and the similarly low seed set with self-pollinated plants and cross-pollinated plants might indicate that this is the case (RUSSELL 1993). It is certainly a possibility that all of these plants are monoclonal, and this question could easily be put to rest by performing genetic testing on the various plants now available.

All of the seed-grown plants currently in cultivation look identical to their parent plants except for one grown by SEIBERT, “Paradox” (aka I503), which has leaves that are “ever so slightly mottled” (SEIBERT 1999). It has been suggested that Salvia divinorum may be a hybrid (RUSSELL 1993), but no reasonable candidates for parent plants have been proposed. Due to the consistent similarity of all known seed-grown plants (excepting the very minor difference in the “Paradox” clone), it seems unlikely that S. divinorum is a hybrid. If the plant were a hybrid, the seed would be expected to produce extremely variable plants (VALLÉS 1999).

There are also the questions of whether or not the plant is a cultigen, whether or not it has been found in the wild, and whether or not it has set seed in its native habitat in Mexico. Cultigens, by definition, require the intervention of human beings to thrive and reproduce. (For example, corn—a true cultigen—cannot survive without human intervention.) In the Sierra Mazateca, Salvia divinorum can clearly do quite well by itself (VALLÉS 1999). The Mazatec curandero DON ÁLEJANDRO VICENTE has stated that the plant does indeed grow wild in the fairly inaccessible highlands of the Sierra Mazateca, and he has also stated that these plants produce seed that can be planted to grow S. divinorum (VALLÉS 1987; VALLÉS 1994; VALLÉS 1999).

It seems unlikely that DON ÁLEJANDRO VICENTE would lie about where Salvia divinorum grows wild, and whether or not it produces seed. Nevertheless, no definitively “wild” stands of S. divinorum have been found to date, and no Mexican-grown plants have been observed by ethnobotanists to produce seed.

Salvia divinorum depends on a shorter photoperiod to produce flowers. In warmer climates, where the plants can be left outside during the late fall and early winter, plants will go to flower naturally. My own plants, grown in California, have flowered every year. Those who live in colder climates that necessitate indoor growing will have to shorten the amount of daily light that the plants receive, in order to induce flowering, should they wish to attempt hand-pollination.

NOTES

1. Seed Germination: Theory and Practice, second edition by NORMAN C. DENO is privately published and distributed by the author. It is available for $20.00 postpaid (to anywhere in the world) from: NORMAN C. DENO, 139 Lenor Drive, State College, PA 16801, USA.

Figure 7: A healthy Salvia divinorum seedling.

applicable to any known species), and prefer the binomial P. papapaloeh (MICHAELS) LAJOSM-SCHREINER. Regarding the above-mentioned list, P. papapaloeh is now the most widespread species of Paspalum in Europe, and the only one reported in Greece. It is very likely that the distribution of this species, as with the other Paspalum, has been seen in recent times, and less likely in the past century, but surely this happened many years after the Conquest. Indeed, considering the dates of the first reports in the neighboring countries (for example, in Italy no one species of Paspalum has been observed before 1900; cf. FERE 1923–1925, GABBAI 1972), the presence of Paspalum sp. in Greece cannot be dated before the past century. It is therefore possible to state with confidence that all of the Paspalum species that originated from the New or the Old World, spread in recent times, due to voluntary or involuntary action of man—whether originally cultivated as fodder then becoming wild, or due to being imported and broadcast together with other cultivated seeds (for example fodder and cereals).

On the basis of these data the presence of P. papapaloeh and any other species of Paspalum in ancient Greece has to be excluded. Furthermore, the insubstantiality of HOFMANN’S second hypothesis regarding the preparation of the kykeon from ergot, is supported by the fact that Claviceps purpurea, ergot of an ergot that exclusively infects graminaceous plants of the Paspalum genus (GRASSO 1955), and its presence in Europe is linked to the recent spreading of its host plants. It’s enough to consider that the presence of C. papatii in France has been reported for the first time only in 1991 (RAYNAL 1996), and that Greek phytopathologists seem to exclude the presence of C. papatii today in Greece (AXAIREN 1988: 252). Again, in Italy Paspalum dilatatum was introduced in 1929 and appeared to be free from ergot until 1948 (TUROL 1965).

Beside the botanical/coriological considerations presented here, a symbolic/iconographic argument could be taken in consideration. The ergot hypothesis of the Eleusinian kykeon is also supported by frequent representations of cereals in the iconography associated with the Eleusinian Mysteries. All the above-mentioned species of Paspalum have an appearance that is very different from that of the cereals cultivated for human consumption; P. papapaloeh has an inflorescence constituted by two (rarely more than one) thin spikes at the top of the stem. It would seem strange that such a characteristic shape would have not found place among the Eleusinian images. Nor does there seem to any hidden link between cultivated cereals and Paspalum, and the species of this last genus have a strongly different ecology (rice apart), and are not inestants of the cultivated fields spread during the Classic Greek period.

Nevertheless, we want to conclude by emphasizing that the reduction of the possibilities proposed by the Swiss chemist does not reduce the viability of the ergot hypothesis. HOFMANN himself stated concerning this: “I mention it only as a possibility or a likelihood, and not because we need P. dictyum to answer Wasson’s question” (HOFMANN 1978: 33). This topic will be examined further and in more detail in a article currently in publication (SASAKIEN 1989).
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thought that muscarine was the inebriating chemical for flies, as well as for human beings. However, attempts at feeding insects with pure muscarine had no effect at all. It was shown, instead, that flies are inebriated by the same alkaloids that are now known to produce effects in human beings.

In Japan, mushrooms that attract flies have also been used for a long time as insecticides. The most well-known example is Tricholoma magniceps Kurokawa, known as hasturi-alumeyi (fly-killing mushroom). This produces another isozaxolic alkaloid, tricholomic acid (= dihydrobetaoin acid) which, apparently, is not psychoactive in man (Takendo & Nakata 1964). Jonathan Ott (1993: 356) noted this compound in the common Pleurotus ostreatus (Jacquin ex F. Bres) Kumm, an edible mushroom cultivated and marketed in great quantities in Europe and America. We should note that this mushroom is a carnivore. In its natural state, it releases a neurotoxin into the soil that immobilizes nematodes, which are then trapped by the hyphae of this mushroom and ingested (Toxin & Barson 1984). Ott is convinced that the neurotoxin is tricholomic acid (i.e. the compound that attracts flies).

It may therefore be the case that isozaxolic alkaloids are produced by mushrooms both as a means of protection against certain predators and as a trap for underground worms, and that by ‘chance’ these substances also attract and inebriate flies (which are clearly not a source of nutrition for these particular mushrooms); carnivorous behavior has not been observed in Amanita muscaria and A. pantherina). But the question remains: why should the maximum concentration of ibotenic acid in these Amanitas be just below the cuticle in the wall (up to theextérieur), instead of in the stem?

Heinroth (1991) notes that flies lay eggs in mushroom stems. The grubs then move toward the gill area to feed. We may therefore imagine that isozaxolic alkaloids might act as an insecticide to prevent the flies from laying there. If this is the case, we do not know why the maximum alkaloid concentration is in the cap just under the cuticle and not in the stem, the preferred site for egg-laying. See, for example, the recent analyses by Gennaro et al. (1997) on fresh samples of Amanita muscaria collected in Piedmont (northern Italy). The muscimol concentration in the cap is 0.38 g/kg and 0.08 g/kg in the stem (ibotenic acid: 0.98 g/kg and 0.23 g/kg, respectively). Furthermore, it is not clear that the grubs of these mushrooms actively sporcocid the spores. Therefore, in another way, fly-aging and flies are one of attraction, not repulsion.

This strange behavior on the part of flies is not just a chance occurrence. Nor is it by mere chance that flies are attracted by fly-aging, or that the flies’ inebriation merely leads to death. Philosophically speaking, “chance” (or what we consider chance), is generally the measure of our ignorance. Faced with chance occurrences, we tend to consider such circumstances in this manner and look no further.

I would therefore like to advance a new hypothesis concerning the natural relationship between fly-aging and flies, and also with respect to the findings on hawkmoth inebriation from Jimson weed. Such behavior patterns are not just recklessness on the part of flies attracted by fly-aging (accidental inebriation mysteriously brought about by a monkey wren in the evolutionary ‘works’). Flies deliberately seek the state of inebriation, as do hawkmoms with Jimson weed. Flies, like the Siberian reindeer, take fly-aging as a drug.

In nature, the relationship between flies and their drug is non-obligatory. The flies exposed to this mushroom are not all “killed” (i.e. undergo the paroxysmic effects of the active principle). The physical and mental effects of Cannabis smoking in humans are gradual. They range from the so-called ‘high’ (a mental and partly physical state of excitation) to a visionary or ecstatic trance, and in this state you can immobilize the consumer for hours on end. The range of effects may depend on quantity, but other factors also come into play. Individual reactions to Cannabis vary and also depend on one’s own personal relationship with the substance and how this has developed over time. If we consider flies, it may well be that—to the present—our observations of their relationship with fly-aging are just the tip of the iceberg, and that other less evident aspects have been neglected. Perhaps flies that are not “killed” by the mushroom are inebriated to a certain extent. Merian has observed the effects of fly-aging in a fruit fly (Drosophila):

It made an attempt to fly off, and spiraled onto the table upon which the mushrooms lay. It remained motionless for at least a minute, and then recovered and flew off (Merian 1995: 102).

Fly-aging may be quite the opposite of an “artificial” paradigm for any number of insects (especially of the woodland undergrowth), and not just the common fly. The great ethnomycologist, R. Gordon Wasson, dedicated an entire chapter of his monumental work Mushrooms, Russia and History (1957, I: 190–234) to the relationship
On careful observation, we see that the flies land on the cuticles of the fly-agary cap and lick the surface. After a while (5–20 minutes), some show signs of inebriation. They fly erratically or not at all; they become sluggish; a tremor appears in the legs or there is a trembling of the wings. Eventually, the flies will roll over onto their backs legs in the air, perfectly still. If you touch them with a pencil tip, some will exhibit no response, while others will move their legs. Under a magnifying glass, one may observe a partialistic movement, which proves that these flies are not dead. Over a period ranging from 30 minutes to 50 hours, the flies wake up and soon move about in a natural manner. BOXER et al. (1965) showed that flies, on awakening, move their legs first, then their wings. They then fly off as though nothing had happened at all. Some flies do not exhibit inebriation on coming into contact with the surface of fly-agary. This may depend on the time of exposure to the inebriant. There are probably various degrees of inebriation, the signs of which range from markedly frenetic behavior during flight, to complete catalepsy.

During the late 1960s, a number of the collaborators of the great French mycologist Roger Heim—one of the founding fathers of modern ethnomycology and a pioneer in visionary mushroom research—at the N.

The name of this mushroom “muscaria” is derived from the Latin for fly, “musca,” because it is known that flies are attracted by the caps of fly-agary and that they are “killed” as a result of contact. In the past, indeed right up to our own century, fly-agary caps have been placed on windowsills as insecticides. Often, the cap (or is) crushed and mixed with sugar or milk to attract large quantities of flies. In this manner, the flies would actually consume greater quantities of the inebriant. The flies then die, probably due to overdose. I have often observed dead flies around the caps of the fly-agary that I have prepared on various occasions (preparation consists of stripping the cap of its spores and laying out the caps in a well-aired place for drying). Unless one wishes to dry the caps with a warm air flow in an open oven, the natural length of time for drying the mushrooms can range from a few to many days according to the temperature and humidity of the surrounding atmosphere. More recent studies (Egloff et al. 1965–67) on the researchers wished to establish the degree of inebriation that counted dozens of flies that had “died” during the drying period. The number depended not so much on the number of caps laid out, or days necessary for complete drying, as on the number of flies in the vicinity. The “victims” of contact with the caps—lying on their backs with their legs up in the typical position of a dead fly—only appear to have died. If you leave them alone and come back after an hour or so, or the next day, you will find that they have flown away! Normally, one might remove these “dead” flies, but perhaps others have taken the place of the first ones you saw, and multiplied by the caps. Seeing them as one would find it hard to distinguish between individual flies, it is hardly surprising that this turnover goes unnoticed. This is the reason for the folk belief that fly-agary kills flies by poisoning them. However, a number of 19th century mycologists noticed that flies were not so much poisoned as drugged into a state of “lethargy,” and it was recommended to those who used the mushroom against flies that they sweep up the immobilized flies and throw them into the fire (see, for example, PAULET 1793 and CORBET 1870: 54).

The most active portion of the mushroom is located immediately under the red cuticles of the cap. It is yellowish and is the region in which we find the highest concentrations of isoxazolic alkaloids (bibzole acid and muscimol). It was once
Fly Agaric, Flies, and Toads: A New Hypothesis
From the forthcoming Italian book Animals that Take Drugs by Giorgio Samorini

Animals take drugs. This is an undeniable fact that has been repeatedly confirmed by animal behavior studies. Some years ago, Siegel (1989) gathered together many instances of such behavior. At present, I am writing a book on the instances observed up to the present in an attempt to explain them in terms of what the biological literature refers to as the "PO factor" or "de-patterning factor."

In brief, we may note that all living species (including plant life) are endowed with a set of primary functions necessary for survival (nutrition, reproduction). However, this is not sufficient. If a species is to preserve itself over time, it must be capable of evolving by modifying and adapting itself to its incessantly changing environment. Apart from the rare cases of "living fossils," species that do not evolve will finally succumb. This is why each living species must also possess an "evolutionary function" that is based, biologists believe, on the PO or de-patterning factor. The PO factor is probably reflected in the behavioral trait of drug-taking noted in animals and human beings. In the final analysis, drug-taking may be considered a viable evolutionary function for the preservation of the species (Samorini, Animali che si drogano, work in progress). Siegel comes to the same conclusion, albeit by a different route.

We already know that hundreds of natural species display this trait (including, surprisingly, lower-order species such as insects). Certain hawkmoths—small nocturnal moths—have developed a long proboscis to draw the nectar of a Jimson weed species. In Arizona, the Manduca quinquemaculata hawkmoth feeds on the nectar of Datura meteloides DC. (D. innotata Mill.). By doing so it aids the pollination of the flowers. Only after repeated observation of the behavior of this species was it noticed by some researchers that this hawkmoth appeared to be intoxicated by the nectar. This was in fact anything but obvious. Firstly, observation took place by night when the plant’s corolla opens. The main tasks of the botanists and entomologists who took the trouble to sit up all night beside these Jimson weeds were identifying the pollinating insects...