自製菌絲瓶

Making Kinshi Bottle

人類是充滿挑戰慾望的動物。總是會有飼育家不滿於市售的菌絲瓶，深信一定還有更好的。也正因為有這一份上進心 (再加上育種)，日本大鍬的體型才會從十幾年前的70 mm一直飆到現在的84 mm。除了生木屑和菌絲以外，菌絲瓶還裝有那麼一點點的添加物，佔總量不到10%。但是這些添加物卻是菌絲瓶好壞的關鍵。1998年時我們曾經取得日本菌絲瓶的種菌，並委託台灣菇寮壓瓶，但是製造出來的菌絲瓶效果卻不理想，雄性成蟲均在40-60 mm之間。可想而知，好的菌瓶中含有哪些添加物成分都是製造商不願公開的商業機密。最基本的添加物為麵粉和味精，但也有聽過綜合維他命、蛋白質、花粉等等。有興趣研發新配方的朋友可以在家自己製作菌絲瓶。

但是製作菌絲瓶是一門很深的學問，可以寫出一本比「沉醉兜鍬」還要厚兩倍的書。由於篇幅限制的關係，在這裡只探討最基本、最重要的概念。對菌絲生態有最基本的了解以後，才能夠駕輕就熟地做出品質穩定的菌絲瓶。

我們從菌絲的生活史談起。首先，一朵成熟的菇 (又名「子實體」) 釋放出數百萬到數千萬的孢子。每一顆孢子都只有子實體一半的基因。這些孢子接

The human being is an animal that seeks challenges. Hobbyists believe that there is always a better kinshi bottle. This is precisely why ***curvidens***' limit has been raised from 70 mm over a decade ago to today's 84 mm. In addition to sawdust and fungus, kinshi bottles contain about 10% of nutrient supplements. These are what separates great bottles from mediocre bottles. In 1998, we were able to obtain a fungus strain from Japan. Then we had it made into kinshi bottles by local Taiwanese farmers. But these bottles didn't perform well. Male adults came out between 4 and 6 cm. Of course, what are added in superb kinshi bottles are commercial secrets. The most basic ingredients contain flour and MSG. Some people use multivitamins, protein, and pollen. Hobbyists interested in developing their own kinshi bottles can do so at home.

Making kinshi bottle is another branch of science. Its content could very well be twice as thick as this book. But due to space limitation, only the most basic and important concepts are discussed in this book. The hobbyist must have fundamental understanding of fungi before making kinshi bottle is possible.

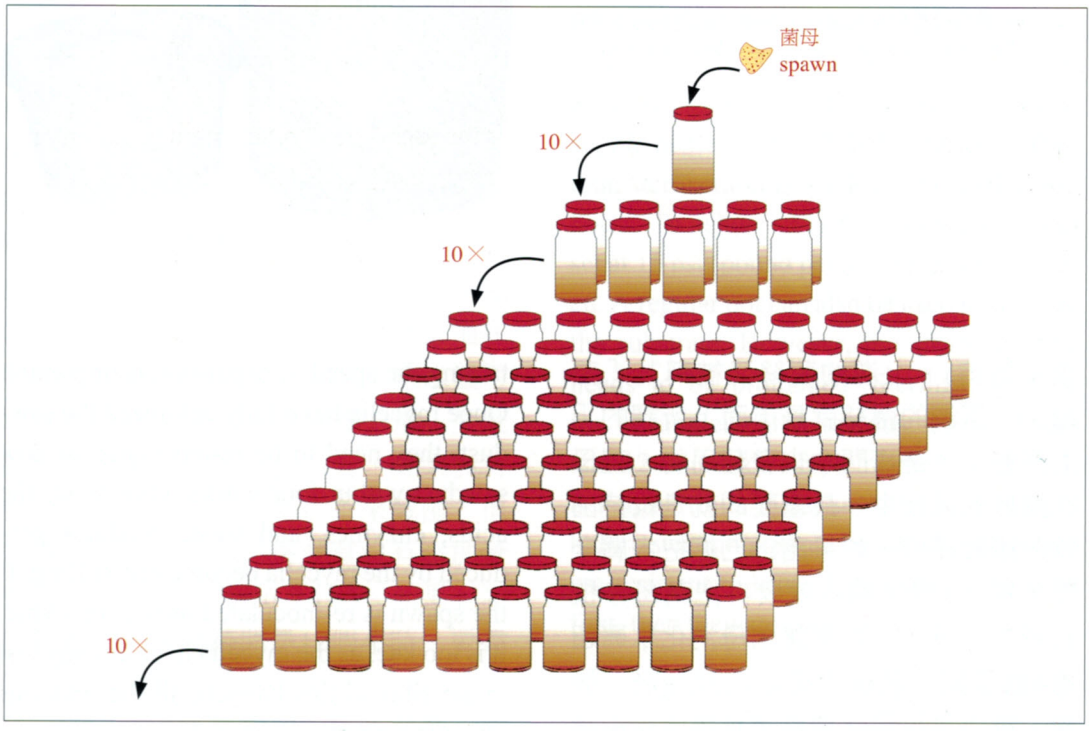
We start with the life cycle of fungi. Everything starts with a mature mushroom, which releases millions to tens of millions of spores. Each spore contains half the genetic material of the mushroom. These spores are

著被風或是動物帶到遠處。當這些孢子落在適合的介質，並且遇到水分後，就會開始發芽，而發出來的就是菌絲。接下來菌絲的任務就是尋找和自己相同種類的菌絲，並且進行交配。交配過後的菌絲會長得更濃密，而且擴散的速度也會更快。菌絲的擴散能力非常地強，基本上沒有所謂「太大的介質」。科學家曾經記錄到拓殖面積高達數千公頃的同一株菌絲。也就是說，再大棵的神木，菌絲都可以輕易佔領。菌絲在拓殖的過程中會釋放熱能和大量的二氧化碳，這也正是為什麼之前有提到，菌絲瓶走菌完成之前不要放入幼蟲。走菌的動作會一直持續到菌絲遇到障礙物為止 (可能是樹木的末端、飼養容器的牆壁、其他株的菌絲等等)。菌絲遇到障礙物以後會放緩新陳代謝的速度，這個時候溫度和二氧化碳的排放量都會下降。如果此時菌絲遇到刺激 (環境溫度劇降、濕氣改變、光線、二氧化碳濃度降低等等)，菌絲就會開始發菇。一旦成熟的子實體釋放孢子，菌絲的生活史也就完成了。

在人為的環境下，剛交配不久的菌絲可以拿來佔據1公升的木屑、1公升的菌絲再佔據10公升的木屑、10公升的菌絲再佔據100公升的木屑、100公升的菌絲再佔據1000公升的木屑。就這麼以此類推，菌絲到最後可以佔據一千萬公升的木屑。這是非常可怕的數據！想一想，一切只由兩顆肉眼看不見的孢子開始！但是話說回來，全世界很少有菇寮可以一口氣栽種一千萬公升的菌絲。一來沒有這種空間，二來沒有這

then taken by wind or animals to faraway places. When conditions are right, spores geminate. Mycelia of the same species mate with each other. After mating, the mycelia become thicker and grow faster. No substrate is too large for the mycelia. Scientists have discovered mycelia from one individual to span thousands of acres. As the mycelia expand, heat and large amounts of carbon dioxide are generated. This is why a larva should not be placed in a kinshi bottle before it is fully colonized. The mycelia expand until they reach a barrier, which could be the end of a log, the wall of the rearing container, or the mycelia of another individual. Then the metabolism of the mycelia slows down. When the mycelia are stimulated, mushroom formation takes place. Stimuli may include a drop of temperature, change in humidity, lighting, a drop of carbon dioxide level, etc. Once the mushrooms release their spores, the life cycle is completed.

In captivity, newly mated mycelia can be inoculated into a container with one liter of raw sawdust. Once fully colonized, the one liter of kinshi (mycelia) can be used to inoculate ten containers each containing one liter of raw sawdust. Then ten becomes a hundred; a hundred becomes a thousand. Inoculation continues by a factor of ten until ten million bottles each containing one liter of raw sawdust are inoculated. However, this is not done in practice. First of all, very few mushroom farms have such space to house ten million bottles. Second, ten million liters of raw sawdust is a lot to obtain at once. Third, no market is big enough to absorb at once two million kilograms of



↗ 一小塊原始菌母可以佔據一千萬公升的生木屑。
The original spawn can colonize ten million liters of sawdust.

麼多木屑，三來一口氣種出兩百萬公斤的香菇很難馬上賣光。但是如果只栽培個十萬公升就讓菌絲發菇不是非常可惜嗎？這樣菇農的收入就少了100倍。要如何才能夠栽培到一千萬公升又不佔太多的空間？答案是1-2°C的冷藏。菌絲在22-25°C的溫度下只能夠活6-12個月。但是如果冷藏在1-2°C的環境中可以活至少五年。專業菇農的作法是，把剛交配不久的菌絲冷藏，每次需要時才取出1平方公分的菌絲，然後以十倍數的方式栽培出一萬公升的菌絲。越上游的菌絲因為細胞分裂次數越少，因此活動力越強，也越不怕被其他黴菌感染。最下游的菌絲因為細胞分裂次數最多，弱化的情形也最嚴重（擴散速度慢、容易被

mushrooms produced. However, if the kinshi are induced to grow mushrooms at only one hundred thousand bottles, wouldn't that be a pity? That means the farmer's income is reduced one hundred times. How can all ten million bottles be inoculated and not use up too much space? The answer is refrigeration at 1-2°C. At 22-25°C, mycelia can only live 6-12 months. But at 1-2°C, they can live at least five years. The professional cultivator keeps newly-mated kinshi refrigerated. A tiny fragment of one square centimeter is retrieved only when needed to expand into ten thousand liters of kinshi. Newly-mated mycelia have the most vigor. But with each expansion, cells lose vigor. "Upper stream" mycelia are known as "spawn" and lower stream mycelia are used for mushroom production. When expanding spawn, main-

→左邊為已經弱化的菌絲，右邊為品質良好的菌絲。
Left is kinshi in decline. Right is healthy kinshi.

感染等等)。上游的菌絲又被稱為「菌母」。下游的菌絲就是市面上所謂的「太空包」，是專門拿來發菇用的。菌母在擴散的過程中，最重要的就是維持菌絲的擴散速度。如果菌母已經把木屑全部佔據，4個星期內就要再把菌母移植到新的介質上。如果讓菌母消化木屑超過4個星期，菌絲所排放的酸性物、酵素、排泄物等等就會累積到讓菌絲中毒的濃度。這個時候再把菌母移植到新的介質已經太慢了；菌絲已經喪失了擴散的活力。這等於前功盡棄，對菇農會是很大的損失。

如果飼育家只是要做個10-100個菌絲瓶，其實是沒有必要用到菌母的。只要用太空包接種就可以了。製作菌絲瓶時最重要的就是無菌的環境。由於菌絲的成長速度比黴菌慢，因此木屑如果被黴菌感染了，菌絲就會無法擴散。使用菌母時更是要格外地小心。如果菌母受到了感染，下游的菌絲將全部受到感染，造成很大的金錢和時間損失。

消除黴菌和細菌等感染原的方式就是把介質放入高溫環境中蒸煮。不過滅菌所需的時間會因為使用的介質、

taining the speed of expansion is important. Once mycelia have fully colonized the sawdust, they need to be re-inoculated to new sawdust within four weeks. Otherwise, the acids, enzymes, and waste products produced by the mycelia become self-stifling. If the spawn is re-inoculated only at this time, it is too late, as the mycelia have already lost vigor. Should this happen, all the previous effort is wasted

If the hobbyist is only going to make 10-100 kinshi bottles, there is no need to use upper-stream spawn. The key to kinshi bottle production is sterile environment. As kinshi grows slower than mold, if the sawdust is contaminated with mold, kinshi will not be able to colonize. This is especially important when working with spawn. If spawn is contaminated, all the down-stream kinshi will be contaimnated, resulting in great monetary and time losses.

The best way to rid of mold and contaminants is steaming the substrate. However, the duration of steaming depends on factors such as the substrate used, the volume of the substrate, presence of additives, temperature, etc. If the substrate is sawdust under five liters without any additives, and

介質的體積、營養物的添加、滅菌的溫度等因素而有所不同。如果使用的介質是木屑、體積在5公升之內、沒有添加營養物、溫度是121°C，那麼2-3個小時就可以把介質中的感染原降低到菌絲可以順利生長的數量。如果木屑中有添加10-20%的營養物，介質就要做到完全滅菌，所需時間是4-5小時。大家都知道在平地水的沸點是100°C。如果要讓水溫可以達到121°C，就必須使用壓力鍋，並且把壓力設在每平方公分1公斤。如果沒有壓力鍋，一般鍋子也可以用來滅菌，但是時間必須加長。如果介質沒有添加營養物，蒸煮的時間是6-7小時。如果有添加營養物，滅菌時間是12個小時。要達到完全滅菌還有一個小技巧，那就是木屑添加水分以後先放個一天再蒸煮。有些細菌的孢子可以抵抗高溫，但是如果先讓牠們發芽，就可以輕易殺死。

菌絲瓶的改良可以朝三個方向進行。一個是研發新的營養添加物配方，一個是嘗試不同種類的闊葉樹木屑，一個是嘗試新的菌絲種類。不過要注意的是，木食性的真菌有好幾百種，但是並不是每一種菌都能夠用來飼養大鍬形蟲的幼蟲。有些甚至會導致幼蟲死亡。目前已經確定不能用來飼養大鍬形蟲幼蟲的真菌有香菇 (***Lentinula edodes***) 和靈芝 (***Ganoderma lucidum***)。目前市面上用來飼養大鍬形蟲幼蟲的菌絲主要來自於***Pleurotus***屬。***P. ostreatus*** (蠔菇/袖珍菇/鮑魚菇) 和***P. pulmonarius*** (鳳尾菇) 都是確定可以飼養大鍬形蟲幼蟲的種類。近年來開始有飼育者使用雲芝菌飼

the steaming temperature is 121°C, then 2-3 hours will have killed enough contaminants to allow kinshi growth. If the sawdust is supplemented with 10-20% nutrients, then total sterilization is needed, which takes 4-5 hours. To achieve 121°C, a pressure cooker set at 15 psi (pound per square inch) is needed. A regular pot can also be used to sterilize the substrate. However, the steaming time needs to be prolonged. Sterilization time for unsupplemented sawdust is 6-7 hours and 12 hours for supplemented sawdust. It is helpful to let moist sawdust sit overnight before steaming. Some bacterial endospores are resistant to heat. If they are germinated first, then they are easy to kill.

The kinshi bottle can be improved in three directions. One is developing new supplement formula. Another is experimenting with sawdust from different species of hardwood trees. Another is experimenting with different species of fungi. But keep in mind: of the hundreds of species of saprophytic (wood-eating) fungi, some are known to kill larvae. Species that are known not to work include the Shiitake mushroom (***Lentinula edodes***) and Reishi, or Ling Chi (***Ganoderma lucidum***). Fungi currently used for ***D. curvidens*** are mainly from the Genus ***Pleurotus***. ***P. ostreatus*** and ***P. pulmonarius*** are known to work for larvae. In recent years hobbyists have begun using Turkey Tail (Yun Zhi) ***Trametes versicolor*** kinshi to rear stag beetle larvae other than ***Mesotopus*** and ***Allotopus***. Why do ***Mesotopus*** and ***Allotupus*** larvae grow well only in Turkey Tail kinshi? According to the book "Grow-

養黑豔鍬和黃金鬼以外的幼蟲。為什麼黑豔鍬和黃金鬼的幼蟲一定要使用雲芝菌才長得好？雲芝菌和其他像是蠔菇或是袖珍菇的菌到底哪裡不一樣？世界食用菇栽植權威保羅・史戴曼茲在「食用及藥用菇之栽培」一書中第384頁寫道，栽種雲芝菌的木屑沒有必要添加任何營養物，因為雲芝菌的酵素從木質中萃取養分的效率實在太高了，導致添加營養物沒有意義。或許是因為這個原因，吃雲芝菌的黑豔鍬和黃金鬼幼蟲才會發育得特別好。另外一點值得一提的是，雲芝廣泛分佈於全世界的森林中，也因此許多鍬形蟲都能夠接受牠也就不奇怪了。

菌絲就好像是人類一樣，每一株都有自己的個性。即使在同一個種類中，有些菌絲喜歡在溫暖的環境中發菇、有些喜歡在寒冷的環境中發菇、有些發菇量很大、有些幾乎不會發菇等等。對菇農而言，發菇量越大的菌絲越好。對養兜鍬的飼育家而言，越不會發菇的菌絲越好。要找到真正適合自己的菌絲並不容易，有時候要花上數年的時間。菌種的取得主要有四個方式。最簡單的就是向菇農購買菌母。第二種方式是到野外鋸開朽木，採集野生菌絲。第三種方式是從子實體根部割下一小塊組織，然後在木屑上培養菌絲。第四種方式是把接近成熟的子實體的菇蓋剪下放在一片玻璃或是列印紙上，等到12-24小時後玻璃充滿一層孢子時，再把孢子灑到木屑上培養 (等待期間可以用一個碗把子實體罩住，防止過分的水分蒸發)。除了第

ing Gourmet and Medicinal Mushrooms" by Paul Statemets, Turkey Tail's enzymes are extremely efficient in extracting nutrients from wood. Perhaps this is why ***Allotopus*** and ***Mesotopus*** larvae thrive in Turkey Tail kinshi. Another point worthy of mention is that Turkey Tail is a global species, found in every forest of the world. It is therefore not strange that many species take to Turkey Tail.

Mycelia are like humans, with each strain having its own personality. Even in the same species, some individuals form mushrooms in warm environment; some do so in cold environment; some form large amounts of mushrooms; others rarely form mushrooms. To the mushroom cultivator, the more mushrooms the better. To the beetle cultivator, the less mushrooms the better. It's not easy to find a strain that truly suits one's purposes. The hunting process may take years. There are four major ways of obtaining a kinshi strain. The easiest is to buy it from a mushroom lab. The second method is collecting it from the wild by sawing open a decayed log with mycelia. The third method is cutting off a small piece of a fresh mushroom and growing the tissue on sawdust. The fourth method is cutting off the cap of a near-mature mushroom and placing it on a piece of glass or clean printing paper. When the glass is full of spores 12-24 hours later, the spores are sprinkled onto sawdust for cultivation (while waiting for the mushroom to release its spores, it can be covered by a bowl to minimize dehydration). Other than the first method, samples collected are

一種方式以外，樣本往往帶有大量的雜菌，需要經過各種純化過程才能夠得到乾淨的菌絲。其中一個方式是把樣本接種在完全沒有添加過營養物，並且經過4-5小時完全滅菌的木屑上。木屑應該壓緊於長條形的塑膠袋中。由於木屑的成分比較有利於木食性真菌的菌絲生長，因此菌絲應該能夠把雜菌拋在後面，率先長到容器末端。這個時候只要把塑膠袋末端減開，取得的應該就是純菌絲。如果不放心，可以用相同的方式再走一次菌。如果菌絲最後接種到有添加營養物的木屑時，沒有發生感染的現象，幾乎就可以確定手上的菌絲是純菌絲。

usually contaminated with other organisms and need to be purified if pure culture is to be obtained. One way is to grow the sample on un-supplemented sawdust that has been sterilized for 4-5 hours. The sawdust should be packed in a tubular heat-resistant plastic bag. Because sawdust favors saprophytic fungi, the mycelia are usually able to outgrow contaminants, reaching the end of the container first. Mycelia at the end of the container are usually contaminant free and can be obtained by cutting the plastic open. To be certain, such mycelia can be grown through another batch of sterilized substrate. If no contamination occurs when the mycelia are grown on supplemented sawdust, the culture can be regarded as pure.

↗把剪下的子實體放在紙上。
Rest fruiting body on paper.

↗24小時後就會有大量的孢子。
Massive spore release after 24 hours.

菌絲瓶中的營養物可以事先混入木屑中，或是菌絲瓶做好以後再添加。兩種作法都有優缺點。如果事先添加，菌絲瓶做好後就可以直接使用，但是滅菌時間要拉長。如果事後添加，雖然滅菌時間縮短了，但是又多出了一道壓菌的手續，而且不能使用太下游的菌絲。此書將先介紹事先添加營養物的菌絲瓶製作方法。

準備材料：壓力鍋、含蓋玻璃瓶或塑膠瓶（需可耐高溫120度）、乾燥生木屑、營養添加劑、擠壓棒、菌種、棉花或水族過濾棉、金屬或塑膠湯匙、75%酒精、大型塑膠袋。

Nutrient supplements can be added to the substrate before or after the kinshi bottle is made. If they are added first, the kinshi bottle is ready for use after it's made, but the steaming time is prolonged. If supplements are added later, although the steaming time is reduced, extra steps follow and downstream mycelia cannot be used. This book will first introduce the method that calls for adding supplements first.

Items: pressure cooker, glass or plastic container (to withstand 120°C) with lid, dry raw sawdust, nutrient supplement, compressor, kinshi, cotton or aquarium filter wool, metal or plastic spoon, 75% alcohol, large

1. 乾燥生木屑和營養添加劑以9比1的重量比例充分混合。
2. 介質和自來水以1比1的重量比例充分混合 (50%溼度)。
3. 用擠壓棒把介質壓緊於玻璃瓶或塑膠瓶中直到八分滿。
4. 在容器蓋子上鑽出兩個直徑5-10 mm的透氣孔，並塞上水族用過濾棉或是棉花。
5. 把蓋子蓋回容器，並用錫箔紙把透氣孔封起來，用意是防止介質的溼度在滅菌的過程中改變。
6. 把裝有介質的容器放入滅菌鍋中蒸煮4個小時。
7. 讓大型塑膠袋的開口套住一張小桌子或是板凳，然後把塑膠袋的尾端用膠帶固定在牆壁上。這就是接種用的無灰塵空間。接種空間內同時擺放菌種瓶、酒精噴霧器，以及一根挖種菌用的小湯匙。
8. 滅菌鍋的溫度降到和室溫一樣時 (至少6個小時)，把介質容器轉移到接種用塑膠袋內。
9. 雙手戴上手套。在接種空間內，用噴霧器對空氣、菌種瓶、介質瓶、雙手，以及湯匙進行噴灑酒精的消毒動作。
10. 用湯匙挖起數塊菌絲到介質瓶中。
11. 接種完畢後把介質瓶從塑膠袋內取出，擺放於25°C以下的陰暗處培養菌絲。

plastic bag.

1. Mix nine part dry raw sawdust with one part nutrient supplement by weight.
2. Mix one part substrate with one part water by weight (50% humidity).
3. Compress substrate into container with compressor until 80% full.
4. Drill two ventilation holes each with 5-10 mm diameter on the container lid and stuff with cotton or aquarium filter wool.
5. Screw the lid back and seal ventilation holes with foil paper to prevent humidity of substrate from changing during sterilization.
6. Place container in pressure cooker and steam for 4 hours.
7. Cover a small table or stool with opening of large plastic bag and tape end of bag to wall. This is dust-proof zone for inoculation. Place kinshi for inoculation, alcohol spray bottle, and spoon in this zone.
8. When the pressure cooker has cooled to room temperature (at least 6 hours), transfer the substrate container to the inoculation zone.
9. Wear gloves. In the inoculation zone, spray alcohol at air, kinshi container, substrate container, both hands, and spoon to disinfect.
10. Transfer a few scoops of kinshi to substrate container with spoon.
11. After inoculation, remove substrate container from inoculation zone. Store in dim area under 25°C and allow kinshi

A 加入營養劑。
Add nutrient supplement.

B 擠壓介質。
Compress substrate.

C 蓋上蓋子。
Cover with lid.

D 封上錫箔紙。
Seal with aluminum foil.

E 滅菌。
Sterilize.

F 高壓蒸煮。
Pressure cook.

G 塑膠袋內接種。
Inoculate in bag.

H 用湯匙取菌。
Retrieve kinshi with spoon.

I 取出菌種。
Scoop out kinshi.

J 移植到介質瓶。
Transfer to substrate container.

K 蓋回蓋子。
Return lid.

L 7 天後。
7 days later

M 30 天後。
30 days later.

N 60 天後。
60 days later.

菌絲瓶的製造過程的確相當麻煩。曾懷疑以上所有的步驟是否過分講究。其實不然。菇農栽種各種菇類於生木屑時，也都一定要先滅菌。這些菌絲的競爭力似乎都不強，一旦有別的黴菌便無法成功地擴散。遭感染的介質會出現綠色、灰色、褐色，或是黑色的黴菌。但是一旦菌絲完全佔據生木屑以後就沒那麼脆弱。使用時只要把工具清洗乾淨即可。

在家也可以自己做菌磚。步驟如下：

1. 取得可耐120^{0}C高溫的塑膠袋 (此材料可到塑膠行購買)。
2. 把塑膠袋的兩個底部角落摺起來，並用金屬夾子固定，如此便可以製造出方形的空間。
3. 用擠壓棒把介質壓緊於塑膠袋內。
4. 用剪刀剪出一個直徑10-20 mm的透氣孔，並塞上棉花或是水族用過濾棉。
5. 把塑膠袋的開口拉合，然後倒摺一次。倒摺處用金屬夾固定。
6. 連同金屬夾，整包放入滅菌鍋蒸煮4個小時。
7. 滅菌鍋的溫度降到室溫後，把介質包移至大型塑膠袋內接種。接種後用膠帶封口。註：因為材質不同的緣故，有些塑膠在滅菌的過程中，有互相接觸的表面會融合在一起，導致開口封死。這個時候要用剪刀剪開才可接種。

colonization.

Making kinshi bottles at home is indeed troublesome. I have wondered if it was really necessary to go through all of the above steps. Unfortunately, yes. All commercial mushroom farms also heat sterilize raw sawdust before implanting the mushroom spawn. Mushroom fungi don't seem to be very competitive, as pest fungi easily take over if not excluded. Contaminated kinshi bottles grow mycelia that are green, grey, brown, or black in color. However, once mushroom mycelia have completely colonized the sawdust, they are no longer as vulnerable.

Kinshi blocks can be made at home as well. Procedures are as follows:

1. Obtain plastic bag heat-tolerant up to 120^{0}C.
2. Fold the bottom two corners and secure with metal clamps to create rectangular space.
3. Compress substrate into bag with compressor.
4. Cut out a ventilation hole 10-20 mm in diameter and stuff with cotton or aquarium filter wool.
5. Pull the opening together and fold once. Place a metal clamp on the fold.
6. Including the metal clamps, pressure cook the bag for 4 hours.
7. When the pressure cooker has cooled to room temperature, transfer the bag to inoculation zone and have it inoculated. After inoculation, seal the opening with

8. 接種完畢後把介質包從塑膠袋內取出，擺放於25°C以下的陰暗處培養菌絲。確定不會再移動介質包後，取下兩側的金屬夾。

tape. Note: due to material difference, some plastic fuse where surfaces touch during sterilization, causing the opening to be sealed. In this case, the bag needs to be cut with scissors to be inoculated.

8. After inoculation, remove bag from in-

A

↗ 準備材料。
Items.

B

↗摺起角落。
Fold corner.

C

↗ 用金屬夾固定。
Secure with metal clamps.

D

↗ 裝入介質。
Fill with substrate.

E

↗ 裝上過濾棉、夾住開口。
Insert filter and clamp opening.

F

↗接種後。等待走菌。
After inoculation. Awaiting colonization.

若菌絲瓶或菌磚在製造的過程中沒有被雜菌感染，幾天後菌絲便會以每天5-10 mm的速度擴散。若菌絲10天後都沒有擴散則表示已被雜菌入侵。接種能不能成功主要取決於兩個關鍵。一個是木屑的滅菌做得徹不徹底。另外一個是接種的環境夠不夠乾淨。針對第一點，用高壓蒸氣鍋以121度蒸煮至少兩個小時是必須的。針對第二點，在一般民眾的家中，最垂手可得用來製造無灰塵環境的器具就是大型塑膠袋。在塑膠袋內部作業時，應該把家中的冷氣或是電風扇以及門窗關閉，如此可以避免大量灰塵在空氣中飄揚。如果擔心接種的環境不夠乾淨，有個小技巧可以增加接種的成功率。那就是鋪一層沒有添加營養物的木屑在有添加營養物的木屑上，如此可以幫助菌絲比感染原更快速地佔據底部的木屑。

如果接種完的菌瓶或菌磚是要拿來養幼蟲的，那麼在接種的過程中有少許的雜菌入侵並沒有關係，只要菌絲能夠正常地擴散。但是如果接種後的菌瓶是要拿來繼續擴瓶用，受感染的菌絲就不適合再繼續使用，否則雜菌最後會爆發到無法收拾的地步。栽種菌絲最困難的一點就是除非感染已經很嚴重，否則無法用肉眼判定菌絲是否有被雜菌入侵。也因此，接種的設備是非常重要的。在一般家庭中，少量製作養幼蟲用的菌絲瓶或是菌磚是沒有問題的，但是如果要大規模地進行菌母拓瓶的操作，就很容易因為遭到感染而失敗。

oculation zone. Store in dim area under 25°C and allow kinshi colonization. Once bag will no longer be moved, remove the side clamps.

If a kinshi bottle or kinshi block is not contaminated during inoculation, the mycelia will start to grow vigorously after a few days. A good growth rate is 5-10 mm per day. If you don't see growth within ten days, inoculation has failed. Successful inoculation depends on two major factors. One is sterilization of the sawdust. Steaming for at least two hours with a pressure cooker at 121°C is a must. The second is a clean inoculation environment. For the generic household, the most readily available item to create a dust-free environment is a large clear plastic bag. When working inside it, have the AC or fan turned off and windows and doors closed to minimize dust in the air. Another tip can help increase the success rate of inoculation. Pack a layer of unsupplemented sawdust on top of supplemented sawdust. The unsupplemented layer can help screen out contaminants and help kinshi colonize the bottom supplemented layer.

If the kinshi bottle or block is for rearing larvae after inoculation, then minor contamination during the inoculation process is acceptable, given kinshi growth is not hindered. But if the bottle or block is to inoculate more substrate, then even lightly contaminated kinshi should be discarded, or contaminants will eventually bloom out of control. However, light contamination can not be detected by the naked eye. As a result, the inoculation equipment becomes critical. In the regular household, making a small

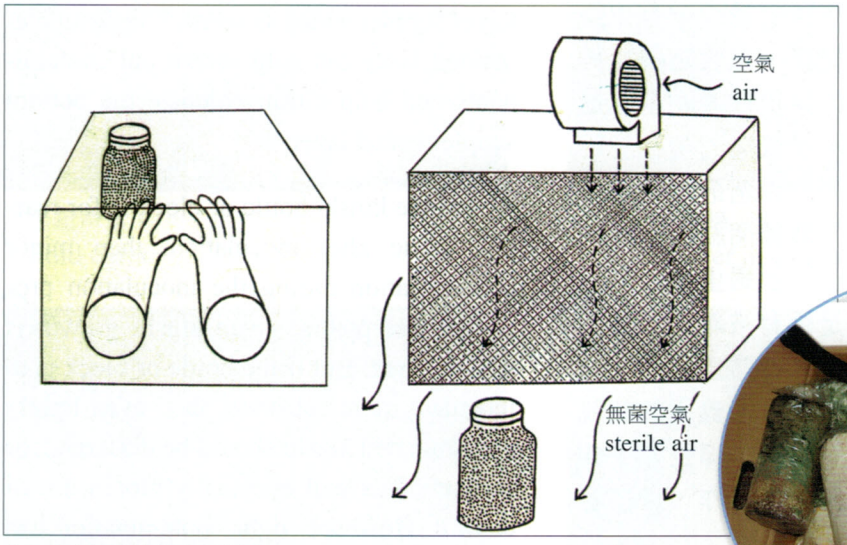
另外一種比較進階的接種工具叫做「手套箱」。它的主體是一個大型的置物箱。其中的一個側面鑽有2個直徑約8 cm的洞。每個洞口各裝上一只塑膠袋或是長管的橡膠手套。接種者透過這兩個塑膠袋或是手套在置物箱內作業。手套箱中放有一罐裝75%酒精的噴霧氣。打開木屑瓶和種菌瓶之前先對手套箱中的空氣以及瓶蓋的四周做酒精噴霧，如此可讓所有灰塵沉澱並殺菌。

最進階的工具叫做「流動囪」，這也是美國專業菇農的選擇。它是一個其中一面裝有醫療級HEPA過濾棉的大型箱子。這種過濾棉可以把空氣中小至0.3微米的感染原做到99.99%的攔截。箱子的最上方裝有一台推風機。空氣被推入箱子後再從HEPA過濾棉流出。接種者就在這一股無菌的氣流中作業。

number of kinshi bottles for rearing larvae is no problem, but to expand kinshi on large scale is difficult due to a lack of sterile environment.

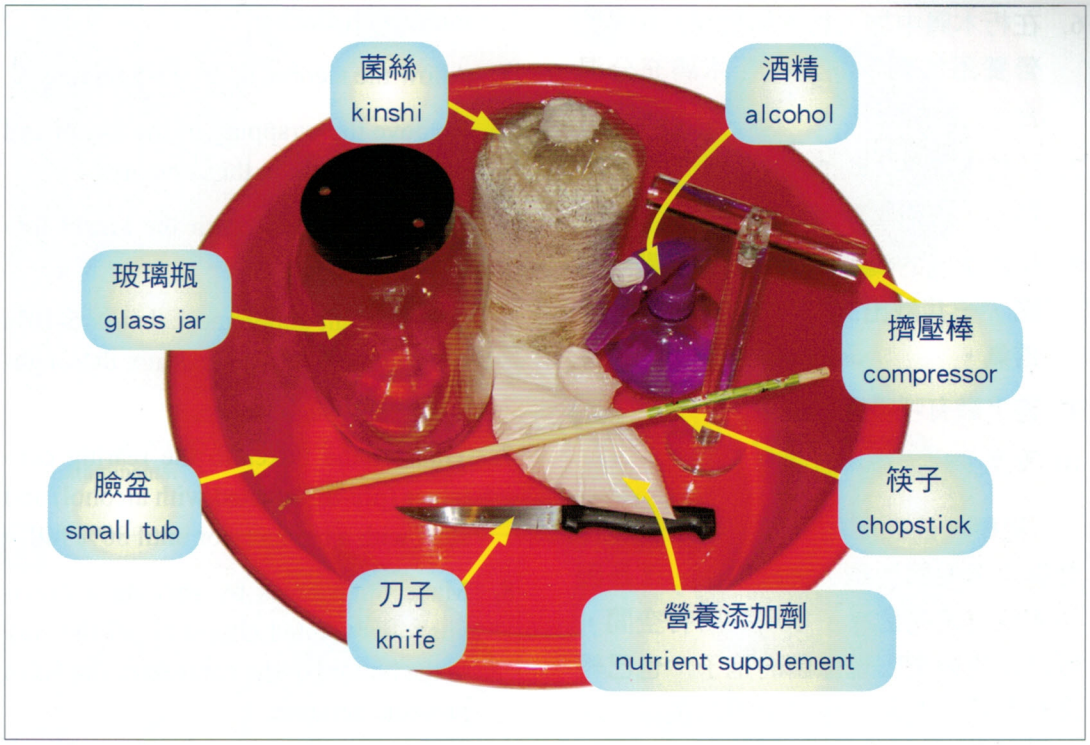
A more advanced equipment for inoculation is called the "glove box." It's a large container with two holes (each about 8 cm in diameter) drilled on one of the sides. A plastic bag or rubber glove is attached to each hole. Inoculation is done inside the container with the operator working through the gloves. A sprayer filled with 75% alcohol is kept in the glove box. The air is sprayed to settle any dust before inoculation.

The most advanced tool is called the "flow hood." It's a large crate with a HEPA (high efficiency particulate air filter) filter installed in the front. It is capable of filtering out 99.99% of contaminants down to 0.3 mi-



↑↗手套箱和流動囪示意圖。
Illustration of glove box and laminar flow hood.

↓遭感染的菌絲包。2002
Contaminated kinshi bags.



之前有提過，營養物也可以做好菌絲瓶以後再添加。步驟如下：

準備材料：臉盆、75%酒精、菌絲、小刀、營養添加劑、含蓋玻璃瓶或塑膠瓶、擠壓棒、筷子。

1. 用清水洗淨大型塑膠盆或是置物箱。
2. 用酒精噴霧塑膠盆或是置物箱內部消毒。
3. 讓酒精風乾 (3-5分鐘)。
4. 把菌磚或是太空包的包裝拆掉、內容物倒到塑膠容器中。
5. 用帶著手套的雙手把菌磚或是太空包的內容物完全壓碎，直到通通變成木屑狀。

cron. An opening is drilled on the top of the crate and installed with an air blower. The blower pushes air through the HEPA filter. A sterile current of air is generated. Inoculation is done in this current.

As previously mentioned, nutrient supplement can be added after the kinsh bottle is made. Procedures are as follows:

Items: Small tub, 75% alcohol, kinshi, small knife, nutrient supplement, glass or plastic container with lid, compressor, chopstick.

1. Thoroughly cleanse a large plastic container with tap water.
2. Disinfect the interior of the plastic con-

6. 在朽木屑中加入朽木屑體積5-10%的營養添加劑，並且和朽木屑充分混合。
7. 把朽木屑裝入用酒精消毒過的飼養容器內，用擠壓棒壓緊至八分滿。
8. 用消毒過的筷子從朽木屑表面戳到瓶底，一共戳出3個洞。如此可以促進透氣。
9. 蓋上戳有呼吸孔的蓋子。
10. 等至少14天後再養蟲。

初學者最想問的問題一定是「為什麼事後再加添加劑不會感染」。這是因為菌絲已經先佔據了木屑的所有空間，所以即使後來出現黴菌的孢子，也已經沒有生長的空間。除非使用的菌絲一開始就已經弱化，否則不用擔心感染，最多只是表面長青黴。不過在這裡要提醒大家，添加物多不見得就是好。近年來也有日本飼育家偏好只添加微量添加物的菌絲瓶，或甚至完全沒有添加物的菌絲瓶。

註：有些甲蟲店會標榜店裡有販售「生木屑」。這是名詞上的一個誤會。蟲店販售的「生木屑」其實是沒有經過發酵的朽木屑。真正的「生木屑」是指沒有經過任何真菌消化過的木屑。

tainer with alcohol.

3. Allow the alcohol to dry (3-5 minutes).
4. Remove the wrapping of the kinshi and place the kinshi in the container.
5. Wear gloves and crush the kinshi into fine flakes.
6. Add nutrient supplement that is 5-10% the volume of kinshi and mix thoroughly.
7. Transfer the flakes to the rearing container (pre-disinfected with alcohol) and stuff with a compressor until 80% full.
8. Make three holes by sticking a previously disinfected chopstick all the way to the bottom of the container. The holes promote aeration.
9. Cover with a lid with ventilation holes.
10. Wait at 14 days before rearing larva.

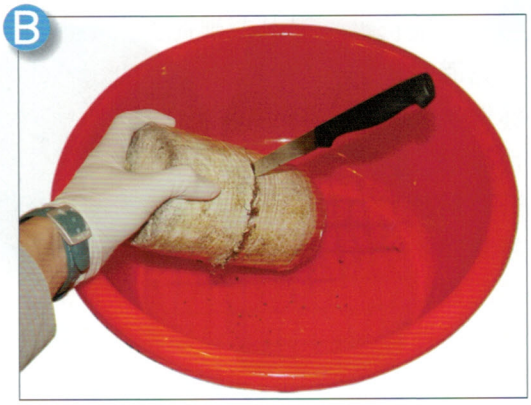
Beginners must be wondering why this method doesn't lead to contamination. This is because the kinshi have already occupied all available spaces on the wood, so mold spores have no place to grow. Unless the kinshi are weak to begin with, there is no worry of contamination. At most, some green mold develop on the surface of the kinshi. As a reminder, however, more additives doesn't necessarily mean bigger beetles.

Note: Some insect stores claim that they sell "raw sawdust." This is a misunderstanding of terminology. Their so-called "raw sawdust" is actually unfermented decayed wood flakes. True "raw sawdust" has not been digested by any fungi.

A

↗ 倒過來晾乾可降低感染原。
Upside-down drying minimizes contaminants.

B



↗割開菌絲包。
Cut open packaging.

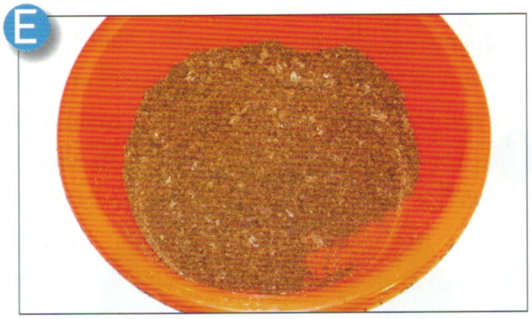
C

↗ 把菌絲放入盆中。
Place kinshi in tub.

D

↗ 加入營養劑。
Add nutrient supplement.

E



↗ 充分攪拌。
Mix thoroughly.

F

↗裝入瓶中。
Transfer to jar.

G

↗ 用擠壓棒壓緊。
Compress substrate.

H

↗ 將筷子插到底。
Stick to bottom with chopstick.

I

↗ 戳出三個透氣孔。
Make three ventilation holes.

J

↗ 蓋回蓋子。
Return lid.

K

↗ 等待走菌。
Wait for re-colonization.

L

↗48 小時後。
48 hours later.

M

↗10 天後。
10 days later.