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Edible Fungi Opportunities

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Whitiwhiti Ora, Land Use Opportunities Project

Waimakariri Farm land use change group

Mandeville, October 19, 2022

What is a mushroom or a truffle?

Fairy Ring Mushroom

Marasmius oreades

Périgord Black Truffle

Tuber melanosporum

Fruiting bodies of fungi

Mushroom spores

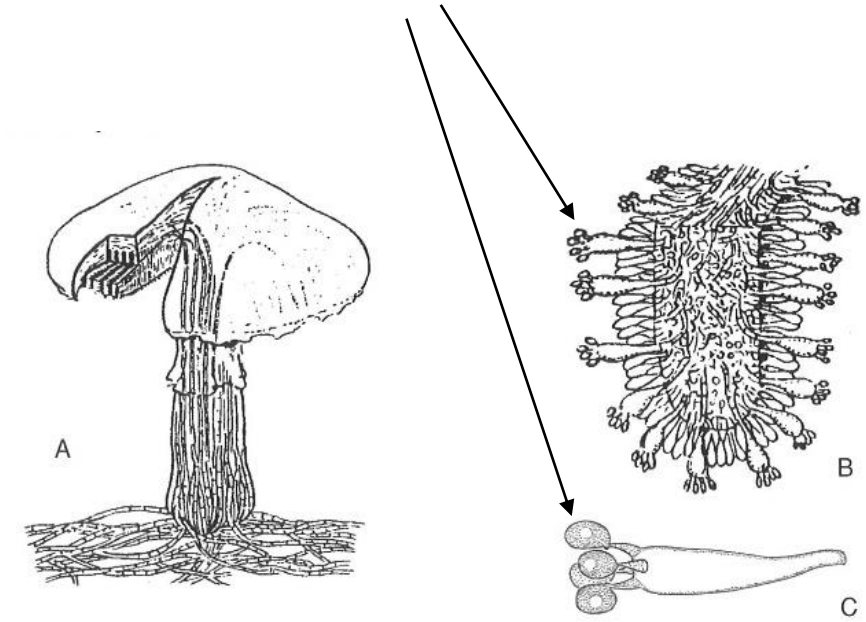
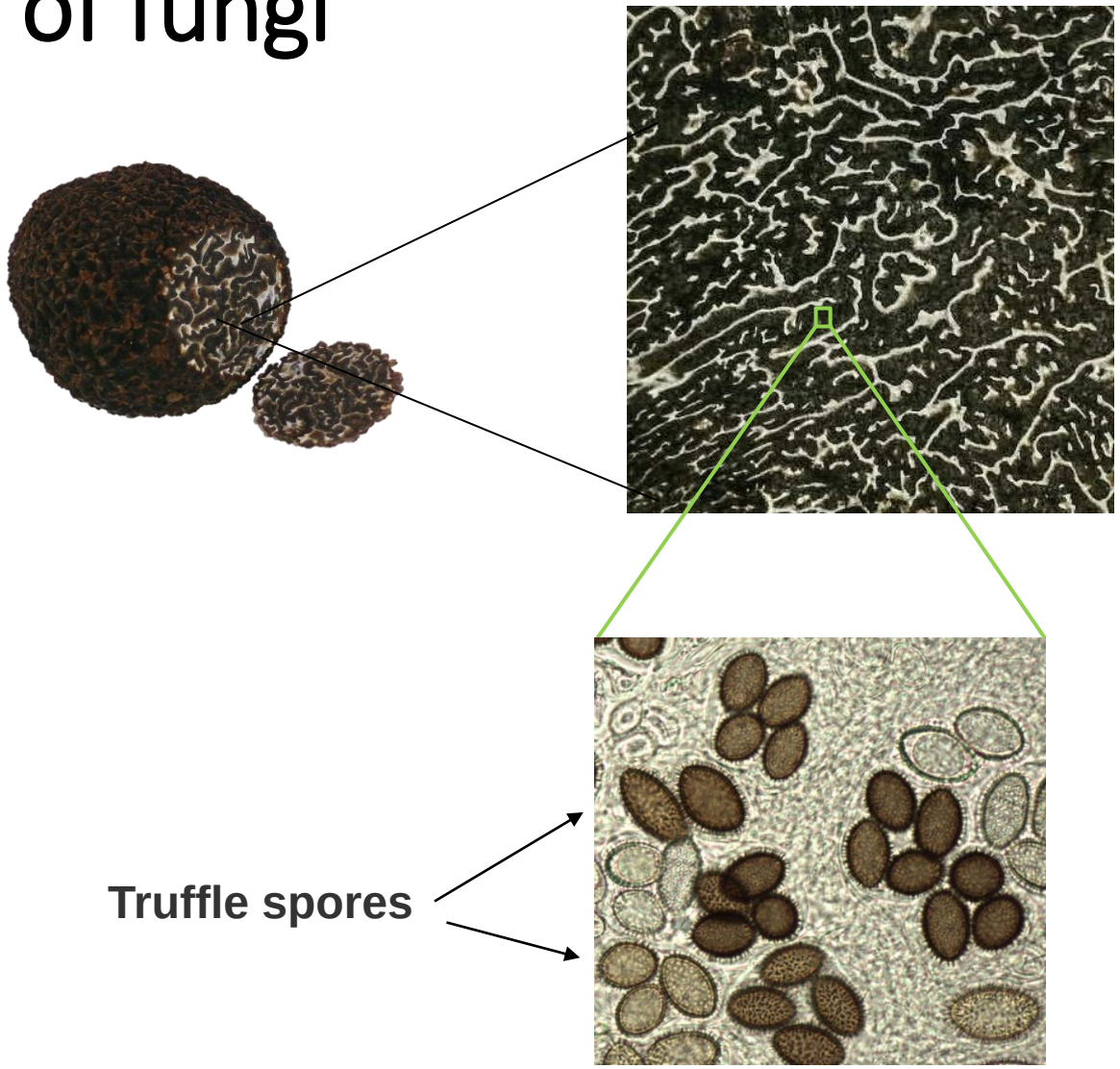


Figure 1.2: Diagrammatic drawings of a basidiome of an agaric. **A:** The basidiome is produced by the mycelium and bears gills with basidia. Like the mycelium, it consists of hyphae. **B:** The gill trama is woven by hyphae and is covered by the hymenium consisting of basidia. **C:** Mature basidium with basidiospores. – A and B from Schmeil-Seybold in Von Frisch 1953. C from Ingold 1971, modified.



Truffle spores

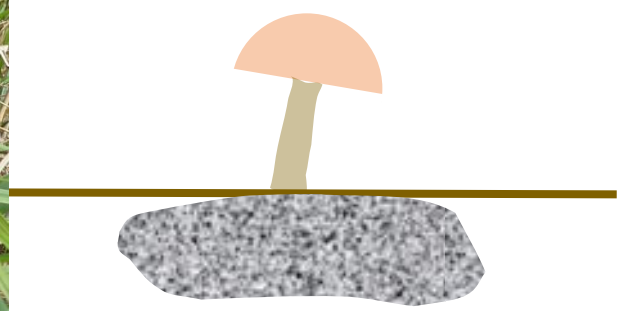
→ **Mushrooms and truffles are ‘fruits’ full of spores (‘seeds’)**

What is a mushroom?

Parasol mushroom

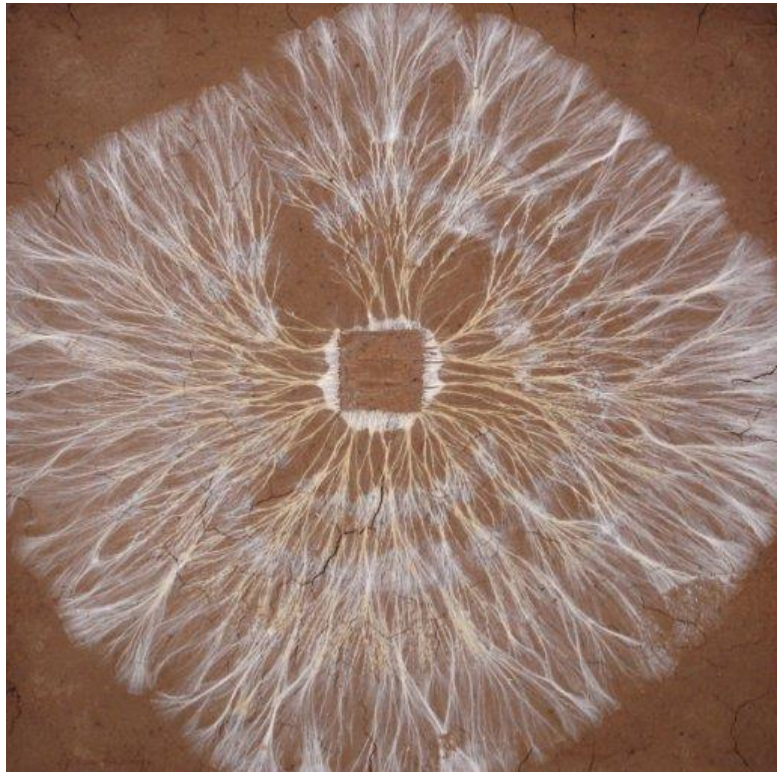
Macrolepiota procera (absent from NZ)

Mushroom or truffle (“fruit”), visible



‘fungus’

Mycelium (“main body”), a network of threads often invisible to the naked eye…



Mycelium is made of individual thin threads (hyphae)

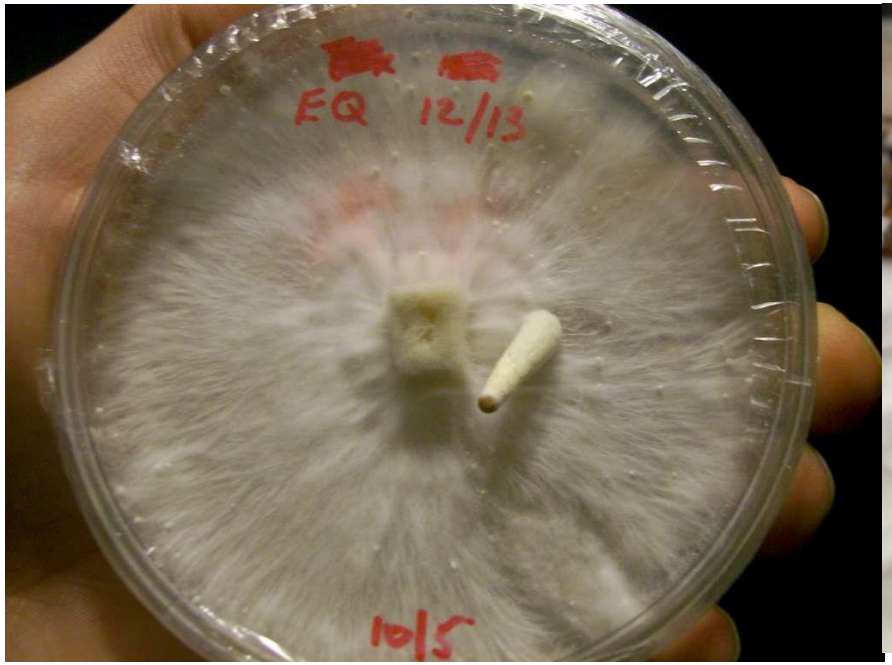
but it is often very large in size and lasting (perennial)

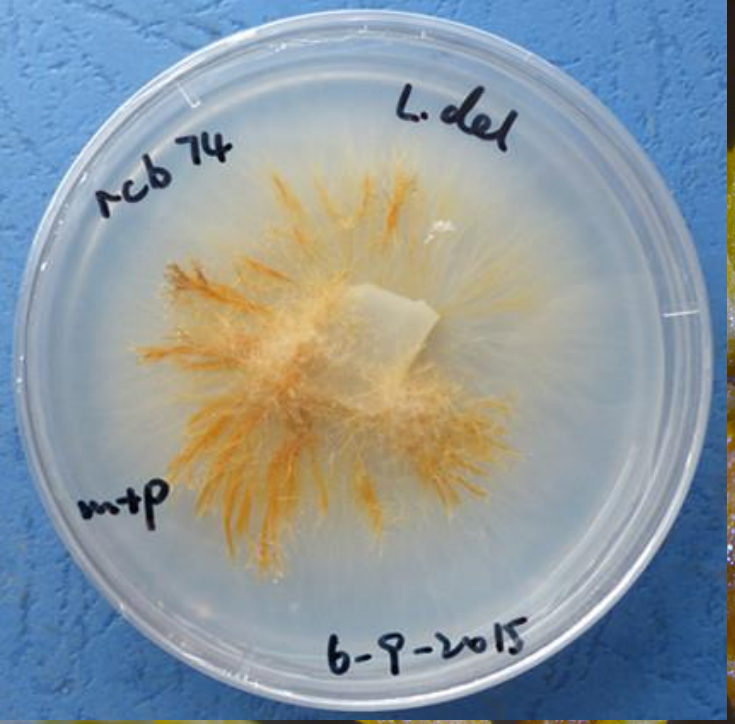
Fruit

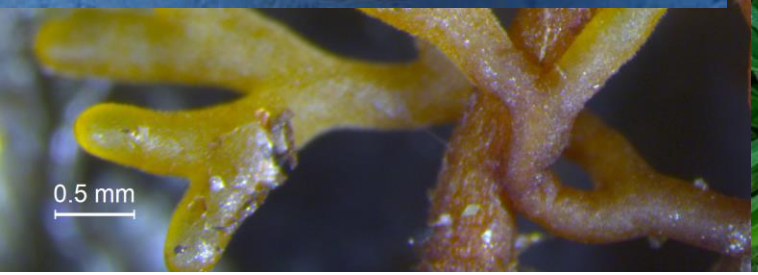
Mycelium

Link between mycelium and fruits

Mycelium grows about anywhere… Soil, litter, wood, and…







Lactarius deliciosus Saffron milk cap

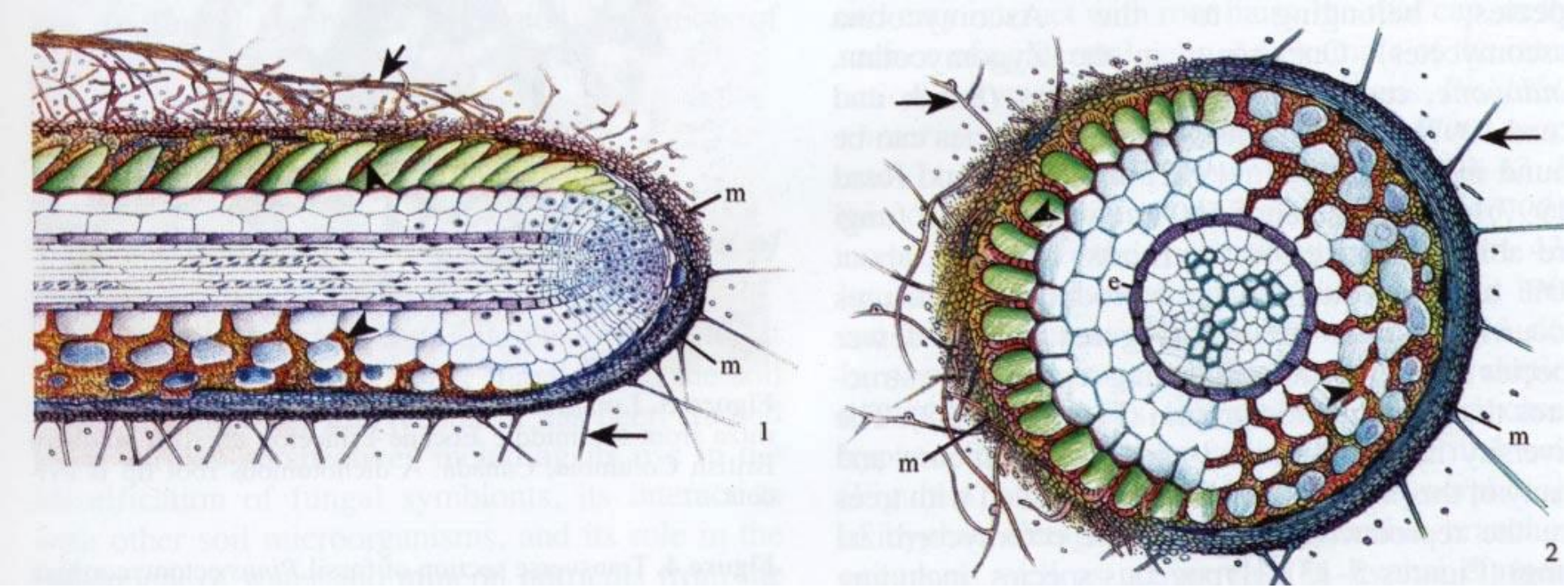
Pine short roots colonised by the mycelium of milk caps (*Lactarius* spp.)

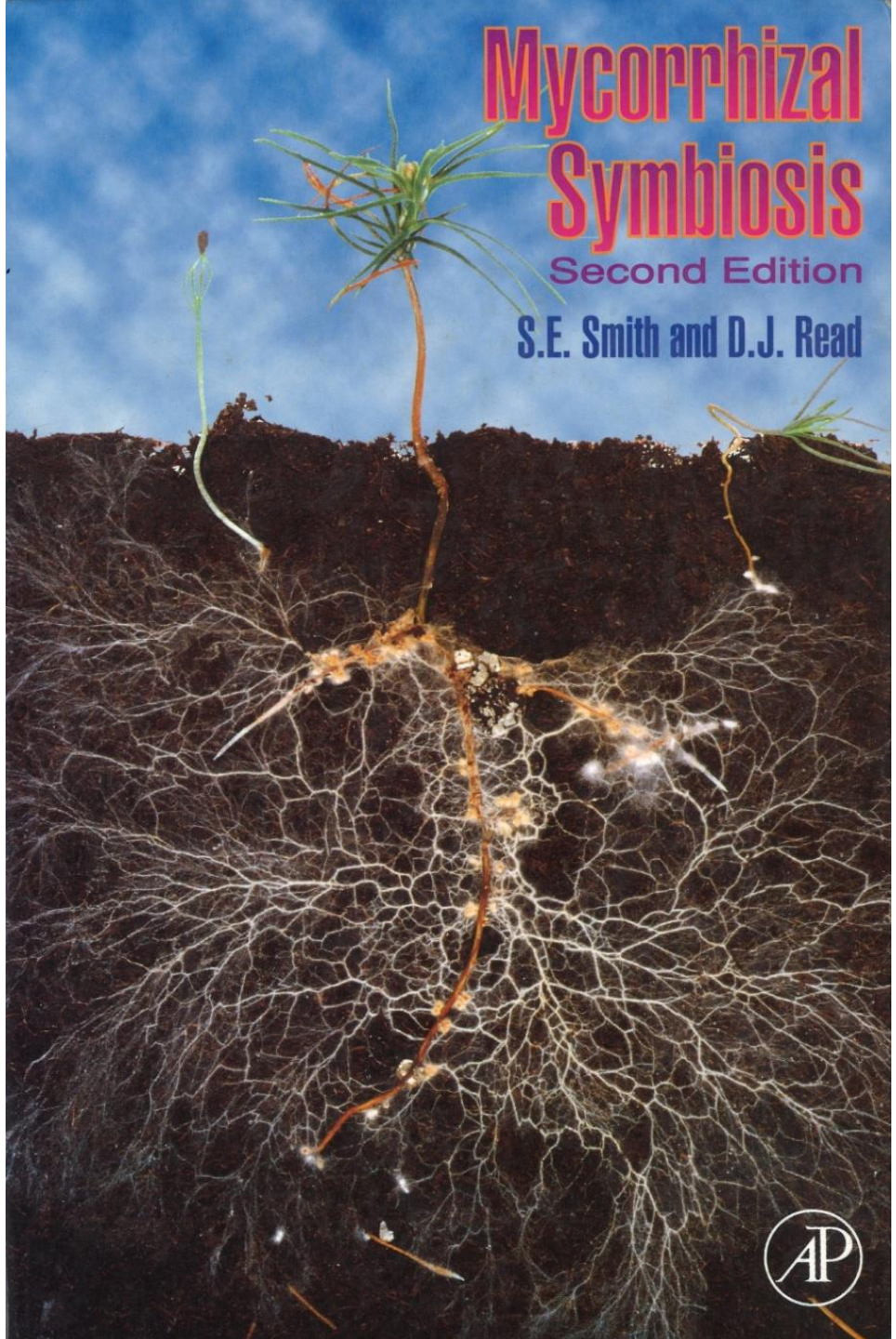
Mycelium grows about anywhere… Soil, litter, wood, and… **on the roots of trees!**

Lactarius hatsudake (absent from NZ)

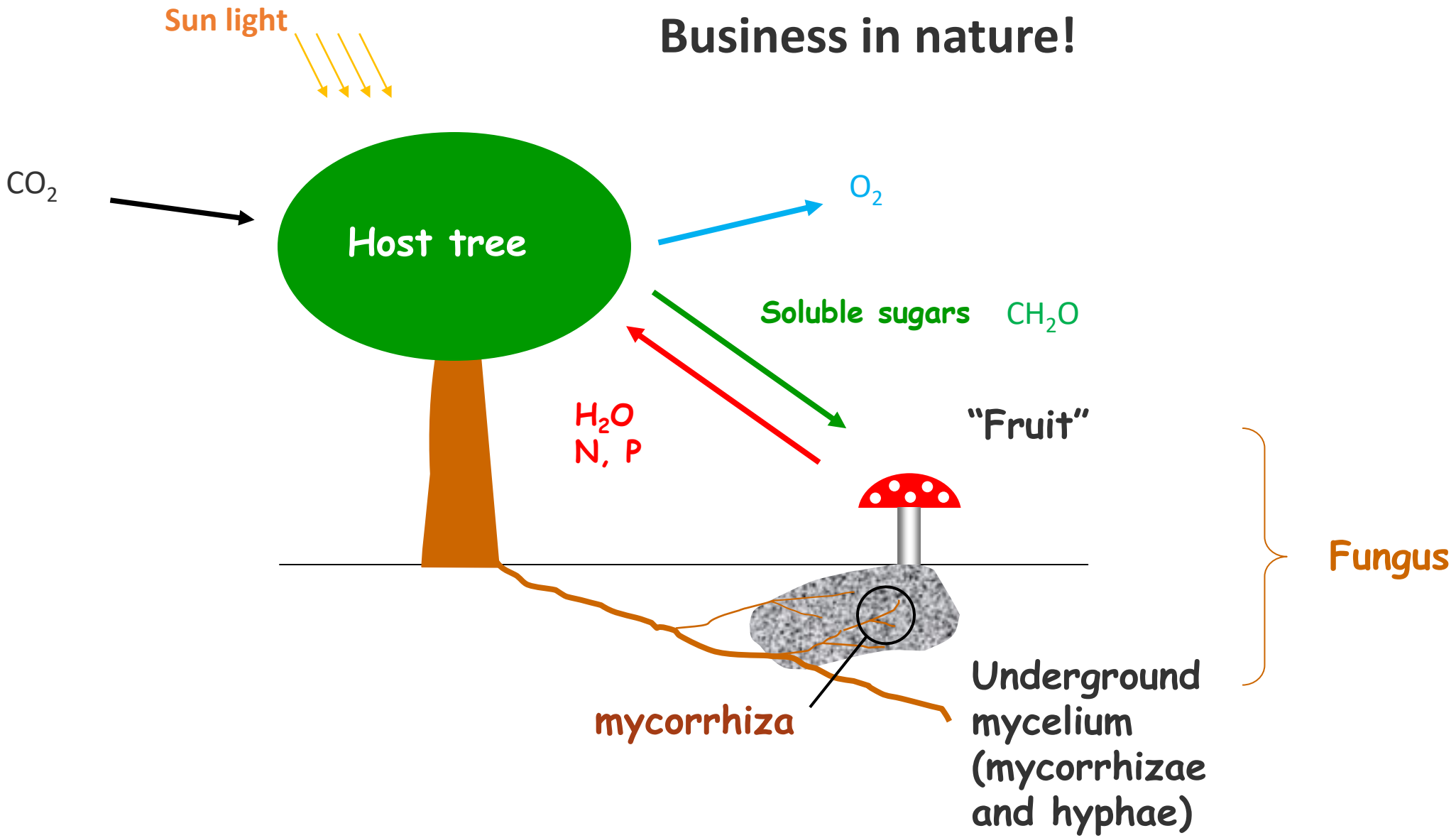
Lactarius vividus (absent from NZ)

Mycorrhiza




Mycorrhizal Symbiosis
Second Edition
S.E. Smith and D.J. Read
AP

Business in nature!



Mycorrhizal fungi make trees grow

Not mycorrhized before planting

Mycorrhized before planting

Song Li Ji

Guizhou Province

China

November 2018

Pinus massoniana
X
Lactarius vividus

Two main kinds of fungi

Edible Mycorrhizal Fungi (EMF) are **symbionts** living in a mutually beneficial association with the roots of living trees.

Saprophytic Fungi are "**decomposers**" of dead wood/organic matter ("waste").

Forest mushrooms or truffles

"Supermarket" mushrooms

Mixed lifestyle possible

Mycorrhizal or Symbiotic (mutualistic)

Truffles

Mushrooms

Edible

or not edible…

Saprophytic Fungi or ‘Decomposers’

Largely cultivated

Both types of fungi are key recyclers of organic matter

EMF can access water, minerals, including from rocks/rock debris, and degrade nutrient-rich organic matter. They contribute to feed plants and enrich the soil with stable organic matter.

Saprobic fungi are the only organisms that can digest wood (lignin and cellulose), breaking it down to get energy and contributing to nutrient cycle and soil formation/health.

This talk focuses on **cultivable fungi**. Cultivation is doable but need specific advice, training, skills and equipment.

Many edible fungi, mycorrhizal or decomposers, can also be **foraged**: field mushrooms, porcini, fairy ring mushrooms, slippery jacks, etc.

Wild
edible mycorrhizal fungi
Canterbury

Boletus edulis Porcini

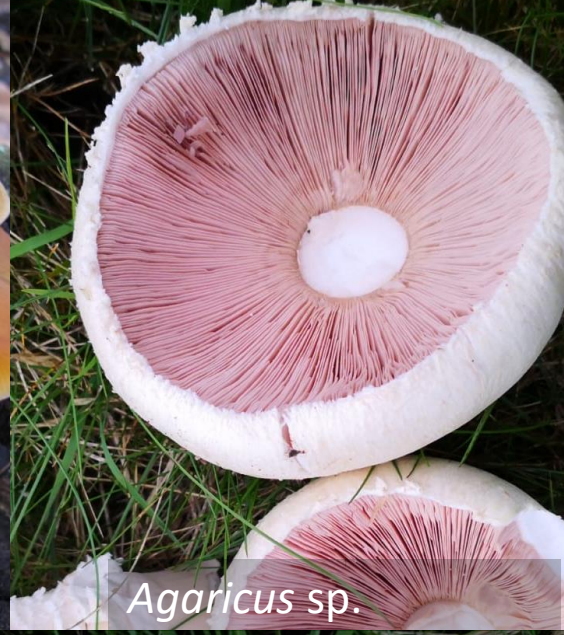
Boletus edulis Porcini

Suillus grevillei Larch bolete

Wild edible saprophytic fungi Canterbury

Marasmius oreades Fairy ring mushroom

Flammulina velutipes Enokitake



Agaricus sp.
Field mushroom

Cyclocybe parasitica Tawaka

Clitocybe nuda Wood blewit

Part I. Edible Mycorrhizal Fungi Cultivation

- Grow slowly with living trees, fruiting around trees every year
- High commercial value
- Initial waiting time but long production span (almost continuous)
- Variable yields but less variable with irrigation/management
- Limited varieties in NZ context and only a few cultivated species
- Cultivation is **recent**, based on planting mycorrhizal seedlings
- Exotic fungi/tree species only

Edible Mycorrhizal Fungi Options

Common name	Latin name	Properties, NZ market value
Périgord Black Truffle	***Tuber melanosporum***	**Highest prestige and market value $3/g**
Bianchetto Truffle (whitish)	***Tuber borchii***	**Less-known but high value and great potential $2.5/g**
Burgundy Truffle (black)	***Tuber aestivum***	**Lasting production, low maintenance $1/g**
Saffron Milk Cap	***Lactarius deliciosus***	**Unique gorgeous aspect, mild flavour and meaty texture, potential commodity, high yields, only with pines, $50-80/kg**
Porcini	***Boletus edulis***	**International prestige and high value >$100/kg, dry storage, not cultivable yet but inoculation of established trees is possible. Can be foraged**
Pine boletes	*Suillus* sp.	Young specimens are nice edible after removing the skin, dry storage. Come naturally, can be foraged.
Birch bolete	*Leccinum scabrum*	Young specimens only, mild flavour, Come naturally, can be foraged.
Larch bolete	*Suillus grevillei*	Young specimens are nice edible, can be foraged
Shoro	*Rhizopogon rubescens*	Truffle-like, pines only, nice when young, can be foraged

Type of trees for EMF

Mostly exotic tree species

Conifers: pine, fir, larch, cedar, spruce

Broadleaf species: oak, hazelnut, hornbeam, beech, chestnut, pecan nut, lime tree (linden), birch

NZ-native trees (never used yet for EMF cultivation)

Native beech (*Nothofagus*)

Fungus/tree specificity dictates possible combinations

EMF/trees Benefits

Grow trees: **carbon sink** especially in the soil (underground mycorrhizal network) at least until stand maturity.

EMF trees can comply with the Emission Trading Scheme. EMF trees must occupy at least 30% canopy cover when mature, be more than 1ha overall and area has an average width >30m (edge of canopy to edge of canopy).

Other benefits of EMF/trees

Environmental benefits:

Soil protection (erosion) and soil building (organic matter, minerals)

Habitat for wildlife

Socio-economic benefits:

Valuable crops, tourism (income)

Healthy food: nutritious, fibres, anti-tumour, low in fat etc

Recreative / Nature connection for city dwellers

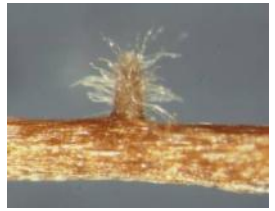
How to grow Edible Mycorrhizal Fungi ?

- Mycorrhizal seedlings - truffières/mushroom orchards
- Suitable soil (texture, pH)
- Suitable climate
- Appropriate management

Cultivation method is very young (45 year-old) still a lot to learn!

Five key stages

1. Mycorrhizal synthesis



Pine root

Mycelium/Spores

Young mycorrhiza

2. Acclimation

Mycorrhizal seedling

3. Plantation and monitoring

Mycorrhiza persistence

4. Onset of fruiting

5. Performing orchards

Mycoscience VOL.62 (2021) 10–28

Mycoscience

AN OPEN ACCESS JOURNAL FOR GENERAL MYCOLOGY

The Mycological Society of Japan

Review

Successes and challenges in the sustainable cultivation of edible mycorrhizal fungi – furthering the dream

Alexis Guerin-Laguette

Microbial Systems for Plant Protection, The New Zealand Institute for Plant & Food Research Limited, 74 Gerald Street, Lincoln 7608, New Zealand

Open Access:

Successes and challenges in the sustainable cultivation of edible mycorrhizal fungi – furthering the dream (jst.go.jp)

Examples of cultivated truffles in New Zealand today

Tuber melanosporum

Tuber borchii

Canterbury

Truffle trees (France)

Field-cultivated Mushroom in New Zealand: Saffron milk cap

Lactarius deliciosus

Mushroom Pine Orchards

Pinus radiata

Pinus sylvestris

Pinus radiata fast growth

September 2013

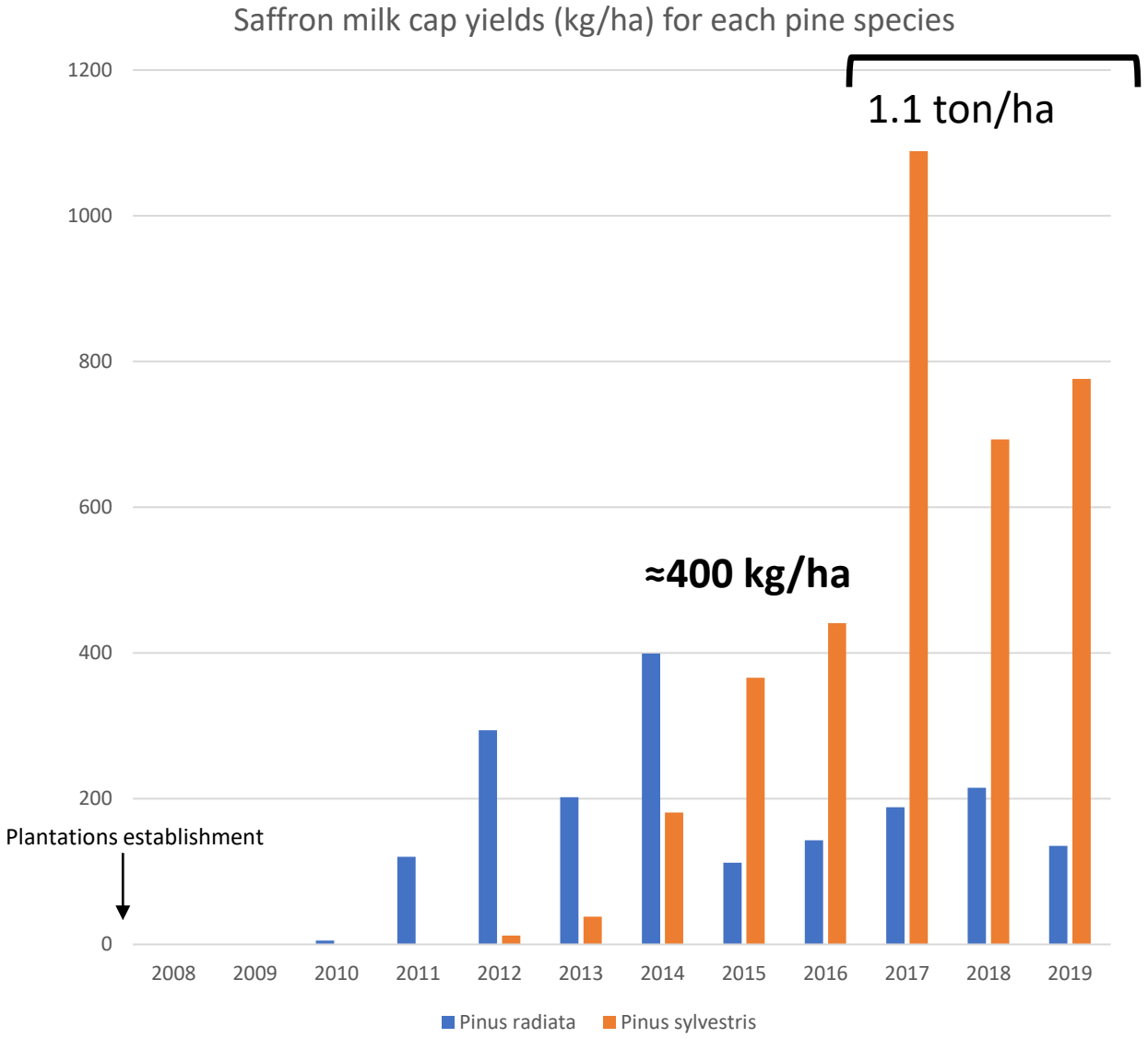
6 yr-old

March 2017

10 yr-old!

12 yr-old!

2019, canopy still opened with lawn



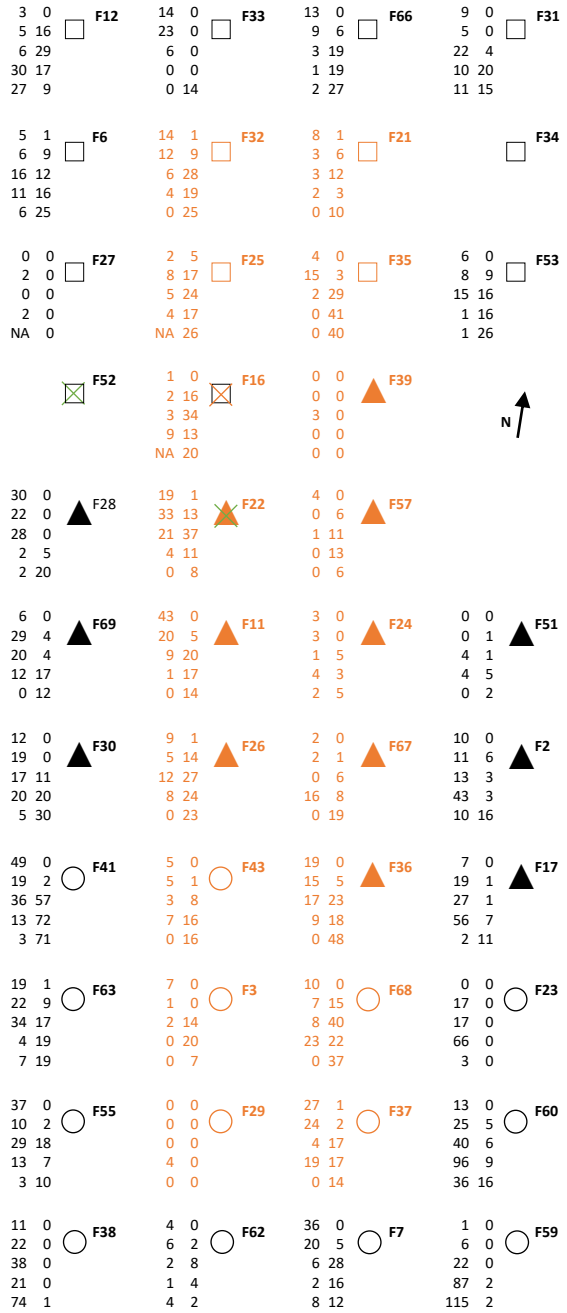
850 kg/ha on average for 2017-2019 on *Pinus sylvestris*

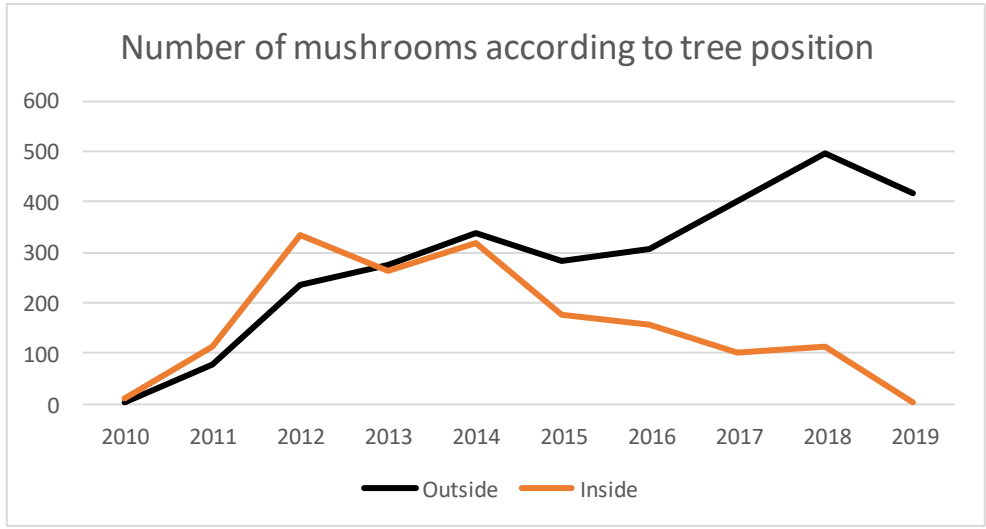
≈160 kg/ha

Mycorrhiza, 24, 511–523

Mushrooms, humans and Nature in a changing world, Chapter 5

Mycoscience, 62, 10–28





Hypothesis: pruning maintains yields

Mycoscience, 62, 10–28

P. radiata

production

P. sylvestris

production

Set-up costs of EMF orchards

- Seedlings: 400 trees per ha ≈ $18,000-28,000
- Planting + accessories ≈ $3,000
- Soil selection and preparation/liming (truffles only) ≈ $2,000-3,000
- Irrigation (depending on climate/objectives) ≈ $0 to 8,000
- Consultancy ≈ $1,000-2,000

Total ≈ $ 24,000-44,000 + GST per ha

Management of EMF orchards

Depends on objectives, intensive vs extensive cultivation

- Mycorrhiza monitoring / Tree pruning to prevent canopy closure
- Grass management via mowing, and/or small livestock grazing (sheep, geese, ducks)
- Depending on soil texture, shallow aeration (10 cm deep)
- Spore enrichment to boost production (truffles)
- Truffle dog

Potential returns of EMF orchards

- Crops: between **$50-300/tree/year from 6-10 years after planting**

  $20,000 to 120,000/ha/year

- Production can last many years, with at least ≈10-15 years high yields
- Pruning “waste” (firewood, organic matter)
- Improved soil
- Mycotourism

Cultivation risk still exists but lower, good time to enter

Truffles and mushrooms marketing

Edible Fungi quality is paramount / Training for grading

- Direct sales to restaurants and specialist food stores
- Sales to specialised distributors (restaurants or general foodstuff)
- Sales to the public: online, markets, on farm tourism
- Export in progress, ultimate goal, e.g., https://www.trufflecoop.nz/
- Truffle inoculum to nurseries
- Mycotourism experience

Part II. Saprophytic Fungi Cultivation

- **Payback period much shorter** (Grow faster than EMF and anytime)
- Less value but **less cost, easier to grow and sell**
- Good yields from farm “wastes”
- Variety of cultivation options (indoor/outdoor; using logs or agricultural/forestry by-products)
- More fungal species available for cultivation (than EMF)
- Both exotic and NZ-native fungi

Saprophytic Fungi Cultivation Benefits

Recycle and make use of organic ‘wastes’

Income

Healthy food

Medicinal products

Saprophytic Fungi Options

1. Exotic mushroom species

Common name	Latin name	Properties
Phoenix Grey Oyster	*Pleurotus pulmonarius*	Easy to grow, nutritious and health benefits
Pink Oyster	*Pleurotus djamor*	Subtropical, premium value (texture/flavour)
Shiitake	*Lentinula edodes*	Slow but long production, premium value
Enokitake	*Flammulina velutipes*	Winter mushroom, premium value, can be foraged
King Stropharia	*Stropharia rugosoannulata*	Easy to grow, myco-remediation, soil building capacities

Saprophytic Fungi Options

2. NZ-native mushroom species (list not exhaustive)

Common name	Latin name	Properties
NZ Oyster	***Pleurotus parsonsiae***	**High yields, dense clusters and high spore load**
NZ Shiitake	***Lentinula novae-zelandiae***	**Dark-coloured, premium but slow-growing**
Tawaka or Poplar mushroom	***Cyclocybe parasitica***	**Bold meaty flavour, cultivable on sawdust blocks or dowels into logs**
Pekepekekiore or Coral Tooth	*Hericium novae-zelandiae*	On dead hardwood trees (beech) or logs, crayfish/crab flavour, great cognitive benefits
Wood Ear	*Auricularia cornea*	Easy to grow on wood or sawdust
Artist's Bracket/Conk	*Ganoderma applanatum*	Medicinal: anti-tumour, anti-bacterial, anti-fibrotic
Turkey Tail	*Trametes versicolor*	Easy to grow or forage. Medicinal: immunity boosting

Saprophytic Edible Fungi

Shiitake

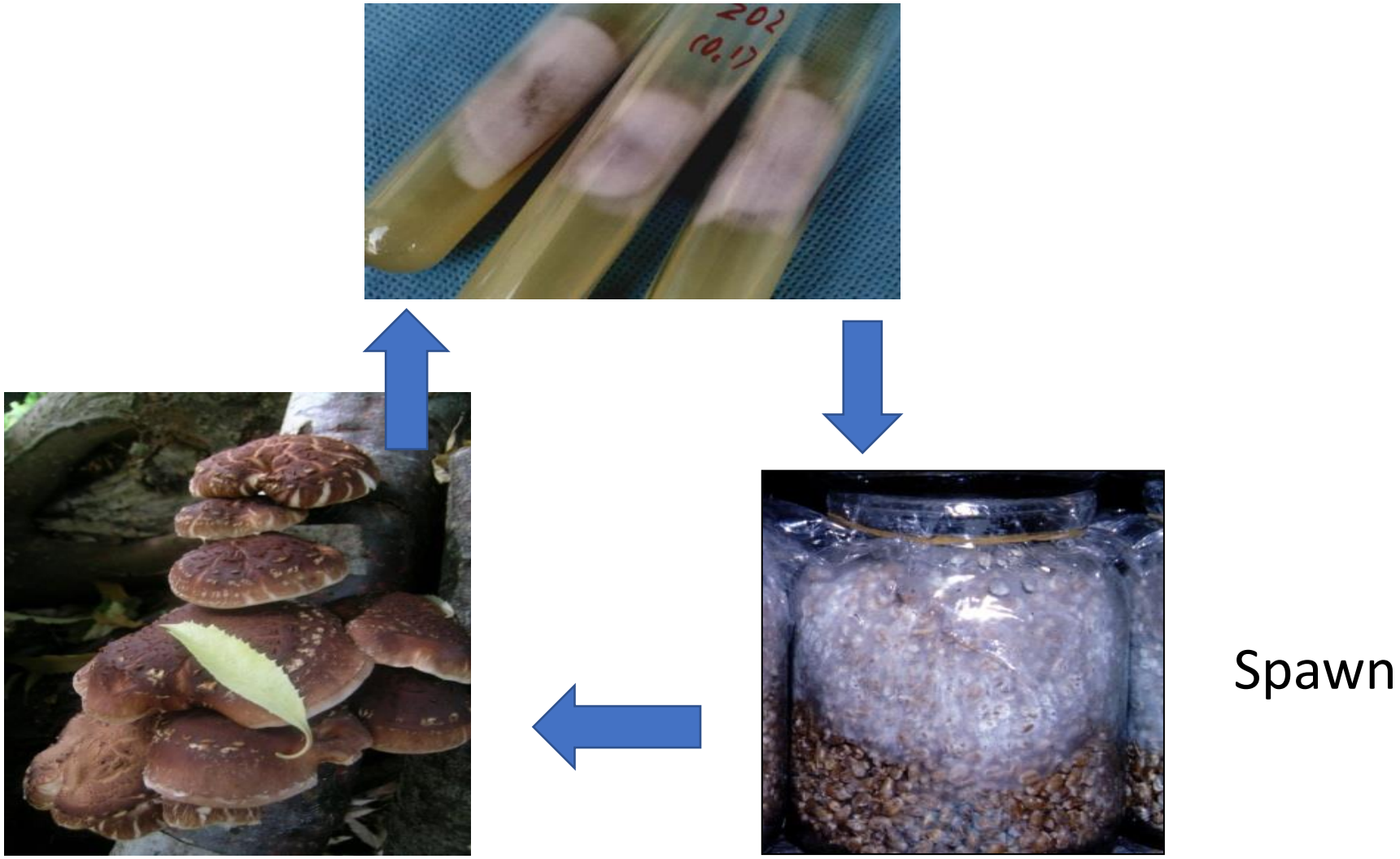
Tawaka

Oyster

Pink Oyster

How to grow saprophytic fungi?

Spawn purchased or self-made (but need lab facilities)



Spawn

How to grow saprophytic fungi?

Substrate wood or made up from ingredients

Environmental conditions humidity, temperature, light (fruiting)

Right balance optimal conditions are important (not easy)

Need consultants/specialists and equipment

Family scale or commercial scale

How to grow saprophytic fungi?

Outdoor:

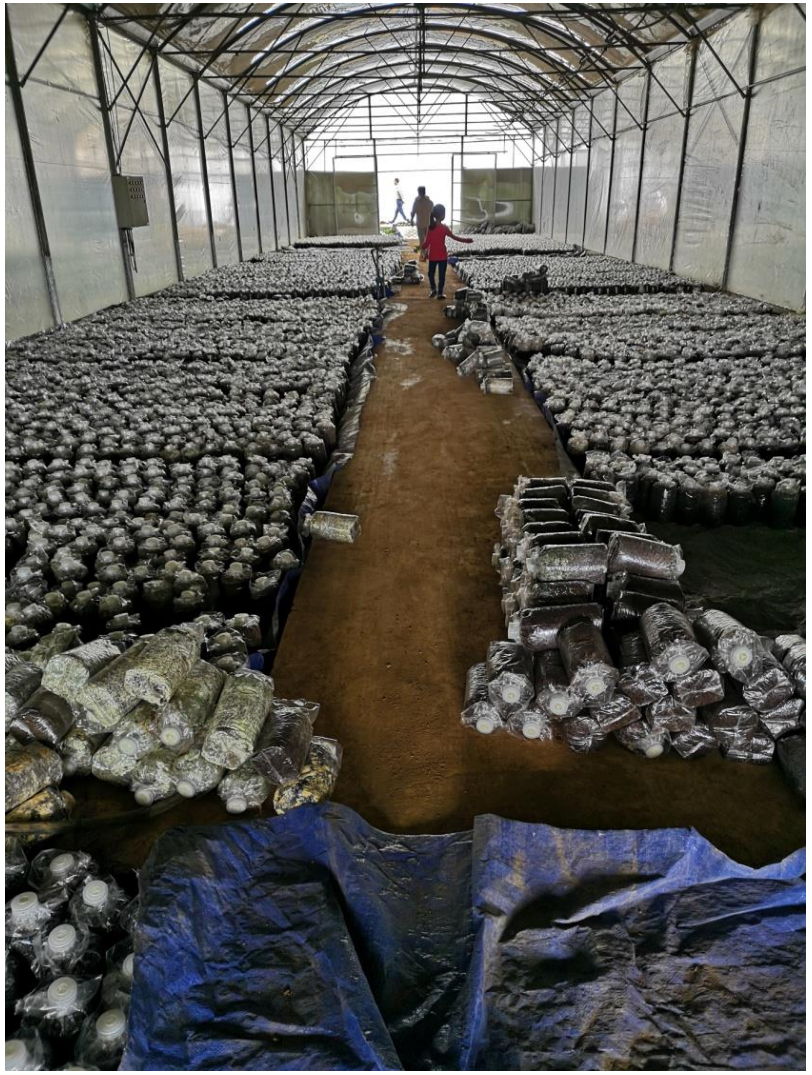
- Under tree canopy
- Agricultural field
- Organic and high-quality crop residues
- Cheap system
- But yields are seasonal and depend on climatic conditions

How to grow saprophytic fungi?

Indoor:

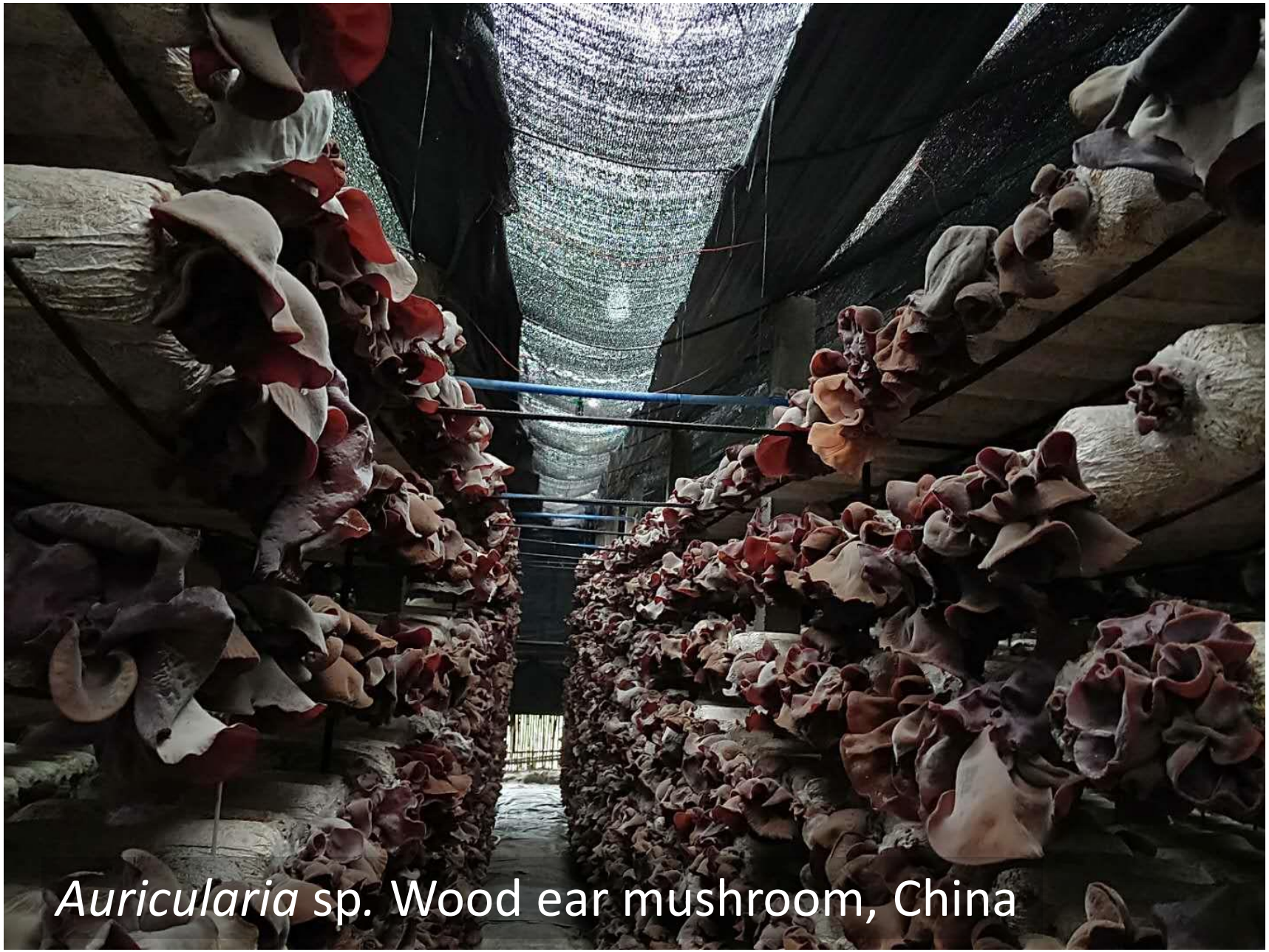
Mushroom house/plastic tunnel

- Controlled environment
- High yields more secured, anytime
- Investment is higher



Management

- Temperature, humidity, light
- Pest control: Contaminations (bacteria, moulds), flies etc



Auricularia sp. Wood ear mushroom, China

Morchella sp. Morels, China

Types of wood/wastes as substrates

Oyster mushrooms

Wood logs: poplar, birch, alder, linden = lime tree (*Tilia* sp.), willow, beech, ash, maple, oak

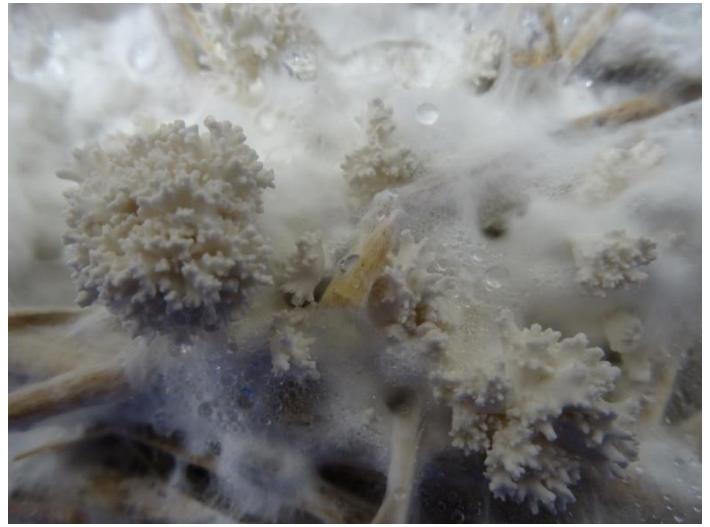
Sawdust of above woods with supplements:

- Bran of wheat, barley, rice
- Sugar
- Minerals

Oyster mushrooms on wheat straw

Example of substrate for Oyster mushroom

Ingredients	Weight
crushed barley or wheat straw (50 mm grid)	250 kg
Gypsum	25 kg
chicken feather meal	7.5 kg
Water	718 L
Total	1 ton



Water content 74.26%, Nitrogen 0.7-0.9% dry matter

No need to compost

Types of wood/wastes as substrate

Shiitake mushroom

Wood logs

- oaks, hornbeams, beech, alder, chestnut, willow, birch
- 10-20cm diameter logs, cut in winter
- Inoculate late May to October (preferably)

Sawdust logs/blocks

Facilities required to grow saprophytic fungi

- Substrate mixer
- Bagging machine
- Steriliser
- Inoculation room
- Incubation rooms (temperature, humidity, light)
- Fruiting rooms (temperature, humidity, light)
- Storage rooms
- Accessories: bags, shelves, and more

Local companies /websites

SporeShift Mushrooms

Oak and Spore

Merci!

Photo courtesy Wayne Tewnion and Cassie, Canterbury, NZ