Chapter 368
Ecological Characters of Truffles

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Abstract We undertook an overview of the physical and chemical quality of soil characteristics, features of morphology, distribution and mycorrhizal relationships of Tuberaceae in China. The topsoil is found to be limestone region, abundant organic matter and the soil type is determined to be sand-clay-slimy. Various characteristics are recorded including ascocarp features (hypogenous, like tubers) and color (peridium, glebe red tones, brown), time of appearance (October to April), host (*Pinus, Rhododendron polifolium, Eragrostis piosa*), habitat (basic soil, sand-clay-slimy, and semi-arid zone), fresh weight (8–150 g) and ascospore morphology (3–5warty spherics, medium size). The relationship between truffle growth and weather, soil, vegetation are particularly elaborated. A general overview of the characteristic of many ecosystem factors of region is described, especially where truffles grow. In conclusion, the habitats of tuberaceae should be protected by turning those fields into natural protected areas.

Keywords Truffles · Ecological · Review · Characters

368.1 Introduction

Truffles are true tuber if it belongs to the section of Ascomycotina, and it is a type of ectomycorrhizal fungus of symbiosis relation with trees such as Pinaceae and Fagaceae etc. [22, 27]. Ascocarp living underground can be eaten so be called

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"Truffle". Some truffles are highly prized as edible fungi [2]. Because of rare product area, scarce yield, vagary scent and expensive delicacy, they are the rarest edible fungi. Meanwhile, truffle mycorrhizal fungi have been recognized as providing "keystone" ecosystem functions, because of their direct access to plant carbon that drives below-ground microbial communities. Truffles as one of mycorrhizas, they assist plants in obtaining water and nutrients, protect plant roots from pathogens, and form below-ground networks that link above-ground plant communities [1, 21, 10, 18]. For the sake of better the development and make use of this rare resources, we carried on initial summary of the physiology ecology characteristic of truffle, be reported as follows:

368.2 Morphological Feature and Emergence Period of Sporocarp

Ascocarp of truffle is subglobose, semi-sphericity, tuber and irregular tuber. Diameter 1.5–12 cm, Fresh weight ranges between 8 and 150 g per ascocarp with the color being brown to dark brown, blackish brown or especially glebe red tones. When dry dust-color. Its surface have different small wart, which are made up of 3–5 pyramids [20, 23]. If carved, there are uncounted rein like marble in ascocarp, when rape from hoar to taupe, vein of truffle are very small and have many branches which arrive epidermis, hypha in vein are distinct with others, they no color, array sparseness [2, 12, 14]. Peridium of ascocarp is more sturdily, so they are not easy to be putrefied. The growth of them experience several months. If the conditions are suitable, we can collect them from midmonth of October to April of second year. If collected earlier, ascocarp is small, few and has bad quality [16]. Ascus is sphericity, semi-sphericity or pyriform, no suspensor, including 1–4 ascospores in each [8, 20]. These data are similar to the data in our work. It is the first time that members of our team find truffles lay in Helan Mountain.

368.3 Ecological Factors

368.3.1 Climatic Factors

Truffles and hosts need light, caloric, water etc. All of them rest on its distribution region. So distribution of them has connected with Climatic factors. Truffles live in southwest, northwest of China, and mainly distribute the broad-leaved wood of the elevation between 1600 and 2400 m and dark coniferous forest of the elevation 2600 m in the mountain [4, 20]. Huidong Country is one of the most outputs of

truffles in Sichuan province. It lays low degree of latitude area, elevation 1500–2500 m. Shining ample, the calories abundant, the year average temperature is 16.1 °C, the month average temperature changes small. Cumulative temperature for ≥10 °C is up to 5117 °C, sunshine of year counts to 2322.8 h, frost-free season for 279 days, rainfall is plentiful, the dry and damp seasons are obvious, the year average rainfall 1056 mm, rain day of whole year 123 days, appearing from June to October. The mountainous country weather shows perpendicular difference [12, 20] following the altitude rising, air temperature and ground temperature falls. On the contrary, air humidity, rainfall and rain day increase. This environmental is suit to propagate for truffle. Another typical area of truffle growth pigeons is Panzhihua city. Altitude 1100–2600 m, sunshine of year count 1900-2700 h, rainfall of year 700–1700 mm, day average temperature is 3.5–11.4 °C. Many research showed that truffle has different temperature in different stage of growth, for example hyphae can grow under 10–35 °C [9], if over 25 °C, grow rapidly. Rapid growth period is summer, soil temperature is 25–30 °C, truffles will ripe in autumn, so the weather would be nice and cool, and not below 0 °C in winter. Other reports consider that the truffles need water differently in different phase of vegetate. Rainfall of spring influences remarkably on producing and yield. If it is dry or little rain in spring and summer, the ascocarp can not form or grow slowly, so yield and quality would be decrease. It is wet in autumn, but not over, thus will benefit on develop of truffles.

368.3.2 Soil Characteristics

Soil is the base material where truffles lies and its host lived. The growths of truffles were closely related with soil type, structure, fertility, degree of consolidation and pH. Some studies consider that soil that produces truffles generally takes place at the limestone region. It implies not only abundant calcium quality, but also magnesium, phosphorus and other various minerals. Including dinas, weathering rock fragment or thick bone scraps. The colour of soil is various, such as: red, purple, yellow–red, brownish red etc. pH is between subacidity and a tiny alkalescence [7, 5]. Mehmet akyüz [16] pointed the topsoil of the fields are found to be 54.73 % sand, 21.97 % clay, 23.30 % dust, 45.27 % dust-clay, 0.126 % nitrogen, 1.848 % organic matter, 3.78 % total lime, 40.92 ppm P_2O_5, 613.0 ppm K_2O, 28.82 ppm Na, 0.164 mmhos/cm salt, 7.12 pH, and a sand-clay-slimy soil type. Studies [4] indicate that those soils contained mental ion and red limestone soil that are in favour of the development of truffles. The truffles are not suitable to develop in viscosity soil. And study indicate that they like living where are many dry branches and fallen leaves, preferable soil fertility, better aerating, higher contain of organic matter. Wang Yue-hua [28] discovers the growth of truffles

includes certain directions orientation. They lived the colder northwest slope avoiding the influence of dry wind from south. On the other hand, the degree of slope would influence the yield and quality of truffles, and it is below 32 degree, because it can hold back the phenomenon of soil run off [7].

368.3.3 Host and Vegetation Factors

The truffle is one of the main symbiosis fungi of ectotrophic mycorrhiza. The fact is that ectomycorrhizal roots gain much more mineral substance with the help of hyphae. Plant roots help ectomycorrhizal fungi to overcome carbohydrate limitation and increase their competitive ability in soil. Both the fungi and the plant can profit from the interaction and absorbe major nutrients (nitrogen, phosphate) fixed in the organic layer [24].

Different truffle formed different mutualistic symbios with advanced plants. The survey from Huidong country indicated that the truffles occurred in the region of mixed coniferous broad leaved forest. The ectomycorrhizal associations are long considered to be rare in the tropics, but much knowledge suggests that all tropical regions support at least five lineages of host plants [15, 25]. It has mycorrhizal associations with the roots of *pinus yunnanensis, Keteleeria evelyniana, pinus armandii*. [16, 29]. Other authers point that thier host are *Quercus, Corylus, Ostrya, Carpinus, Tilid, Populus, Salix, Alnus, Fagus, Castaned, Pinus, Cedrus, Abies, Juglans, Helianthemum* etc. by cultivating [7, 16, 29]. Our team found that the truffles become symbiosis with the root of *Picea crassifolia.* There are about 202 families and 1554 species, the forest fraction of coverage leads to 30.02 % in Huidong country. Research of Panzhihua city showed that the frequentness of producing truffles in theropencedrymion is more than other forest. Vegetation cover degree attains 77 %. The truffle secrete the substance which are harmful to ruderal, so there are little weed in the region of them, weed springs up out of the region.

368.3.4 Wild ANIMAL of the Truffles Region

Fungi are indispensable components of the biota of any region. Their presence and distribution are of paramount importance to flora and fauna, and their ecological function may be responsible for the presence or absence of many other species, particularly animals [19]. The wildlife category of the truffle habitat is a lot. However rodents associate closely with the growth of truffles. The investigation indicated there are 6 families and 34 species in the region of the district where truffles grew in Huidong country. Major in *Petaurista clarkei*, *Petaurista alborufus*, *Drmorays pernyipernyi*, *Callosciurus evythracus, Apodemus sylvaticus, Apodemus chevrieri* [3, 4]. They liked to eat truffles depending on their sharp olfaction, thus spores are spread in anywhere by them [7].

368.4 Appropriate Habitats of Truffles

Truffles are nutritive symbiosis of ectotrophic mycorrhiza fungus. Their development has closely associate with Climatic factors, Soil characteristics, earth slope features, host, vegetation factors and wild animal of producing truffles area etc. [3, 17, 26]. Appropriate the ground temperature and rainfall are two most important climate factors for truffle to develop. The soil is found to be limestone region, abundant organic matter, the soil type is determined to be sand-clay-slimy. The hosts of truffles are *pinus, Quercus fabri, Rhododendron polifolium, eragrostis piosa* et al. Animals became the best medium for truffles multiply in the nature. They can spread spores through eating ascocarp and expelling dejecta.

Although we summarize all of those, some fundamental aspects concerning truffles have not yet to be fully elucidated. All of us will keep trying to protect, exploit and study truffles. As a beginner of studying truffle, the author strongly recommended that the habitats of the species should be protected by turning those fields into natural protected areas.

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