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Diversity of Wild Mushrooms in the Commonwealth of Benito Juarez, Tetela De Ocampo; Puebla-Mexico

[1]Omar Romero-Arenas, [1]Manuel Huerta Lara, [1]Marcelino Becerril Herrera,
[2]Juliana Bautista Calles, [1]Miguel Angel Damian Huato, [1]Ana Maria Tapia Rojas,
[3]Ma. De Los Angeles Valencia De Ita and [4]Luis Alberto Bonilla Vazquez
[1]Benemerita Universidad Autonoma De Puebla (BUAP), BUAP
[2]Colegio De Posgraduados, Mexico
[3]Department of Environmental Sciencies, [4]Department of Agro-Forestry Engineering,
Benemerita Universidad Autonoma De Puebla (BUAP)

Abstract: The studies on wild mushrooms in the Sierra Norte in the state of Puebla are scarce to date. This fact requires the preparation of inventories that can give to know the main species that exist in the area. In order to identify and record the main species of wild fungi living in the northern sierra of Puebla, collections were conducted between the months of June-October 2007 in the municipality of Tetela de Ocampo, with the permission of collecting scientific issued by SEMARNAT SGPA/DGVS/05065/07 in motion. As a result, we identified 10 genera and 16 families of different fungi macromycetes, there among are: *A. Muscaria, Amanita caesaria*, *Amanita virosa*, *Amanita pantherina*, *Amanita phalloides*, *Boletus edulis*, *Ganoderma aplanatum*, *Lactarius delicius*, *Lycoperdon perlatum*, *ramaria flava*, *Russula emetogenic*, etc. In which families were frequently *Rusulaceae*, *Agaricaceae* and *Marasmiaceae* to July-October months. We found 17 species of mushrooms, 7 species of fungi toxic, 7 saprophytes fungal species, 13 species of mycorrhizal fungi and 1 species of medicinally mushroom. With regard to the relationship with the natural environment that surrounds it, these fungi were found in forests of pine, oak low, medium or much intervention, as in open fields.

Key words: Wild mushrooms, forests of pine and oak, SEMARNAT (Natural secretary of environment and resources)

INTRODUCTION

It has been shown that fungi are the largest group of organisms on earth, after the insects. It is estimated that there are >1,500,000 fungal species, so its impact on the environment is enormous (Hawksworth, 1991). The diversity of these organisms that exists in the country is about 200,000 species of fungi, which are known 7,000 (Guzman, 1998).

In the forests of Mexico grows >200 species of edible fungi, many of which are very abundant in the rainy season. They are widely distributed in the coniferous forest of oaks and pines, as well as in the plains, but their growth is possible in whatever medium that is why there is a great diversity of fungi capable of being exploited (Guzman, 1977).

The research of the fungi is of primary importance in ecosystems, where they live, as they represent along with other organisms, an important link in the food chain (Seymour, 1985). Most of them have a vital role in maintaining the ecosystem because they are responsible for the remains of plants and animals is in the ground (saprophytes), degrading organic matter and incorporating environmental elements which will be then the basis for the nutrition of plant organisms. Thus, fungi comply with the balanced cycle energy-matter (Chacon *et al*., 1995). The forest is also, in need of fungi, as they form on the roots of trees symbiotic called mycorrhizal associations, which are essential to the life of the trees (Herrera, 2003; Ulloa, 1991). Other fungi degrade the humic acid, which is the main fraction of soil organic matter (Steffen *et al*., 2002), some have contributed significantly to the advancement of chemistry and pharmacology (Michelot and Melendez-Howell, 2003) and many more are edible (Ortega and Zarate, 2006).

With regard to the marketing of wild mushrooms in Mexico, mentioned that the interest abroad has increased, according to statistics from the Ministry of Environment and Natural Resources (SEMARNAT) 1999 throughout the country was 112 ton. It should be noted that the

Corresponding Author: Omar Romero-Arenas, Benemerita Universidad Autonoma De Puebla (BUAP), BUAP

available statistical information relates to the production officially reported with notices of forest use, but we think that these figures greatly underestimate the total production of wild mushrooms in the country.

Between 1984 and 1987, Mexico exported mushrooms to the United States, Puerto Rico, El Salvador, Guatemala, the United Kingdom, Sweden, West Germany, Belize, Panama and Spain with a value close to half a million dollars (Villarreal and Perez, 1989). Significantly, the geographical distribution of fungi at the national level comprises 28 states, from the standpoint of production, the State of Mexico, Veracruz, Michoacan, Oaxaca and Puebla (Villarreal, 1995). Therefore, the present study was performed with the aim of identifying and recording the main species of wild fungi living in the northern sierra of Puebla.

MATERIALS AND METHODS

The field research was conducted in the Commonwealth of Benito Juarez, the Municipality of Tetela de Ocampo; Puebla, Mexico, which is located in the Sierra Norte del Estado de Puebla, reaching parallels 19°43 '00' and 19°57 '06" latitude north and between 97° 38' 42' and 97° 54 '06" west longitude. Their adjoining are to the north Cuautempan and Tepetzintla, to the south Ixtacamaxtitlan, to the west by Xochiapulco and Zautla and the West with Aquixtla, Zacatlan and Ixtacamaxtitlan (Fig. 1).

This community presents a temperate humid ranging from C (w1) in the southern part C (w2) in the northern portion. The height of the Municipality is between 1500 and 300 m above sea level, are identified soil belonging to the following groups: Andosol; covers the northwestern town (phase presents stone, rock less than 50 cm thick) Feozem; occupies a narrow strip southeast of the county (present phase lithic deep), Luvisol; occupies about 75% of the municipality.

In addition, the study area is located in the basin slope (RH27bd) north of the state of Puebla, slope formed by the various partial basins of the rivers that flow into the Gulf of Mexico.

The municipality presents most of its territory covered by forests, pine and pine-oak associations include the following: red pine, lacia and ayacahuite; red oak, loss and *Abies* sp.

Among mixed in mountainous areas, usually on the sides of roads and some rivers are incorporated areas to farming-type temporary, which have gradually gained ground to forests. The collections of wild mushrooms began in June and ended in October. The methodology consisted of field trips first day of each month, making

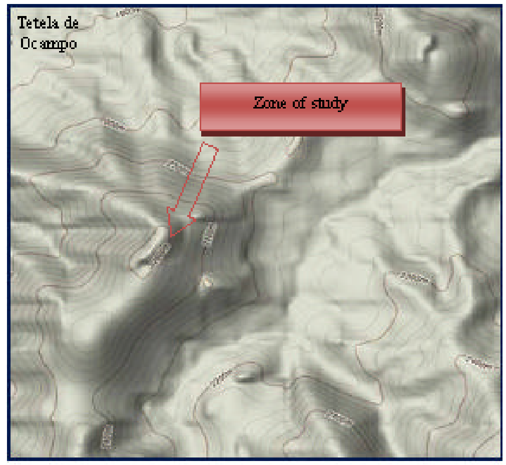

Fig. 1: Commonweal the of benito juárez, tetela de ocampo; puebla, México

transects within the study area (consisting mainly of coniferous forest: pine-oak), it spoke to collectors to find mushrooms and edible species common names of the most recognizable place. For the determination of the specimens were used in the basic techniques proposed by mycology (Guzman, 1977; Pacioni, 1980; Largent *et al*., 1977; Caballero, 2000) for most of the macromycetes and Gilbertson and Ryvarden (1986) for fungi poliporoides.

A fungi collected were taken on fresh macroscopic characteristics such as size, shape, color, texture and consistency in the various parts of basidiocarp (pileo, context and himenoforo stem). In addition, preparations were made temporary with KOH 5% and reagent Melzer, making transverse and longitudinal cuts of the different parts of basidiocarp. It took the taxonomic significance of microscopic characteristics such as size, shape and color of the spores, basidios, cistidios, mushrooms and hyphae and also noted the type of system and hifal presence fibulas. Specimens were identified with the research of Burt (1914-1926), Chacon and Guzman (1983), Dennis (1978), Gilbertson and Ryvarden (1986), Heim (1931), Perez-Silva (1967), Rifai (1968), Ryvarden (1991) and Largent (1973). For the settlement of taxonomic groups of fungi considered in this study was used classification system proposed by Hawksworth *et al*. (1995).

RESULTS

In the transepts made within the community forests of Benito Juarez, Tetela de Ocampo; Puebla-Mexico, identified a total of 370 species of fungi belonging to 10 genera, including 16 in families, all belonging to the division *Basidiomycota* (Table 1). In the study area were detected 17 species of fungi gastronomic importance,

Table 1: Diversity of wild mushrooms in the community of Benito Juarez, Tetela de Ocampo; Puebla-Mexico, year 2007

Family place	Estation	No. sp.	*Coordinates (UTM)	Scientific name	Family
A	June-September	16	N19 48.445 : W97 48.102	*Coprinus disseminatus*	*Agaricaceae*
B	June-August	39	N19 48.393 : W97 48.016	*Agaricus campestre*	*Agaricaceae*
B	July-August	12	N19 49.045 : W97 47.633	*Agaricus silvicola*	*Agaricaceae*
A	August-October	2	N19 48.396 : W97 48.012	*Macrolepiota procera*	*Agaricaceae*
C-B	July-August	3	N19 48.435 : W97 48.111	*Calvatia utriformis*	*Agaricaceae*
A	August-September	5	N19 48.810 : W97 47.474	*Amanita caesarea*	*Amanitaceae*
C	August-September	8	N19 48.799 : W97 47.449		
C	August-September	9	N19 48.786 : W97 47.495	*Amanita muscaria*	*Amanitaceae*
A	June- September	2	N19 48.905 : W97 47.591	*Amanita phalloides*	*Amanitaceae*
C	August-September	4	N19 48.810 : W97 47.481	*Amanita pantherina*	*Amanitaceae*
C	August-October	1	N19 48.395 : W97 48.024	*Amanita virosa*	*Amanitaceae*
A	June-September	1	N19 48.819 : W97 47.462	*Amanita verna*	*Amanitaceae*
B	June-August	7	N19 48.902 : W97 47.587	*Panaeolus sphinctrinus*	*Bolbitiaceae*
A	July-August	14	N19 48.415 : W97 48.079	*Xerocomus badius*	*Boletaceae*
C	July- September	18	N19 48.516 : W97 48.100	*Suillus brevipes*	*Boletaceae*
A	Jun-September	2	N19 48.839 : W97 47.480	*Boletus edulis*	*Boletaceae*
D	July-August	2	N19 48.416 : W97 48.087	*Cantharellus cibarius*	*Cantharellaceae*
D	July-September	5	N19 48.506 : W97 48.095	*Craterellus cornucopioides*	*Cantharellaceae*
C	September-October	1	N19 48.459 : W97 48.105	*Anthurus archeri*	*Clathraceae*
D	September -October	2	N19 48.908 : W97 47.593	*Ganoderma applanatum*	*Ganodermataceae*
C	July- August	4	N19 48.785 : W97 47.495	*Geastrum triples*	*Geastraceae*
A	August-October	1	N19 48.425 : W97 48.096	*Helvella pythyophila*	*Helvellaceae*
A	July-August	1	N19 48.387 : W97 48.048	*Helvella lacunosa*	*Helvellaceae*
A	July-August	34	N19 48.398 : W97 48.022	*Hygrophorus roseodiscoideus*	*Hygrophoraceae*
C	June-August	9	N19 48.462 : W97 48.096	*Lycoperdon gemmatum*	*Lycoperdaceae*
C	July-September	47	N19 48.527 : W97 48.135	*Armillaria mellea*	*Marasmiaceae*
A	August-October	17	N19 48.862 : W97 47.503	*Ramaria flava*	*Ramariaceae*
A	July-October	1	N19 48.835 : W97 47.488	*Lactarius volemos*	*Russulaceae*
A	August-October	2	N19 48.821 : W97 47.474	*Lactarius deliciosus*	*Russulaceae*
A	July-September	38	N19 48.523 : W97 48.148	*Rusula virecens*	*Russulaceae*
A	July-October	49	N19 48.524 : W97 48.147	*Rusula emetica*	*Russulaceae*
A	July-September	6	N19 48.390 : W97 48.021	*Strobilomyces strobilaceus*	*Strobilomycetaceae*
C	June-August	7	N19 48.396 : W97 48.013	*Baeospora myosura*	*Tricholomataceae*
D	August-October	2	N19 48.482 : W97 48.091	*Clitocybe nebulares*	*Tricholomataceae*

A) Forest Pine-Oak, B) Pasture, C) Pine Forest), D) Oak Forest, *UTM (Universal Transversal of Mercator)

Fig. 2: *Amanita caesarea*, collected by jaime juárez huerta found in forest of pine-oak

Fig. 3: *Armillaria mellea*, collected by luis bonilla vázquez found in forest of pine

including: *Agaricus campestres*, *Agaricus forestry*, *Amanita caesarea* (Fig. 2), *Xerocomus badius*, *Suillus brevipes*, *Boletus edulis*, *Cantharellus cibarius*, *Craterellus cornucopioides*, *Helvella pythyophila*, *Helvella lacunos*, *macrolepiota procera*, *Calvatia utriformis*, *Armillaria mellea* (Fig. 3), *Ramaria flava*,

Fig. 4: *Amanita muscaria*, collected by omar romero arenas found in forest of pine

Fig. 5: *Rusula emética*, collected by omar romero arenas found in forest of pine- oak

Lactarius volemus, *Lactarius deliciosus*, *Clitocybe nebularis*, which are the subject of collecting and selling in the town and surrounding municipalities of the Sierra Norte State of Puebla.

With regard to toxic or poisonous fungus, there are 7 species, the most dangerous: *Amanita muscaria* (Fig. 4), *Amanita phalloides*, *Amanita pantherina*, *Amanita virosa*, *Amanita verna*, *Rusula virecens* and *Rusula emetogenic* (Fig. 5), *Panaeolus sphinctrinus* (Herrera and Perez-Silva, 1984).

There was a kind of medicinal fungi: *Ganoderma applanatum* (Fig. 6), which are used in Oriental countries to cure certain types of cancer (Hobbs, 1996). Saprophytic fungi found were: *Anthurus archeri*, *Geastrum triplex*,

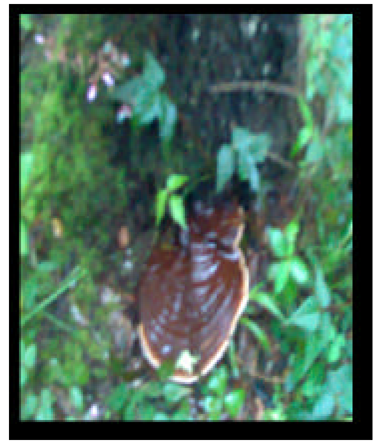

Fig. 6: *Ganoderma applanatum*, collected by luis a. *Bonilla vázquez* found in forest of pine-oak

Fig. 7: *Lycoperdon gemmatum*, collected by omar romero arenas found in forest of pine-oak

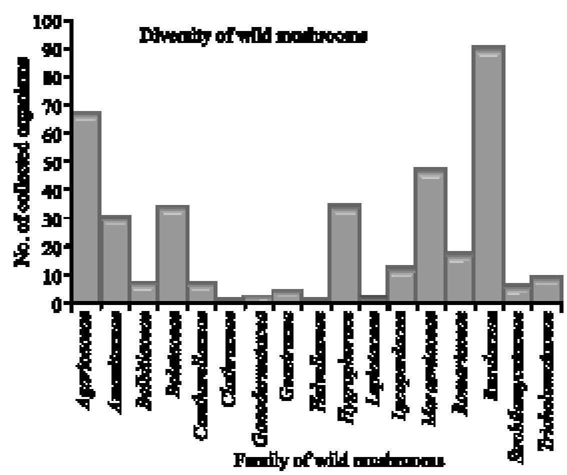

Fig. 8: Diversity per family of wild mushrooms in the community of Benito Juarez, Tetela de Ocampo, Puebla-Mexico, year 2007

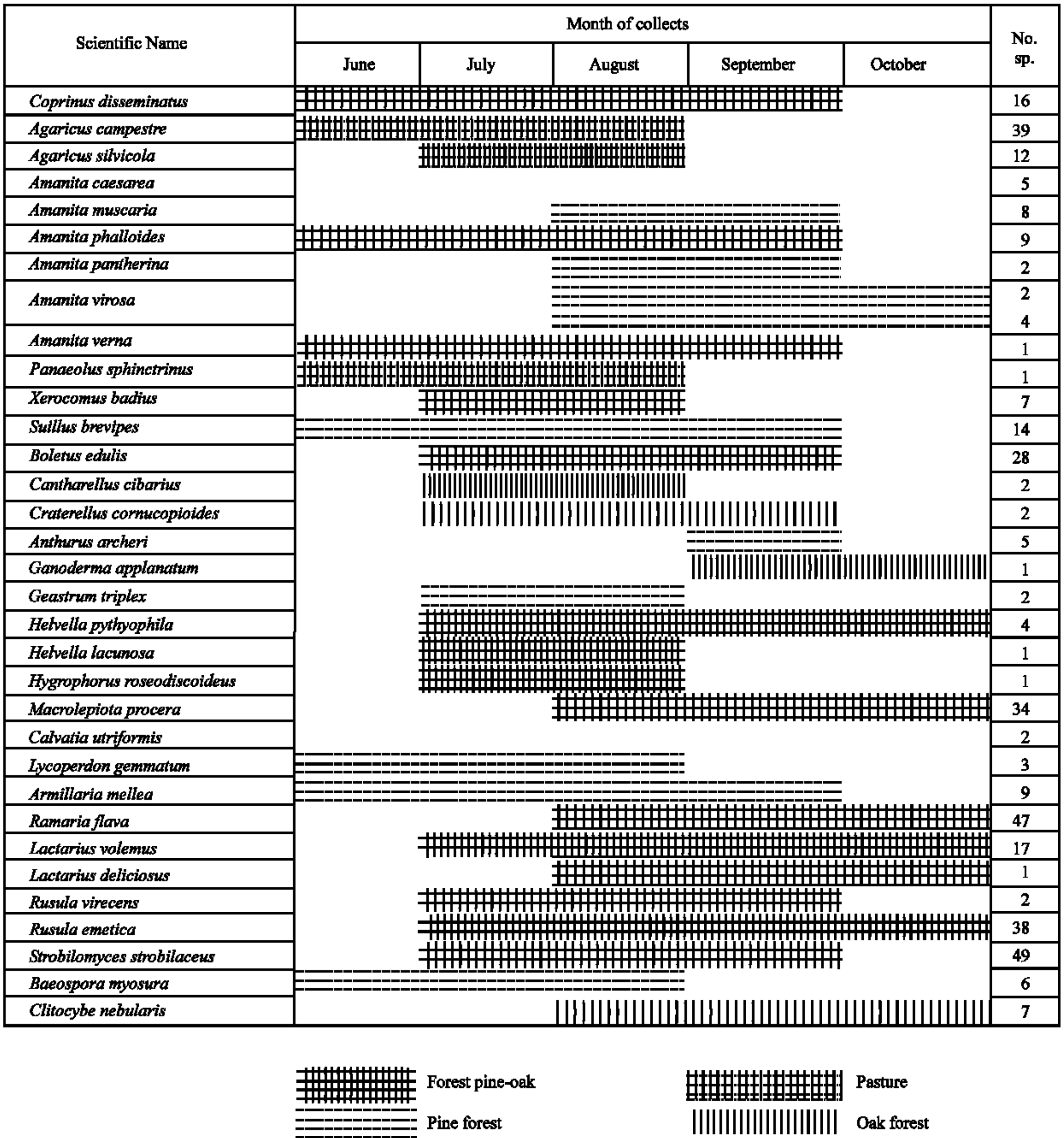

Fig. 9: Emergence of fruiting bodies of wild fungi collected in the community of Benito Juárez, Tetela de Ocampo, Puebla-México, year 2007

Hygrophorus roseodiscoideus, *Lycoperdon gemmatum* (Fig. 7), *Baeospora myosura* (Guzman, 1987).

Mycorrhizal fungi were abundant in the region, with a total of 13 species. These are important because they are used for reforestation programmes, highlighting, inter alia: *Strobilomyces strobilaceus*, *Cantharellus cibarius*, species of *Amanita*, as *A. Muscaria*, *A. Pantherina*, *A. Caesarea*, *A. Phalloides*, *A. virosa* and *A. Verna*; *Lactarius species*, as *L. Volemus* and *L. Deliciosus*, as well as some *Boletaceos*: *Boletellus edulis* and *Xerocomus badius*, *Suillus brevipes*, all these mycorrhizal characteristic of pine and oak (Moreno *et al*., 2005).

The diversity of this area of study is of great importance because it found mycological first to the family of the *Rusulaceae* with 24%, followed by the family *Agaricaceae* with 18% and in third place in the family *Marasmiaceae* with 13%. Other families had a lower percentage (Fig. 8).

In the pine forest were the most abundant species: *Amanita muscaria*, *Amanita pantherina*, *Amanita virosa*, *Suillus brevipes*, *Anthurus archeri*, *Geastrum triplex*, *Lycoperdon gemmatum*, *Armillaria mellea* and *Baeospora myosura*, while in *Quercus* excel in *Cantharellus cibarius* production, *Craterellus cornucopioides*, *Ganoderma applanatum*, *Clitocybe nebularis*, the largest population of species of fungi was wild in the forest of pine-oak; *Coprinus disseminatus*, *Amanita caesarea*, *Amanita phalloides*, *Amanita verna*, *Xerocomus badius*, *Boletus edulis*, *Helvella pythyophila*, *Helvella lacunosa*, *Hygrophorus roseodiscoideus*, *Macrolepiota procera*, *Ramaria flava*, *Lactarius volemus*, *Lactarius deliciosus*, *Rusula virecens*, *Rusula emetogenic* and *Strobilomyces strobilaceus*. The period of increased production in the pine forest was from June to September and in the forest of oak was obtained between July and October.

In the pine-oak forest, the peak of production were found between July and October, while in the peak of pasture production was between July-August (Fig. 9). After the peaks presented a rapid decrease in the production of fruiting bodies, which was due to the change of season and periods of rain.

DISCUSSION

About the ecological importance of species of wild fungi, the data of this study agreed with Guzman (1998), in which the most important family within the community of Benito Juarez, Tetela de Ocampo Puebla-Mexico, by the number of registered species, was *Russulaceae*. Also, the value of importance of species of this family was remarkable, as much in the pine-oak Forest. The species of *Lactarius deliciosus* is easily confusing with *Rusula emetica* and *Russula virecens* that can cause gastrointestinal micetismo (Perez-Silva, 2004).

With respect to the *Hygrophoraceae* family it was observed that *Hygrophorus roseodiscoideus* appears with Frequency in the pine-oak forest, who present displays an ample distribution in Mexico (Guevara *et al*., 1985; Perez-Silva and Leon de la Luz, 1997). In *Marasmiaceae* identify the eatable species of *Armillaria mellea* that is parasitic of superior plants like *Quercus* sp. (Welden and Guzman, 1978; Varela and Cifuentes, 1979; Guzman and Guzman-Davalos, 1984; Perez-Silva and Leon de la Luz, 1997).

As far as the toxic fungi *Amanita muscaria* was the species better represented with 9 units, this species can cause muscarinico micetismo, whereas *A. pantherina*, the panterinico micetismo, most dangerous are the faloidiano micetismo, derivative of the consumption of, *A. Verna and A. Virosa* (Perez-Silva *et al*., 1983). Numerous taxones well is known in mycobiota of Mexico: within most important and of greater distribution is the sort *Amanita* (Acosta and Guzman, 1984; Perez-Silva and Herrera, 1986; Perez Silva and Leon de la Luz, 1997).

Most of the species eatable, studied they come from pine-oak forest and of oak forest, the species identified with greater culinarie use within the region were: *Amanita caesarea Suillus brevipes*, *Boletus edulis*, *Cantharellus cibarius*, *Calvatia utriformis*, *Ramaria flava*, *Lactarius deliciosus*, *Clitocybe nebularis*, that corresponds frequently to taxones mentioned for Mexico (Aguirre and Perez-Silva, 1978; Welden and Guzman, 1978; Perez-Silva *et al*., 1983; Guevara *et al*., 1985).

Several families of *Suillaceae*, considered *Boletaceae* and *Strobilomycetaceae* in this study are eatable and Mycorrhizal fungi: *Xerocomus badius*, *Suillus brevipes*, *Boletus edulis* and *Strobilomyces strobilaceus*, fructifying mainly in forests of pine-oak during the summer, since it has been observed in diverse organizations of Mexico (Welden and Guzman, 1978; Varela and Cifuentes, 1979; Castillo *et al*., 1979; Perez Silva and Herrera, 1986; Perez-Silva and Leon de la Luz, 1997).

Taxones observed in the study locality has been mentioned in diverse states of the country (Welden and Guzman, 1978; Varela and Cifuentes, 1979; Castillo *et al*., 1979; Perez-Silva and Herrera, 1986).

CONCLUSION

The community of Benito Juarez presented a wide variety of wild mushrooms, which was due to the wide range of climates, soils and vegetation. This study was updated knowledge that we have about the fungal species from the mountains north of the state of Puebla, which yielded a total of 370 recognized species. Given the wide range of vegetation types in the Sierra, we may have a greater number of species of fungi, since in the present study only studied species of coniferous forests and open spaces.

It was found that the pine-oak forest had greater diversity of fungal species and higher yield than the forest of pine or oak separately. The period of increased production in the pine-oak forest is between the months of July-October, while for the oak forest was between the months of July-October. It is important to properly identify the species of plants that are associated with these wild mushrooms families for further study.

RECOMMENDATION

On the other hand, it is recommended to conduct studies to determine the genus and species of the different types of forests, in order to characterize and be able to correctly identify them to properly manage this natural resource, to be considered in programmers of sustainable use of these ecosystems, in order to promote their conservation. This is due to the constant disturbance of the ecosystem posed a serious populations risk of fungi, as well as its own plant in connection with forest systems. Most of the partners between these fungus and forests play an important role in the forest ecosystem to form mutual symbiosis with some tree species.

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