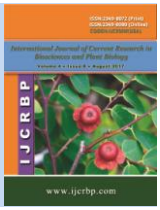
International Journal of Current Research in
Biosciences and Plant Biology
Volume 4 • Number 8 (August-2017) • ISSN: 2349-8080 (Online)
Journal homepage: www.ijcrbp.com



Original Research Article **doi:** https://doi.org/10.20546/ijcrbp.2017.408.004

Investigation on Wild Germplasm Resources of *Machilus* and *Phoebe* in Jiugongshan National Nature Reserve, Hubei Provience, China

Ming Tu[1], Xiaori Tu[2], Jie Tu[3], Chengshi Huang[1], Qingjia Mao[4], Jiafen Xie[4], Wei Zhu[5] and Die Hu[1]*

[1]*Germplasm Resources Evaluation and Innovation Center of Phoebe Yangtze University, Jingzhou-434025, Hubei, China*
[2] *Hubei Yinyan Financial Supporting Services co.LTD, Wuhan- 434025, Hubei, China*
[3] *Tongji Hospital Tongji Medical College, Huazhong University of Science & Technology, Wuhan - 434025, Hubei, China*
[4] *Hubei Jiugongshan National Nature Reserve Administration Bureau, Xianning - 437600, Hubei, China*
[5] *Xianning Academy of Agricultural Sciences, Xianning - 437100, Hubei, China*

Corresponding author.

Abstract

Phoebe and *Machilus* are rare and famous timber species in China and South Asia. The natural populations of *Phoebe* and *Machilus* community are gradual decreasing. For protection and rational utilization of *Phoebe* and *Machilus* community, ecological investigations were adopted to analysis the natural distribution of *Phoebe* and *Machilus* in Jiugongshan National Nature Reserve, Xianning City, Hubei Province, China. The result showed that there were abundant wild germplasm resources of *Phoebe* and *Machilus* communities, including two species of *Phoebe* and three species of *Machilus*, among 2 places there were 2 incremental communities. Besides, the middle slope with shady orientation is the most suitable living environment of them. It is found that four of them, such as *M. kusanoi*, *P. chinensis*, *M. rufipes* and *M. leptophylla*, they are found for the first time in Jiugongshan National Nature Reserve. Moreover, some conservation strategies for protecting these endangered wild plant resources are presented on the base of analyzing the current situation of wild resources.

Article Info

Accepted: 25 July 2017
Available Online: 06 August 2017

Keywords

Conservation strategies
Jiugongshan National Nature Reserve
Machilus
Phoebe
Population characteristic

Introduction

Phoebe is a traditional precious species in China, which refers to *Machilus*, *Phoebe* and some related species (Li et al., 1988). *Phoebe*, which is known as "wood in the gold" (Jiang, 2000), has high economic and ecological value, and it's occupying a very important position in forestry, light industry, medicine and other aspects. *Phoebe* and *Machilus* are naturally distributed in the tropical America and Southeast Asia, and there are about 100 species in the world. In China, it's mainly distributed in the south of the Yangtze River (Wu et al., 2008). The main distribution species are 7 species of *Phoebe*, and 4 species of *Machilus* in Hubei Province, China (Li, 1982). In view of its wide range of uses and extremely large economic value, the destruction of wild resources of *Phoebe* and *Machilus* are extremely serious, the number of population is dropping and the community plaques are shrinking. It's difficult to find natural *Phoebe* and *Machilus*. There are as many as 71

species of endangered species of 82 species of *Machilus* in China (Zhong and Xia, 2010). Many species of *Phoebe* are also endangered (Jiang and Dong, 2008). It shows that Chinese resources endangered situation of *Phoebe* and *Machilus* are very worrying. It's urgent to protect *Phoebe* and *Machilus*. It's of great significance to study the germplasm resources of *Phoebe* and *Machilus* and to understand its ecological characteristics in depth for understanding the causes of endangered *Phoebe* and *Machilus* and putting forward scientific and reasonable conservation measures.

Materials and methods

Survey area and sample profile

Overview of the physical geography of the study area

Jiugongshan National Nature Reserve is located in the southern part of Tongshan County, Hubei Province, China. Its geographic location is in longitude 114º23'35"~ 114º39'48", latitude 29º19'27 "~ 29º27'08". The total area is 16608.7hm^2. It's located in the middle of the Jiugongshan National Nature Reserve. The area is high in the mountains and the valley is deep, the steep is slope and valley is narrow, the valley is arranged in parallel with each other. Under the external forces such as glaciers, flowing water and weathered, the landscape at an elevation of 117-1657 meters between is formed a unique Zhongshan landscape. It's a subtropical monsoon climate and its four seasons are distinct. The annual average temperature is 11°C and the maximum summer temperature does not exceed 30°C, it has typical mountain climate characteristics.

Sample profile

The survey site is located at Golden Rooster Valley Scenic Area and Stone Gragon Gap Scenic Area in Jiugongshan National Nature Reserve. It across the 114˚ 34' 11.06" to 114˚ 39' 19" in longitude and 29˚ 22' 00.79" to 29˚45'43.13" in latitude. Its elevation is between 430-524 m. The soil type is mountain red soil and mountain yellow brown soil, PH value of which is mainly in the range of 5.5-6.5, so the whole soil is acidic. The community types are evergreen broad-leaved mixed forest, and the canopy density is between 0.4 and 0.8, and the coverage is between 63% and 93%. The distribution of wild resources of *Phoebe* and *Machilus* in this area are relatively concentrated, distribution of which are along the river valley, and the population is better preserved.

Research methods and data analysis

Research methods

In this paper, the typical sampling method is used. According to the field survey, we found that the distribution of wild *Phoebe* and *Machilus* resources can only be found in two spots (Golden Rooster Valley and Stone Gragon Gap) in Jiugongshan National Nature Reserve. In the two plots, there are randomly distributed on both sides of the valley. According to the populations and the actual landform characteristics of the two statuses, the discovered *Phoebe* and *Machilus* resources were wholly recorded, and we finally completed investigation of 14 main quadrats and 12 samples. The main sample length of the sample is 20 m; the area is 20×20 m^2 square. Quadrats can also be set to rectangular in special cases, but the shortest side length of the rectangle is not less than 5 m.

The habitat of the plot was investigated and recorded, such as soil type, slope, aspect, slope position, elevation, canopy closure, coverage and human disturbance. Then we recorded species of trees, shrubs and herbaceous plants appeared in the community. In light of aimed species, number of *Phoebe* and *Machilus*, H and DBH were recorded and classified with Every foot test method (Wu et al., 2017), data is used to count the quantitative characteristics of population on *Phoebe* and *Machilus*. We summarized the survey data to build the database and calculated the number of plant populations on *Phoebe* and *Machilus*. Per unit area in different slope areas, slope position, elevation and different communities, and the number of plant populations of *Phoebe* and *Machilus* in different habitats were analyzed and compared. Finally we found relation of different ecological factors and natural population distribution of *Phoebe* and *Machilus*.

Data analysis

Calculation of the importance value of species: the results of the measurements of each sample are summarized and the relevant indicators in the community are calculated by the following formula.

Importance value = (relative density + relative dominance + relative frequency)/3
Density = individual amount /sample area
Dominance = base area or coverage area total / sample area
Frequency = contains the number of samples / samples of the species
Relative density = (density of a species / total density of all species) × 100%
Relative dominance =
(dominance of a species/total dominance of all species) × 100%

Relative frequency =
(the frequency of a species / the total frequency of all species) × 100%

Because it is difficult to determine the exact growth age of the population from the outside, the age structure of the population is analyzed by using the DBH structure instead of the age structure. DBH structure is divided into the main forest layer (H ≥ 5 m), the successor layer (5 m > H ≥ 1 m), and the renewal layer (H < 1 m) according to the height of *Phoebe* and *Machilus* (Qu et al., 1952; Liu, 2007).

Results

Population characteristics of plants

The quantitative characteristics of population on *Phoebe* and *Machilus*

In the range of 4500 m^2 of quadrats, the total number of *Phoebe* is 544, among which there were 166 trees and 378 seedlings. Its total distribution is 0.12 plants/m^2. The main habitat for *Phoebe* and *Machilus* are the ditch side, the valley on both sides of the crevice, of which there are 219 strains in sunny slopes and 325 strains in shady slope.

Findings based on the statistics of the number of *Phoebe* and *Machilus* on different aspect, such as sunny slope and shady slope, and different levels, such as renewal layer, succession layer and main forest layer. They are shown in Table 1: distribution of the renewal layer, the successor layer and the number of the sunny and shady slope is not very different in number per unit area, and the main forest layer is close to 0.03 plants/m^2, the renewal layer is close to 0.06 plants/m^2; the succession layer is close to 0.02 plants/m^2; distribution of *Phoebe* and *Machilus* in the overall slope (0.1161/m^2) are less than that in the sunny slope (0.1288 plants /m^2).

Table 1. The statistics of population on *Phoebe* and *Machilus.*

Slope direction	Highly structure	Quantity	Slope area /m^2	Number of plants per unit area/m^2
Sunny slope	Update layer	120	1700	0.0705
	Successor layer	44		0.0258
	Main forest layer	55		0.0323
	Total	219		0.1288
Shady slope	Update layer	175	2800	0.0625
	Successor layer	39		0.0139
	Main forest layer	111		0.0396
	Total	325		0.1161
Total		544	4500	0.1208

Effects of different habitat factors on community of *Phoebe* and *Machilus*

Based on the different slope, slope position and elevation, the population of *Phoebe* and *Machilus* under different habitats were analyzed and compared, and then we find the relationship between different habitat factors and distribution quantity.

Slope

As the results shows in Table 2, the population of *Phoebe* and *Machilus* at two plots in Jiugongshan National Nature Reserve mainly distribute in the slope and under the slope position, the number of *Phoebe* and *Machilus* distribution in the slope of between 25° and 35° is more than the slope of between 35° and 55°.

Table 2. The distribution of population on *Phoebe* and *Machilus* at different slopes.

Slope	Highly structure	Quantity	Average diameter at breast height (cm)	Average tree height (m)
Golden Rooster Valley (35°-55°)	Update layer	125	0.91	0.92
	Successor layer	44	2.63	3.63
	Main forest layer	55	7.73	9.43
Stone Gragon Gap (25°-35°)	Update layer	157	0.89	0.87
	Successor layer	45	3.82	3.51
	Main forest layer	87	7.66	7.26

Slope position

Findings from Table 3 shows: The *Phoebe* and *Machilus* at the two plots (Golden Rooster Valley Scenic Spot and Stone Gragon Gap Scenic Area) mainly distribute in the area of slope and under the slope. In the upper part of the slope or the flat part, the distribution of *Phoebe* and *Machilus* are less. The number of *Phoebe* and *Machilus* in the renewal layer reaches the maximum in the slope and under the slope, but they are scattered on the slope and flat ground.

Table 3. The distribution of population on *Phoebe* and *Machilus* at different slope positions.

Slope position	Highly structure	Quantity	Average diameter at breast height(cm)	Average tree height(m)
On the slope	Update layer	0	0	0
	Successor layer	3	3.31	3.22
	Main forest layer	11	7.02	7.21
Slope	Update layer	157	0.89	0.87
	Successor layer	45	3.82	3.51
	Main forest layer	87	7.66	7.26
Under the slope	Update layer	125	0.91	0.92
	Successor layer	44	2.63	3.63
	Main forest layer	55	7.73	9.43
Flat ground	Update layer	0	0	0
	Successor layer	4	3.12	3.14
	Main forest layer	13	7.13	8.53

Elevation

As the results shows in Table 4, in the two plots of the Jiugongshan National Nature Reserve, there are differences of populations between the *Phoebe* and *Machilus* at different altitudes. The number of *Phoebe* and *Machilus* in the renewal layer reaches the largest, there are 157 strains when altitudes is 490~524m. The successor layer is less at altitudes. Distribution of the main forest layer reach the most, there are 100 strains when altitudes is 430 ~ 490 m.

Characteristics of *Phoebe* and *Machilus* community in Jiugongshan National Nature Reserve

Species composition of *Phoebe* and *Machilus* community

According to the statistical results of the survey plots in Table 5, there are 2179 species of vascular plants belonging to 857 genera in 209 families of *Phoebe* and *Machilus* community in Jiugongshan Nature Reserve, among which there are 2370 species of ferns belonging to 74 genera in 35 families, 39 species of gymnosperm belonging to 19 genera in 6 families, and 1770 species of angiosperms belonging to 764 genera in 168 families. In general, angiosperms are predominant in the survey area, ferns and gymnosperms are relatively poor.

Family and genus composition of *Phoebe* and *Machilus* community

The most species belonging to the vascular botanic families of the *Phoebe* and *Machilus* community in the investigated area was Lauraceae, and there are 5 species of 2 families accounting for 12.51% of the total species, which are followed by Rosaceae, Liliaceae, Compositae, Araceae and Berberidacea, of which Plantaginaceae, Papilionaceae, Elaeagnaceae, Meliaceae, Ranunculaceae, Vitaceae, Aceraceae, Saururaceae, Saxifragaceae, Polygonaceae, Oleaceae, Moraceae, Nephrolepidaceae, Araliaceae, Orchidaceae, Scrophulariaceae, Iridaceae, Crassulaceae, Solanaceae and Cruciferae were all single species accounting for 63.33% of the total family, 37.51% of the total genus, and 30.28% of the species. In general, the plant composition of the *Phoebe* and *Machilus* community in Jiugongshan National Nature Reserve are relatively complicated and abundant.

As the results shows in Table 6, in the investigation area, the number of *P. hunanensis* reaches the highest in Stone Gragon Gap, and the relative frequency was 14.3%, the relative density was 88.1%, the relative

dominance was 48.8%, the importance value was 50.4 followed by the *M. kusanoi*, and the frequency of *M. leptophylla* is the only once. Surroundings are rich in other associated species such as *Phyllostachys pubescens, Evodia daneillii, Cornus controversa, Quercu smacrocarpa* and *Diospyros*. As for sample in Golden Rooster Valley, *M. kusanoi* is the most and followed by *P. hunanensis* and *P. chinensis* of which the distribution is relatively scattered, and frequency of *M. rufipes* is the only once. At the same time, there are *Dalbergia hupeana, Kalopanax septemlobus, Emmenopterys henryi, Camellia fraterna, Acer oliverianum, Celtis tetrandra, Ilex latifolia, Pinus thunbergii* and other associated species, and the dominant species in the tree layer is oak tree, the dominant species in the shrub layer is the bamboo, dominant species in the herbaceous layer is the tough grass. Surrounding vegetation is rich, structure of the community is relatively excellent, and there is a certain ability of natural regeneration.

Table 4. The distribution of population on *Phoebe* and *Machilus* at different elevation.

Elevation (m)	Highly structure	Quantity	Average diameter at breast height (cm)	Average tree height (m)
Golden Rooster Valley (430-490)	Update layer	125	0.97	0.96
	Successor layer	44	4.69	7.61
	Main forest layer	100	8.77	9.43
Stone Gragon Gap (490-524)	Update layer	157	0.95	0.89
	Successor layer	45	5.82	8.51
	Main forest layer	66	9.65	7.26

Table 5. The statistics of vascular plants in *Phoebe* and *Machilus* community in Jiugongshan National Nature Reserve.

Groups	Composition		
	Family	Generic	Specifics
Ferns	35	74	370
Gymnosperms	6	19	39
Angiosperms	168	764	1770
Total	209	857	2179

Table 6. Frequency index, coverage and dominance of *Phoebe* and *Machilus* in Jiugongshan National Nature Reserve.

Sample name	Species name	Quantity	Sample area	Relative density %	Relative frequency %	Relative dominance %	Importance value
Stone Gragon Gap	*P. hunanensis*	391	1060	88.1	14.3	48.8	50.4
	M. kusanoi	8		1.8	14.3	1.0	5.7
	M. leptophyla	1		0.2	14.3	0.2	4.9
Golden Rooster Valley	*P. hunanensis*	28	3440	1.9	14.3	9.7	8.6
	M. kusanoi	107		7.4	14.3	37.1	19.6
	M. leptophyla	1		0.07	14.3	0.4	4.9
	M. rufipes	1		0.07	7.14	0.4	4.9
	P. chinensis	7		0.47	7.14	2.4	3.3

Discussion and conclusion

Comparison of new and old record species of *Phoebe* and *Machilus* in Jiugongshan National Nature Reserve

Compared to the records of *Phoebe* and *Machilus* in Hubei in the "Flora of China" (Zhou et al., 2007), "Botany Illustration of China", "Flora of Hubei" (Fu et al., 2002) and "Botany Chronicles of Hubei" (Zhou, 1982). The Jiugongshan National Nature Reserve of *Phoebe* and *Machilus* distribution have been recorded only one kind of *P. hunanensis* in "Hubei Flora" and other literature. The results of field in germplasm resource estivation showed that there were two species of *Phoebe* and three species of *Machilus* in Jiugongshan National Nature Reserve. Among them, *P. hunanensis* and *P. chinensis*, *M. kusanoi*, *M. rufipes* and *M. leptophylla* were first found in Jiugongshan National Nature Reserve, and the new records of species were

initially confirmed. *P. hunanensis* was the original recorded species, and it is also large quantity in number of species of wild *Phoebe* and *Machilus* found in the survey.

The characteristics of population on *Phoebe* and *Machilus*

Among the 2 places there were 2 incremental communities and have the complete main forest layer, the successor layer and the new layer structure, the number of the new layers reaches maximum. The existing population of *Phoebe* and *Machilus* are little effected on the seedlings and saplings due to the small human disturbance, and all of them have better natural breeding and growth, the structure of population is relatively complete. From the development of the community, we found the growth in number of population on *Phoebe* and *Machilus* were relatively well. Of which four seedlings of *P. chinensis* and *M. leptophylla* with a relatively large community appeared. The combination of young trees and adult trees is more conducive to the growth and intergenerational substitution of the target species, so that the high quality tree species of *Phoebe* and *Machilus* are better preserved and breed.

Effects of different habitats on the distribution of *Phoebe* and *Machilus* community in Jiugongshan National Nature Reserve

From the analysis of the survey data, the distribution of population on *Phoebe* and *Machilus* are selective about ecological factors, such as elevation, slope and slope position. The number of *Phoebe* and *Machilus* distributed in the shady slope is much higher than that in the sunny slope, the *Phoebe* and *Machilus* community grew relatively well at 23°~35°C in the shady slope and under the slope, and there were no significant correlation with the altitude in the survey area, the main reason for the analysis is that *Phoebe* and *Machilus* in Jiugongshan National Nature Reserve are distributed in the valley on both sides of the waterfront roadside and flat of the land, the interference intensity is small, so the community can get a better natural breeding and growth, seedlings and saplings are less affected. The *Phoebe* and *Machilus* community are mainly distributed in the area with abundant water source, *Phoebe* and *Machilus* are the deep root tree species, and the water at the slope level can be better obtained by *Phoebe* and *Machilus*. The seeds and seedlings in the lower slope are easily affected by the flood season. It's difficult to survive or develop into the main forest layer, and whether it's in the living environment or natural environment. Animal activity in the zone near the water is more frequent, so seedlings are stampeded and destructed more frequent. In general, the *Phoebe* and *Machilus* community are more abundant in the shady slope, and we conjecture that it's related to the strong tolerance of seedlings, which is consistent with the results of the study of the plantations of the *Phoebe* and *Machilus* (Jiang et al., 2009).

Analysis on the endangered causes of *Phoebe* and *Machilus* in natural conditions

Decrease of population plots resulting from habitat destruction

Vandalism is the most crucial factor. Due to the strong resistance and strong seed production, the adaptability of *Phoebe* and *Machilus* for natural habitat change are relatively excellent, so natural factors are not the main reason for the habitat fragmentation. And the human seek fine texture of wood and have destructive logging, which result in a significant reduction in the number of populations, and community structure have also been destroyed; human seek development and construction for their own to have road construction, reclamation and other activities, which make the *Phoebe* and *Machilus* habitat decrease, narrow the community plaque and play the habitat fragmentation. Although *Phoebe* and *Machilus* have high fecundity and massive seed, the seed dormancy is long and the dormancy will make loss due to seed inactivation. Seedling growth is slow, and it's difficult to repair the habitat fragmentation in the short term by virtue of its own strength, which leads to genetic drift change and a series of problems, further aggravates the endangered plant, finally fall into a vicious cycle.

From seedlings to saplings cause huge loss on *Phoebe* and *Machilus*

As there is a huge loss in the conversion that *Phoebe* and *Machilus* from seedlings to saplings, which results in community replacement obstacles, the observations of the current study is falling in line with the study conducted by Zhang et al. (2002). It's not difficult to find it from above table that, regardless of the condition of the plots, the number of seedlings of the population on *Phoebe* and *Machilus* is very rare, even in the relatively large population, the *Phoebe* and *Machilus* are

also disproportionate to other standstill levels. Divided according to height, the successor layer is almost in a state of breaking. This phenomenon hinders the replacement and development of population on *Phoebe* and *Machilus*. Human activities have also exacerbated this phenomenon, which causes the main forest layer is much larger than the number of layers and the succession layer in two sample of Golden Rooster Valley Scenic Area and Stone Gragon Gap scenic area. The People's Republic of China state environmental protection agency (1987) reported that as part of the *Phoebe* and *Machilus* distributes in the lot, where human activities are more frequent. *Phoebe* and *Machilus* community may be regarded as a local geomancy tree and be preserved. But what human beings mainly protect is the forest that already form the main forest, collecting firewood in the forest or walking through the seedlings will have an impact on the seedlings, and it also affect animals and insects' activities which will promote pollination and seed propagation of *Phoebe* and *Machilus*. Some villagers even pick tall and thin plants to cut down as firewood, which directly hinders the formation and development of the successor layer.

Protection strategies and recommendations

Phoebe is one of the national second-class important protected plants in China and its endangered grade is dangerous (Wang and Xie, 1999; Tao et al., 1987). As a relatively long juvenile and slow growth of *Phoebe* and *Machilus*, which are coupled with gradual increase of the current social awareness of the economic value, we should step up efforts of the protection and management. Their growth status should be regularly inspected and recorded, which can avoid pests and diseases and other causes of natural losses as far as possible. In the annual fruit period, the seeds of wild *Phoebe* and *Machilus* can be harvested, of which some seeds with high quality are preserved as wild resources of germplasm, and the other part of the healthy seeds of *Phoebe* and *Machilus* are used for artificial cultivation. The cultivated seedlings can be used for development and utilization, supplemented with the number of individual species in *Phoebe* and *Machilus* community to expand the population and improve the community stability. At the same time, artificial cultivation and domestication should be given through the introduction and breeding to determine whether it is adapted to Jiugongshan National Nature Reserve geographical climate and biological environment, and then select the appropriate habitat for a small amount of field planting so as to enrich the wild botanic population and expand the wild protection of botanic resources of Jiugongshan National Nature Reserve.

Conflict of interest statement

Authors declare that they have no conflict of interest.

Acknowledgement

This work was supported by the national second survey for key protected wild plant resources (special investigation for *Phoebe* and *Machilus* in Hubei Province), the Science and Technology Support Program in Hubei Province of P. R. China (2013BBB24), the Youth fund program in Yangtze University of P. R. China (2015cqn80).

References

Fu, S. X., 2002. Flora Hubei. Hubei Science and Technology Press, Wuhan, China. 03, 3.

Jiang, H. X., 2000. Wood in the gold of *Phoebe zhennan*. Land Greening. 5, 41.

Jiang, X. M., Xiao, F. M., Ye, J. S., 2009. *Phoebe bournei* (Hemsl.) Yang natural forest and plantation growth characteristics research. J. Jiangxi Agric. Univ. 31(6), 1049-1054.

Jiang, Z. F., Dong, Z. M., 2008. The development and utilization of plant resources in *Phoebe* Nees. Heilongjiang Agric. Sci. 6, 119-121.

Li, S. G., 1982. Flora China. Beijing Science Press, China. pp.1-121.

Li, S. G., Wei, F. N., 1988. A revision of the name of the valuable timber *Phoebe zhennan*. J. Guangxi Bot. 8(4), 297-300.

Liu, T., 2007. Population Ecology of Natural Japanese Yew. Northeast Try. Univ.

Qu, Z. X., Wen, Z. W., Zhu, K. G., 1952. An analytical study of the forest of the spirit valley, Nanking. Acta Bot. Sin. 2(1), 18-45.

Tao, G., Lu, A., Jiang, Z., Chen, H., Zhang, X., Sun, H., Ding, J. and Wu, Y., 1987. New resource plants of natural camphor and linalool. J. Biol. 29(5), 541-548.

The People's Republic of China State Environmental Protection Agency, 1987. List of Rare and Endangered Plants in China. Beijing Science Press, China. pp.23-28.

Wang, S., Xie, Y., 1999. Chinese species red list. Beijing Higher Education Press, China. 334p.

Wu Y M., Yu P Y., Zhou M Q., Fei Y J.,2017. Research

on *Phoebe zhennan*'s population structrue and community characteristics in Xianfeng. Hubei Try. Sci. Technol. 46(1), 38-43.

Wu, Z. Y., Raven, P. H., Hong, D. Y., 2008. Lauraceae. In: Flora of China. Vol. 7. Science Press, Beijing and Missouri Botanical Garden Press, St. Louis. pp.102-254.

Zhang, W. H., Zu, Y. G., Liu, G. B., 2002. Population ecological characteristics and analysis on endangered cause of ten endangered plant species. Acta Ecol. Sin. 22(9), 1512-1520.

Zhong, Y., Xia, N. R., 2010. Leaf epidermal features of *Machilus* Nees from China and their systematics significance. J. Trop. Subtrop. Bot. 18(2), 109-121.

Zhou, H. B., Liu, J. M., Wang, J. H., 2007. Counter measures on current status of rare endangerd plant and protection in Yichang. Hubei Try. Sci. Technol. 1, 47-53.

Zhou, X. C., 1982. Ecological survey of alpine forest species in Yichang. Hubei Try. Sci. Technol. 5, 23-51.

How to cite this article:
Tu, M., Tu, X., Tu, J., Huang, C., Mao, Q., Xie, J., Zhu, W., Hu, D., 2017. Investigation on wild germplasm resources of *Machilus* and *Phoebe* in Jiugongshan National Nature Reserve, Hubei Provience, China. Int. J. Curr. Res. Biosci. Plant Biol. 4(8), 22-29. **doi:** https://doi.org/10.20546/ijcrbp.2017.408.004