Preplanned Studies

Mushroom Poisoning Outbreaks — China, 2019

Haijiao Li[1]; Hongshun Zhang[1]; Yizhe Zhang[1]; Kaiping Zhang[1]; Jing Zhou[1]; Yu Yin[1]; Shaofeng Jiang[1]; Peibin Ma[1]; Qian He[1]; Yutao Zhang[1]; Ke Wen[1]; Yuan Yuan[1]; Nan Lang[1]; Junjia Lu[1]; Chengye Sun[1,#]

Summary

What is already known about this topic?

Mushroom poisoning is becoming one of the most serious food safety issues in China, which is responsible for nearly a half of all oral poisoning deaths.

What is added by this report?

In China, many mushrooms were previously "recorded" as poisonous. In this study, about 70 species obtained from mushroom poisoning incidents including several new records were confirmed accurately by morphological and molecular evidence in 2019, and spatial and temporal distribution characters of 13 lethal mushrooms were summarized systematically.

What are the implications for public health practice?

Precise and timely species identification is of pivotal importance in mushroom incidents. More efforts and cooperation are continued to be needed urgently for the governments, CDC staff, doctors and mycologists in future.

Macrofungi, commonly known as mushrooms, are important sources of foods and medicines especially in China (*1*). But with the utilization of wild edible and medicinal mushrooms, many poisoning incidents occur every year. At least 100 estimated people die every year worldwide, which is likely underestimated given the approximate 50–100 deaths separately reported each year in both Europe and China (*2*–*5*). Mushroom poisoning is a major cause of death by oral poisoning in China and is characterized by typical space-time clustering (in South areas of China, from summer to autumn), high mortality (about 20%), and high risk to farmers (*3*,*6*). After mushroom poisoning events, mushroom poisoning information is systematically collected by a technical support network including professional staff of CDC, doctors and mycologists, and an epidemiological investigation is immediately conducted. In 2019, 276 independent mushroom poisoning incidents from 17 provinces involving 769 patients and 22 deaths were investigated and the overall mortality was 2.86%.

Currently, 480 varieties of poisonous mushrooms have been recorded in China (*1*) that result in seven different kinds of clinical syndromes including acute liver failure, acute renal failure, rhabdomyolysis, gastroenteritis, psycho-neurological disorder, hemolysis, and photosensitive dermatitis (*2*,*6*). Among these clinical syndromes, poisonous mushrooms resulting in acute liver failure and rhabdomyolysis are responsible for almost all deaths.

Information from epidemiological investigations was systematically recorded and analyzed, and the information focused primarily on location, poisoning time, incubation, complaints, number of patients and deaths, mushroom species, method of acquisition (including self-harvested, market purchase), and syndromic classification. The patients' number of a few incidents resulting gastroenteritis or psycho-neurological disorder were not accurately obtained, they were treated as one patient for each incident. Following poisoning events, mushroom specimens were obtained by local CDC, China CDC, or hospital professionals from the venue where the mushrooms were consumed or from the field and confirmed by the patients. Almost all specimens were processed and deposited in the National Institute of Occupational Health and Poison Control (NIOHPC) of China CDC. Some were also deposited in Cryptogamic Herbarium of Kunming Institute of Botany, Chinese Academy of Sciences (HKAS), Herbarium of College of Life Sciences, Hunan Normal University (MHHNU), and other local CDCs. All mushroom specimens were identified by morphological and molecular analyses, DNA gene fragment internal transcribed spacer (ITS) was selected for species recognition. Related clinical symptoms data were summarized from the hospital records.

In 2019, a total of 276 independent mushroom poisoning incidents from 17 provinces involving 769 patients and 22 deaths were investigated and the overall mortality was 2.86%. Among them, the

mushroom species could accurately be identified in 264 incidents (95.65%). There were 26 patients from 9 incidents with 1 death who had eaten poisonous mushrooms purchased from market. Ten patients from five incidents had been poisoned after eating dried *Russula* spp. or boletes. Patients from 33 incidents had consumed mixed wild mushrooms. Mushroom poisoning happened every month all year round and centered from June to October with its peak in July, which involved 85 incidents including 200 patients and 4 deaths (Figure 1).

In terms of geographical distribution, the provincial-level administrative division with the most incidents was Hunan, which involved 77 incidents and 221 patients, followed by Yunnan, Zhejiang, Guizhou, and Chongqing. The number of incidents and patients in the top 5 provinces accounted for more than 80% of the total (82.61% and 80.49%) and 95.45% (21/22) of the total death toll. The number of cases ranged from 1 to 23,* and 6 outbreaks involved more than 10 patients. Yunnan had 14 patients die after eating poisonous mushrooms, followed by Guizhou (5 deaths), Zhejiang (2 deaths), and Sichuan (1 death).

In addition, There were 12 patients from Burma who had been involved in 3 incidents with 6 deaths. There was one patient who had eaten *Chlorophyllum molybdites*, which causes gastroenteritis, four patients who had consumed *Psilocybe thaiaerugineomaculans*, which leads to hallucinations, and the other seven patients had eaten the lethal mushroom *Amanita exitialis*.

About 70 species of poisonous mushroom causing 6 different kinds of clinical syndromes were successfully identified by morphological and molecular studies (Table 1). Seven species (*Entoloma strictius*, *Gymnopilus lepidotus*, *Inocybe serotina*, *I. squarrosolutea*, *Lactarius atrobrunneus*, *Lactifluus vellereus*, and *Psilocybe thaiaerugineomaculans*) were newly recorded as poisonous mushrooms in 2019 and were added to the Chinese poisonous mushroom list. This is the first report of *I. serotina* and *P. thaiaerugineomaculans* in China. *Gerhardtia sinensis* and *Tolypocladium dujiaolongae* were treated as highly suspected poisonous species and further investigations will be continued to certify their edibility or toxicity.

Nine species (*A. exitialis*, *A. fuliginea*, *A. cf. fuliginea*, *A. pallidorosea*, *A. rimosa*, *A. subjunquillea*, *A. subpallidorosea*, *Galerina sulciceps*, and *Lepiota brunneoincarnata*) causing acute liver failure resulted in 41 incidents involving 100 patients and 20 deaths and thus, *A. exitialis* had been recognized as the most dangerous mushroom in 2019 (Table 1). *Russula subnigricans* which leads to rhabdomyolysis resulted in 15 incidents involving 54 patients and 1 death (Table 1). Three species (*A. neoovoidea*, *A. oberwinklerana*, and *A. pseudoporphyria*) from the genus *Amanita* causing acute renal failure were identified, leading to 11 incidents involving 23 patients and no deaths (Table 1). As almost all deaths for mushroom poisoning were attributed to acute liver failure,

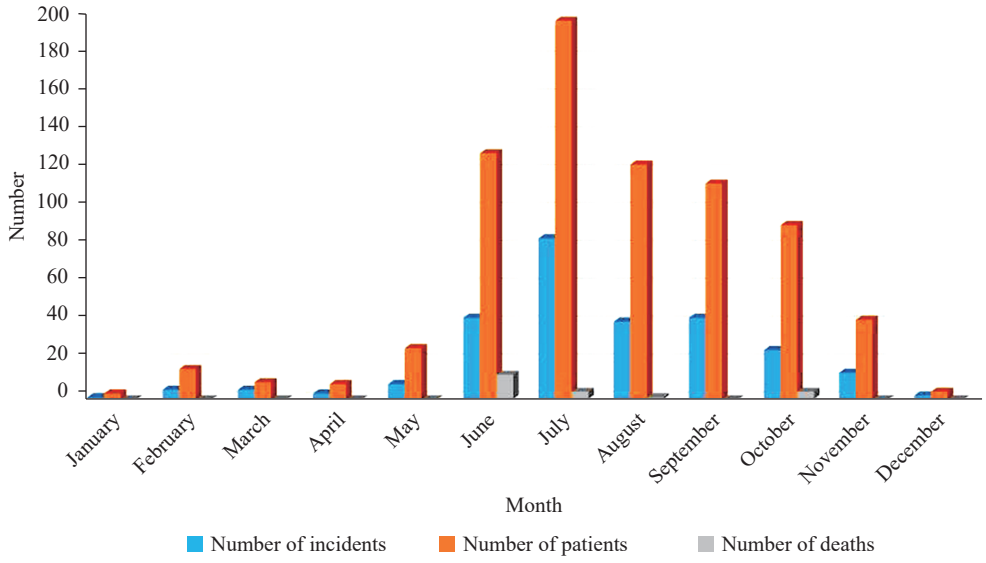

FIGURE 1. Monthly distribution of mushroom poisoning in China, 2019.

* The median number of cases was two.

TABLE 1. Toxic mushroom species causing poisoning incidents in China, 2019.

Mushroom species	Number of incidents	Number of patients	Deaths	Mortality (%)
Acute liver failure				
Amanita exitialis	8	25	13	52.00
Amanita fuliginea	4	9	0	0
Amanita cf. fuliginea	2	5	1	20.00
Amanita fuliginea or *Amanita rimosa*	4	14	1	7.14
Amanita pallidorosea	4	9	1	11.11
Amanita rimosa	2	4	0	0
Amanita subjunquillea	1	3	0	0
Amanita subpallidorosea	7	11	3	27.27
Galerina sulciceps	4	9	1	11.11
Lepiota brunneoincarnata	5	11	0	0
Rhabdomyolysis				
Russula subnigricans	15	54	1	1.85
Acute renal failure				
Amanita neoovoidea	1	2	0	0
Amanita oberwinklerana	9	18	0	0
Amanita pseudoporphyria	1	3	0	0
Gastroenteritis				
Agaricus cf. *arvensis*[*]	1	1	0	0
Agaricus subrufescens[*]	1	4	0	0
Other *Agaricus* spp.	4	10	0	0
Baorangia pseudocalopus	2	2	0	0
Chlorophyllum globosum	2	8	0	0
Chlorophyllum hortense	1	1	0	0
Chlorophyllum molybdites	54	126	0	0
Chlorophyllum molybdites and *Chlorophyllum hortense*	1	7	0	0
Entoloma omiense	8	31	0	0
Entoloma quadratum	1	2	0	0
Entoloma strictius	1	2	0	0
Entoloma sp.	1	3	0	0
Gerhardtia sinensis	2	6	0	0
Lactarius atrobrunneus	1	1	0	0
Lactarius torminosus and *Megacollybia clitocyboidea*	1	4	0	0
Lactifluus vellereus	1	7	0	0
Omphalotus guepiniformis	3	19	0	0
Porphyrellus cf. *holophaeus*	1	2	0	0
Russula cf. *emetica*	1	3	0	0
Russula foetens	3	8	0	0
Russula grata	1	2	0	0
Russula illota and *Entoloma* cf. *abortivum*	1	2	0	0
Russula japonica	26	68	0	0
Russula cf. *japonica*	10	43	0	0
Russula japonica and *Amanita sepiacea*	1	3	0	0

TABLE 1. (continued)

Mushroom species	Number of incidents	Number of patients	Deaths	Mortality (%)
Russula japonica and *Entoloma omiense*	1	1	0	0
Russula japonica and *Russula foetens*	3	7	0	0
Russula sp.	1	4	0	0
Scleroderma cepa	4	8	0	0
Scleroderma sp.	1	1	0	0
Suillus pictus	1	5	0	0
Sutorius flavidus	1	1	0	0
Sutorius sp.	1	3	0	0
Tricholoma terreum[*]	3	6	0	0
Tylopilus neofelleus	1	1	0	0
Psycho-neurological disorder				
Amanita concentrica	4	6	0	0
Amanita melleiceps	1	5	0	0
Amanita rufoferruginea	2	4	1	25.00
Amanita subglobosa	3	10	0	0
Amanita cf. *subglobosa*	1	2	0	0
Amanita cf. *virgineoides*	1	1	0	0
Boletus cf. *bicolor*	1	9	0	0
Butyriboletus roseoflavus	1	7	0	0
Clitocybe sp.	4	14	0	0
Gymnopilus dilepis	2	3	0	0
Gymnopilus lepidotus	1	1	0	0
Gymnopilus sp.	2	2	0	0
Inocybe rimosa	2	4	0	0
Inocybe serotina	1	2	0	0
Inocybe squarrosolutea	1	1	0	0
Panaeolus fimicola and *Conocybe* sp.	1	2	0	0
Psilocybe cubensis	1	5	0	0
Psilocybe cubensis and *Panaeolus papilionaceus*	1	6	0	0
Psilocybe samuiensis	2	7	0	0
Psilocybe thaiaerugineomaculans	1	4	0	0
Photosensitive dermatitis				
Cordierites frondosus	2	3	0	0
Unclassified				
Amanita citrinoannulata	1	4	0	0
Amanita clarisquamosa	1	3	0	0
Amanita fritillaria	2	8	0	0
Amanita hamadae	1	1	0	0
Lepista sordida[*]	1	1	0	0
Macrocybe gigantea[*]	1	1	0	0
Scleroderma yunnanense[*]	1	1	0	0
Tolypocladium dujiaolongae[*]	3	9	0	0
Other mushrooms	12	46	0	0

[*] Species recorded as edible mushrooms.

rhabdomyolysis, and acute renal failure, and these species have drawn the most attention and been regarded as the most dangerous mushrooms.[†]

As displayed in Table 1, about 30 species causing gastroenteritis were identified. *Chlorophyllum molybdites* is the most common poisonous mushroom followed by *Russula japonica*, *Russula* cf. *japonica*, and *Entoloma omiense*. This study also confirmed that several recorded poisonous mushrooms were involved in poisoning incidents including *Entoloma quadratum*, *E. strictius*, *Lactarius atrobrunneus*, *L. torminosus*, *Lactifluus vellereus*, *Megacollybia clitocyboidea*, and *Suillus pictus*.

The 18 species from 8 genera causing psycho-neurological disorder were also identified (Table 1). *Amanita concentrica*, *Gymnopilus lepidotus*, *Inocybe serotina*, *I. squarrosolutea* and *P. thaiaerugineomaculans* were confirmed involving in poisoning incidents in China. *Inocybe serotina* and *P. thaiaerugineomaculans* were the first time recorded in China (*7*). *Cordierites frondosus* appeared from Yunnan and Guizhou provinces resulted in 2 incidents with photosensitive dermatitis.

The 8 species resulting in 11 incidents had been still not clear about their clinical classification (Table 1). *Amanita clarisquamosa* and *A. fritillaria* were previously recorded as poisonous mushrooms although their clinical classification remains poorly understood (*1*). Moreover, toxicity of *Amanita citrinoannulata* and *A. hamadae* had been not recorded (*1*,*8*–*9*). *Lepista sordida* and *Macrocybe gigantea* were deemed as edible mushrooms, but two people ate these two mushrooms and then exhibited gastrointestinal symptoms, which indicated that some edible mushrooms are toxic to some humans in certain circumstances (*1*). *Tolypocladium dujiaolongae*, a new species seen in China, was used as medicine (*10*), and nine patients from three independent incidents after eating this species showed gastrointestinal and psycho-neurological disorder symptoms. In one incident from Yunnan, left-over mushroom samples were identified as *Scleroderma yunnanense*, which is edible and often consumed in large quantities by local residents. This may possibly be due to a mixture of *Scleroderma* mushrooms being sold in the market and real poisonous mushroom samples not being obtained.

Discussion

Mushroom poisoning is becoming one of the most serious food safety issues in China. Mushroom poisonings are reported every month and concentrated from summer to autumn peaking in July. Southwestern and Central China are the most seriously affected areas, followed by Eastern and Southern China with noticeably lower levels in Northern, Northeastern and Northwestern China. Notably, Zhejiang in Eastern China has been viewed as the region with the fastest growing threat. About 70 species, including 7 newly recorded species causing 6 different clinical syndromes, were successfully confirmed. This study accumulated first-hand information of mushroom poisoning, which is considerably valuable for mushroom poisoning control, diagnosis, and treatments for patients and for popular science education for thousands of people who are potentially threatened by poisonous mushrooms.

Most mushroom poisoning incidents have favorable outcomes, only presenting with gastrointestinal or psycho-neurological disorder complaints and needing symptomatic treatments. Almost all deaths were caused by lethal mushrooms companied by acute liver failure and rhabdomyolysis (*6*). Lethal mushroom species causing acute liver failure were mainly concentrated in the genera of *Amanita*, *Galerina*, and *Lepiota* (*1*,*6*). The 12 species from *Amanita* section *Phaloideae* were discovered in China (*1*,*8*–*9*), and 6 recorded species and 1 species currently identified as *A.* cf. *fuliginea* were involved in mushroom poisoning in 2019 (Table 1, Supplementary Table S1). The 14 poisonous *Galerina* species were recorded in China (*1*,*11*), and the most common species was *G. sulciceps* which caused 4 incidents in 2019 (Table 1, Supplementary Table S1). Eight poisonous *Lepiota* species were recorded in China (*1*,*12*–*13*), and the most common species was *L. brunneoincarnata* (Table 1, Supplementary Table S1). *Russla subnigricans* and *Tricholoma equestre* could cause rhabdomyolysis, and the former species is the most common resulting in at least 50 deaths in the last 2 decades in China (*6*,*14*).

Accurate and timely species identification is of pivotal importance in mushroom incidents. Unfortunately, previous studies suggested that the rate of correct species identification in mushroom incidents was considerably low, between 5% and 27%, or even lower (*15*). Of the 212 reported incidents from 2010 to 2014 in China, the mushrooms were scientifically identified only in 2 incidents (*3*). In recent years, a large number of mycologists have begun participating

[†] Supplementary Table S1 (available in http://weekly.chinacdc.cn) summarized their spatial and temporal distribution.

in mushroom poisoning in China, which has greatly benefitted mushroom poisoning control. Beginning in 1996, a 24 hour/365 day on-call mycological service became available in northern Italy, which has helped with the identification of poisonous mushroom in 89.6% of incidents (*15*). A similar poisoning-counselling service (010-83132345) became available in China in 1999 and plays a crucial role in mushroom poisoning control.

In Europe, mushroom poisoning risk dramatically increased and was ascribed to recent mass immigrations to Europe (*2*). Likewise, thousands of foreigners come to China every year and the three mushroom poisoning incidents involving Burmese people in 2019 drew attention to the need for targeted science and health education for foreigners in addition to local residents.

The incidents investigated in this report only represent a portion of the variety of mushroom poisonings happening every year. More effort and continued cooperation are needed urgently from local and national governments, CDC staff, doctors, and mycologists to properly control mushroom poisoning events.

Acknowledgements

We gratefully acknowledge Profs. Zuohong Chen, Ping Zhang (Hunan Normal University); Drs. Xianghua Wang, Gang Wu, Hong Luo, Zaiwei Ge, Yanchun Li (Kunming Institute of Botany, Chinese Academy of Sciences); Profs. Taihui Li, Wangqiu Deng, Dr. Ming Zhang (Guangdong Institute of Microbiology); Prof. Tolgor Bau (Jilin Agricultural University); Prof. Junfeng Liang, Dr. Jie Song (Research Institute of Tropical Forestry, Chinese Academy of Forestry); Profs. Yucheng Dai, Baokai Cui, Shuanghui He (Beijing Forestry University, China); Dr. Chuanhua Li (Shanghai Academy of Agricultural Sciences); Profs. Haisheng Yuan, Yulian Wei (Institute of Applied Ecology, Chinese Academy of Sciences); Dr. Yuguang Fan (Hainan Medical University); Prof. Tiezhi Liu (Chifeng University); and Prof. Wenfei Lin (Zhejiang University) for species identification of poisonous mushrooms. Many people from CDC and hospitals are acknowledged for collecting specimens, and offering data on mushroom poisoning and clinical symptoms. Special thanks to Dr. Jing Si (Beijing Forestry University, China) for improving the manuscript. This study was supported by the National Science Foundation of China (No. 31501814). The study was approved by the National Institute of Occupational Health and Poison Control Ethics Committee, Chinese Center for Disease Control and Prevention (NIOHP201904).

[#] Corresponding author: Chengye Sun, suncy@chinacdc.cn.

[1] National Institute of Occupational Health and Poison Control, Chinese Center for Disease Control and Prevention, Beijing, China.

Submitted: December 27, 2019; Accepted: January 03, 2020

References

1. Wu F, Zhou LW, Yang ZL, Bau T, Li TH, Dai YC. Resource diversity of Chinese macrofungi: edible, medicinal and poisonous species. Fungal Divers 2019;98:1 – 76. http://dx.doi.org/10.1007/s13225-019-00432-7.
2. White J, Weinstein SA, de Haro L, Bédry R, Schaper A, Rumack BH, et al. Mushroom poisoning: a proposed new clinical classification. Toxicon 2019;157:53 – 65. http://dx.doi.org/10.1016/j.toxicon.2018.11.007.
3. Zhou J, Yuan Y, Lang N, Yin Y, Sun CY. Analysis of hazard in mushroom poisoning incidents in China mainland. Chin J Emerg Med 2016;25(6):724 – 8. http://dx.doi.org/10.3760/cma.j.issn.1671-0282.2016.06.008. (In Chinese).
4. Dadpour B, Tajoddini S, Rajabi M, Afshari R. Mushroom poisoning in the northeast of Iran; a retrospective 6-year epidemiologic study. Emergency 2017;5(1):e23. http://dx.doi.org/10.22037/emergency.v5i1.13607.
5. Diaz JH. Evolving global epidemiology, syndromic classification, general management, and prevention of unknown mushroom poisonings. Crit Care Med 2005;33(2):419 – 26. http://dx.doi.org/10.1097/01.CCM.0000153530.32162.B7.
6. Chen ZH, Yang ZL, Bau T, Li TH. Poisonous mushrooms: recognition and poisoning treatment. Beijing: Science Press. 2016. (In Chinese).
7. Guzmán G, Ramírez Guillén F, Hyde KD, Karunarathna SC. Psilocybe s.s. in Thailand: four new species and a review of previously recorded species. Mycotaxon 2012;119:65 – 81. http://dx.doi.org/10.5248/119.65.
8. Yang ZL. Atlas of the Chinese species of Amanitaceae. Beijing: Science Press. 2015. (In Chinese).
9. Cui YY, Cai Q, Tang LP, Liu JW, Yang ZL. The family Amanitaceae: molecular phylogeny, higher-rank taxonomy and the species in China. Fungal Divers 2018;91:5 – 230. http://dx.doi.org/10.1007/s13225-018-0405-9.
10. Li CR, Hywel-Jones N, Cao YP, Nam S, Li ZZ. Tolypocladium dujiaolongae sp. nov. and its allies. Mycotaxon 2018;133(2):229 – 41. http://dx.doi.org/10.5248/133.229.
11. Bau T, Zhang H. Strophariaceae of China (VI): *Galerina*. J Fungal Res 2012; 10(2): 72 – 96. http://mall.cnki.net/onlineview/MagaView.aspx?fn=yjjw201202*1*. (In Chinese).
12. Yang ZL. Flora fungorum sinicorum. Vol. 52. Fungi lepiotoidei (Agaricaceae). Beijing: Science Press. 2019. (In Chinese).
13. Zhang YZ, Zhang KP, Zhang HS, Sun J, Yin Y, Li HJ, et al. *Lepiota subvenenata* (Agaricaceae, Basidiomycota), a new poisonous species from southwestern China. Phytotaxa 2019;400(5):265 – 72. http://dx.doi.org/10.11646/phytotaxa.400.5.2.
14. Li GJ. The taxonomy of *Russula* in China. Beijing: University of Chinese Academy of Science; 2013. http://www.wanfangdata.com.cn/details/detail.do?_type=degree&idY2746994. (In Chinese).
15. Cervellin G, Comelli I, Rastelli G, Sanchis-Gomar F, Negri F, de Luca C, et al. Epidemiology and clinics of mushroom poisoning in Northern Italy: a 21-year retrospective analysis. Hum Exp Toxicol 2018;37(7):697 – 703. http://dx.doi.org/10.1177/0960327117730882.

SUPPLEMENTARY TABLE S1. Spatial and temporal distribution of 13 lethal mushrooms causing poisoning incidents in China, 2019.

Mushroom species	Time of poisoning	Distribution（City, Province）	Remarks	References
Acute liver failure				
Amanita exitialis	March 3, 2019 March 7 , 2019 June 11, 2019 June 20, 2019 June 29, 2019 June 30, 2019 July 13, 2019 July 28, 2019	Shenzhen, Guangdong Shenzhen, Guangdong Dehong, Yunnan Dehong, Yunnan Baoshan, Yunnan Dehong, Yunnan Baoshan, Yunnan Chuxiong, Yunnan	*Amanita exitialis*, the most common lethal mushroom in Guangdong, is called the "Guangzhou Destroying Angel". It grows in broad-leaved forest, and often appears in Guangdong from March to May. Remarkably, it was first found in tropical Yunnan areas (Dehong, Baoshan, Puer, etc.) in June to July every year and usually grows in subtropical Yunnan areas (Chuxiong, Dali, etc.) in July to early August, occasionally even late to early October (Kunming). This species also caused an incident in Qiannan, Guizhou Province in early June 2017.	(*6*,*8*–*9*) and this study
Amanita fuliginea	June 10, 2019 June 11, 2019 June 22, 2019 July 18, 2019	Xiangtan, Hunan Chenzhou, Hunan Changde, Hunan Hangzhou, Zhejiang	*Amanita fuliginea*, one of the most common lethal species in central China, is called "East Asian Brown Death Cap". It is recognized as the most dangerous species in Hunan Province in June. The species, widely distributed in Eastern, Central, Southern, and Southwestern China (Anhui, Fujian, Guangdong, Hunan, Jiangxi, Sichuan, Yunnan, and Zhejiang, etc.), grows in broad-leaved or mixed forests with Fagaceae and Pinaceae and appears from late spring, summer to autumn.	(*6*,*8*–*9*) and this study
Amanita cf. *fuliginea*	June 26, 2019 June 28, 2019	Qiannan, Guizhou Qiannan, Guizhou	Morphologically, *Amanita* cf. *fuliginea* is similar to *A. fuliginea*, but this species has distinctly larger basidiomata and different microstructures. Phylogenetic analyses also confirm it is different from *A. fuliginea*. Further studies are needed for its accurate identification and thus it is temporarily named as "*A.* cf. *fuliginea*" in this study.	This study
Amanita pallidorosea	June 26, 2019 July 10, 2019 July 16, 2019 July 17, 2019	Qiannan, Guizhou Enshi, Hubei Bijie, Guizhou Zunyi, Guizhou	*Amanita pallidorosea* is a common lethal mushroom distributed in northeastern, eastern, northwestern, central and southwestern China (Anhui, Gansu, Guizhou, Henan, Hubei, Jilin, Liaoning, Shaanxi, Shandong, and Yunnan). It is called "Pale-Rose Death Cap" because of its pale red pileus. This species grows in broad-leaved or mixed forests with Fagaceae and Pinaceae and appears from late June to mid-September.	(*6*,*8*–*9*) and this study
Amanita rimosa	July 8, 2019 July 24, 2019	Qiannan, Guizhou Shaoxing, Zhejiang	*Amanita rimosa*, a common lethal mushroom distributed in eastern, central, southern, and southwestern China (Guangdong, Guizhou, Hainan, Hubei, Hunan, Jiangxi, and Zhejiang), is called "Splitting Death Cap". It is considered as one of the most dangerous species in Guizhou, Hunan, Hubei, and Zhejiang from June to July, where poisoning incidents caused by this species happened frequently. This species grows in broad-leaved or mixed forests with Fagaceae and Pinaceae and appears from mid-May to mid-September.	(*6*,*8*–*9*) and this study
Amanita subjunquillea	August 21, 2019	Zibo, Shandong	*Amanita subjunquillea*, the most widely distributed lethal amanita in China including Anhui, Beijing, Gansu, Guizhou, Hebei, Henan, Hubei, Inner Mongolia, Jilin, Liaoning, Shaanxi, Shandong, Shanxi, and Yunnan, is called "East Asian Death Cap". It grows in broad-leaved forests dominated by Fagaceae and appears from July to mid-September.	(*6*,*8*–*9*) and this study

TABLE S1. (continued)

Mushroom species	Time of poisoning	Distribution（City, Province）	Remarks	References
Amanita subpallidorosea	October 16, 2019	Zunyi, Guizhou	*Amanita subpallidorosea* is only discovered from Guizhou, Hubei, Hunan, and Taiwan in China. It grows in broad-leaved forests dominated by Fagaceae and appears from September to early November. This species has become the first mushroom killer in Guizhou Province from late autumn to early winter.	(*6*,*8*–*9*) and this study
	October 21, 2019	Zunyi, Guizhou		
	October 22, 2019	Zunyi, Guizhou		
	October 27, 2019	Zunyi, Guizhou		
	October 27, 2019	Zunyi, Guizhou		
	October 27, 2019	Zunyi, Guizhou		
	November 1, 2019	Zunyi, Guizhou		
Galerina sulciceps	October 5, 2019	Chengdu, Sichuan	*Galerina sulciceps* is the most common poisonous species from the genus *Galerina* in China. It is distributed in Central, Northern, and Southwestern China (Beijing, Guizhou, Hubei, Jiangxi, Sichuan, and Yunnan). This species grows on rotten wood or even on sawdust and appears from late June to early December.	(*6*, *11*) and this study
	November 19, 2019	Zunyi, Guizhou		
	November 21, 2019	Enshi, Hubei		
	December 6, 2019	Zunyi, Guizhou		
Lepiota brunneoincarnata	April 30, 2019	Zhuzhou, Hunan	*Lepiota brunneoincarnata* is the most common poisonous species from the genus *Lepiota* in China. It is widely distributed in Northeastern, Northern, Northwestern, Eastern, and Central China (Beijing, Gansu, Hebei, Hunan, Jiangsu, Jilin, Liaoning, Ningxia, Shandong, Shanghai, Shanxi, Xinjiang, and Zhejiang, etc.). Previously, this species is discovered only from temperate areas including Northeastern, Northern, and Northwestern China. Recent years, it also caused several poisoning incidents in subtropical areas, including several provinces of Eastern and Central China. Further studies are needed for its geographic expansion. *L. brunneoincarnata* grows in pine forest and appears from late April to early September.	(*6*,*12*) and this study
	July 2, 2019	Shanghai		
	July 2, 2019	Zhejiang		
	July 16, 2019	Suzhou, Jiangsu		
	August 30, 2019	Shanxi		
Rhabdomyolysis				
Russula subnigricans	July 14, 2019	Yongzhou, Hunan	*Russula subnigricans* is the most common poisonous mushroom leading to rhabdomyolysis in China. It is widely distributed in Northern, Eastern, Central, Southern, and Southwestern China (Chongqing, Fujian, Gansu, Guangdong, Guizhou, Hainan, Hunan, Jiangxi, Shandong, Taiwan, Yunnan, and Zhejiang, etc.). This species grows in broad-leaved or mixed forests with Fagaceae and Pinaceae and appears from June to September.	(*6*,*14*) and this study
	July 16, 2019	Changsha, Hunan		
	July 17, 2019	Yongzhou, Hunan		
	July 22, 2019	Yongzhou, Hunan		
	August 6, 2019	Zhejiang		
	August 12, 2019	Miluo, Hunan		
	August 13, 2019	Huzhou, Zhejiang		
	August 16, 2019	Wenzhou, Zhejiang		
	August 18, 2019	Changsha, Hunan		
	August 19, 2019	Chongqing		
	August 21, 2019	Baoshan, Yunnan		
	August 22, 2019	Changde, Hunan		
	August 23, 2019	Chongqing		
	August 28, 2019	Nanping, Fujian		
	September 1, 2019	Hangzhou, Zhejiang		
	September 6, 2019	Huzhou, Zhejiang		

TABLE S1. (continued)

Mushroom species	Time of poisoning	Distribution（City, Province）	Remarks	References
Acute renal failure				
Amanita neoovoidea	June 19, 2019	Dehong, Yunnan	*Amanita neoovoidea*, a common poisonous mushroom distributed in Eastern, Central, Southern, and Southwestern China (Anhui, Fujian, Guangdong, Guangxi, Hunan, Jiangxi, Sichuan, and Yunnan), is called “East Asian Egg Amidella ”. It is regarded as edible in Japan and some areas in Anhui Province, China. But in recent years, several poisoning incidents happened after eating this species and thus, it cannot be removed from poisonous mushroom list. This species grows in pine, broad-leaved, or mixed forests and appears from June to October.	(*6*,*8*–*9*) and this study
Amanita oberwinklerana	June 24, 2019	Guiyang, Guizhou	*Amanita oberwinklerana*, the most common poisonous mushroom causing acute renal failure in China, is called “Oberwinkler's Destroying Angel ”. It is distributed in Northeastern, Central, Eastern, Southern, and Southwestern China (Anhui, Guangdong, Guizhou, Hainan, Hubei, Hunan, Jiangsu, Jilin, Taiwan, Yunnan, and Zhejiang). This species grows in broad-leaved or mixed forests with Fagaceae and Pinaceae and appears from July to September.	(*6*,*8*–*9*) and this study
	June 30, 2019	Guiyang, Guizhou		
	July 1, 2019	Changde, Hunan		
	July 2, 2019	Changde, Hunan		
	July 8, 2019	Yichang, Hubei		
	July 9, 2019	Changde, Hunan		
	July 11, 2019	Changde, Hunan		
	July 19, 2019	Huzhou, Zhejiang		
Amanita pseudoporphyria	June 28, 2019	Changsha, Hunan	*Amanita pseudoporphyria*, the most widely distributed mushroom causing acute renal failure in China, is called “Hongo's False Death Cap ”. It is distributed in Northern, Central, Eastern, Southern, and Southwestern China from tropical, subtropical to temperate areas (Beijing, Fujian, Guangdong, Guangxi, Guizhou, Hainan, Henan, Hunan, Jiangsu, Jiangxi, Sichuan, and Yunnan). This species grows in scattered pine, broad-leaved, or mixed forests with Fagaceae and Pinaceae and appears from June to September.	(*6*,*8*–*9*) and this study