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Comparative study on bryophytes of Carlin gold mine and non-gold field area in Nipu, Guizhou

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Abstract: In this paper, the bryophytes both on Carlin gold mine and non-gold field area of Jiucailantan in Nipu Village of Pu'an County in Guizhou Province were reported for the first time. 15 species belonging to 8 genera of 3 families were found on the Carlin gold mine of Jiucailantan, and 20 species belonging to 15 genera of 9 families on non-gold field area in Nipu. Through comparison, the similarity coefficient of species level was 11.4% between the two sample sites in Nipu. It showed the distinct diversity on bryophytes of Carlin gold mine and non-gold field area. Among these bryophytes, 13 species of them (*Pohlia leucostoma*, *P. proligera*, *Trematodon longicollis*. etc.) only grew on Carlin gold mine, indicating that some bryophytes adapted to the substrate of Carlin gold mine, and there were some relations between bryophytes and Carlin gold mine distribution in Nipu area.

Key words: bryophytes; carlin gold mine; coefficient of similarity; Nipu gold field

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It was believed that there were high technology and big investment on prospecting Carlin gold mine (Liu, 2003). However, biological prospecting was attended as one of important ways to solve this difficulty. In recent years there has been renewed interest in the use of vegetation as a guide to mineralisation. Two main techniques were used in this method: the first of which was known as geobotanical prospecting, this procedure involves a visual examination of the plant cover to detect indicator plants or morphological changes typical of certain types of mineralisation (Cannon, 1960); another method is known as biogeochemical prospecting and it depends on chemical analysis of the vegetation in which reliance is placed on the accumulation of elements from the substrate to an extent proportional to the amount present (Brooks, 1971). However, bryophytes is the most effective in accumulating elements (Wu *et al.*, 2005). Persson (1948) has reported on the use of *Mielichhoferia mielichhoferi* (Hook.) Wijk. Et Marg. in prospecting for copper. And "copper mosses" was used widely in prospecting in many countries (Brooks & Yates, 1972). Samecka-Cymerman prospected gold deposites using aquatic bryophytes (Samecka-Cymerman & Kempers, 1998). And it was found that there are plentiful bryophytes on Carlin gold deposit from our research. So the study is feasible to use bryophyte to prospect Carlin gold deposit.

Moreover, geobotanical prospecting and geobotanical prospecting using bryophytes should be based on well knowing the situation about the bryophytes. So it is necessary to compare the bryophytes between the Carlin gold mine and non-gold field area. The Carlin gold mine of Nipu is the most important part of

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"Golden Triangle" of Yunnan, Guizhou and Guangxi (Hu *et al.*, 2004). Nobody had reported the bryophytes on Nipu of Guizhou before. Therefore, research on the bryophytes of Nipu will be hope to open the door of studying the relation between bryophytes and Carlin gold mine distribution.

1 Methods

1.1 Field works

Nipu in Xingyi Bu-yi Autonomous Prefecture in southwestern Guizhou of China is situated between 104°51′～105°9′ E, 25°18′～26°10′ N, belongs to south subtropical with an average annual temperature of 15.4 ℃ and annual precipitation about 1 500 mm (Zhou, 1996; Wei *et al.*, 2004). Two sorts of sampling plot (Carlin gold deposit and non-gold field area) were selected in this study. The sampling plot of Carlin gold deposit of Jiucailantan (sampling site 1) was stopped exploiting three years ago. The area is about 400 m^2. There weren't trees but some mosses and few ferns on the mine, and the plants were only found in humid plot. The sampling plot of non-gold field area included two sampling sites (sampling site 2 and sampling site 3). Sampling site 2 was the stone which was covered with thin soil on the gold mine or near the gold mine, which is about 30 m^2. There were some mosses, some grass and few bush among the stones. Sampling site 3 was the surface of the coal mine of Datianyakou. The area is about 1 200 m^2. There weren't trees and bushes, but some ferns, grass and some mosses. And the distance is about 1 000 m far from sampling site 3 to sampling site 1 and 2. Sampling site 1, 2 and 3 were in the same mountain, and have similar ecological environment. 62 specimens of bryophytes were collected from Nipu on February 8, 2005. The situations of the sampling sites were shown as table 1.

1.2 Laboratory works

The specimens of bryophytes were analysed and identified with light microscope (XSZ-107TS), anatomical microscope (HWG-1) and classifyed with reference books in the laboratory in School of Geography and Biology of Guizhou Normal University.

1.3 Similar index

Coefficient of similarity is useful for understanding fully the relation between the species and the environment by comparing the plants in different sampling sites (Dombois & Ellenberg 1986). This expression of coefficient of similarity below was used to analysed the bryophytes (Wang *et al.*, 1995; Zhang *et al.*, 2002).

Table 1 The situation of the sample plot

Sampling plot	Entironment of sampling sites	Altitude(m)	specimens
Carlin gold deposit (sampling site 1).	It was stoped exploiting three years ago. There were some ferns and mosses on the humid plot, but no trees.	1 500	29
Non-gold field area (sampling site 2 and sampling site 3).	Sampling site 2 was the stone which was covered with thin soil on the gold mine or near the gold mine. There were some mosses, some grass and few bush.	1 500	15
	Sampling site 3 was the surface of the coal mine of Datianyakou. There were some mosses and some grasses.	1 500	18

$$S_x = 100\% \times \frac{2c}{A+B}$$

A: All the species of carlin gold deposit. B: All the species of non-gold field area. c: The common species in three sampling sites.

2 Results

2.1 The bryophytes on Carlin gold mine

The ecological environment was destroyed seriously in Carlin gold mine, where there were no trees and bushes. Bryophytes cann't be found on the drouthy area, but humid plot, and the life forms of bryophytes were all short turfs. In our preliminary study, 29 specimens of bryophytes were collected from the Carlin gold mine, 15 species in 8 genera, 3 families were reported (Table 2), and *Pohlia* in Bryaceae is the dominant genera.

2.2 The bryophytes in non-gold field area

The ecological environment was also destroyed seriously. There was only few bush , grass and some bryophytes on non-gold field area, and the life form was only short turfs. 20 species belonging to 15 genera of 9 families, including *Cephalozia lacinulata* (Jack.)

Spr. ,*Weisiopsis plicata* (Mitt.) Broth. ,*Plagiothecium denticulatum* (Hedw.) B. S. G. and so on, were found on non-gold field area(Table 3). And there isn't obvious dominant genera in non-gold field area.

Table 2 The list of the bryophytes on Carlin gold mine

Family name	Genus name	Species name
Dicranaceae	*Trematodon*	*T. longicollis* Michx.
Pottiaceae	*Didymodon*	*D. rufidulus*(C. Muell.) Broth.
	Hyophila	*H. spathulata*(Harv.)
Bryaceae	*Pohlia*	*P. drummondii*(C. Muell.) Andr.
		P. gedeana(Bosch. et Lac.) Gang.
		P. nutans(Hedw.) Lindb.
		P. proligera(Kindb.) Lindb.
		P. leucostoma (Bosch. et Lac.) Fleisch.
		P. nutans(Hedw.) Lindb.
	Brachymenium	*B. exile*(Doz. et. Molk.) Bosch et Lac.
		B. pendulum Meut.
	Anomobryum	*A. gemmigerum* Broth.
	Plagiobryum	*P. zierii*(Hedw.) Lindb.
	Bryum	*B. pallescens* Schleich.
		B. yuennanense Broth.

2.3 The comparison between Carlin gold mine and non-gold field area

The result was shown as Fig1. Two species of bryophytes, *Pohlia drummondii* (C. Muell.) Andr. and *Brachymenium exil* (Doz. et. Molk.) Bosch et Lac. were found on Carlin gold mine and non-gold field area 18 species of bryophytes grew on non-gold field area. There were 13 species of bryophytes on Carlin gold deposit.

By the formula , the coefficient of similarity of species level was 11.4% of bryophytes of three sampling sites(1, 2 and 3). Moreover, the coefficient of similarity was 34.8% at genus level and 50% at families level, respectively.

3 Conclusion

By the investigation, there are 2 common species of bryophytes both on Carlin gold mine and non-gold field area, *Pohlia drummondii* (C. Muell.) Andr. and *Brachymenium exile*(Doz. et. Molk.) Bosch et Lac. There are 18 species of specific bryophytes in non-gold field area, and 13 species of specific bryophytes in carlin gold mine. The similar index are 6.06%, 21.05%, 33.33% respectively in species, genera, families level of bryophytes between Carlin gold mine and non-gold field area in Nipu. It was shown that the diversity is very distinct in the two sorts of plots. The dissimilar bryophytes selected different substrates. It was obvious that the distributions of some bryophytes have

Table 3 The list of the bryophytes on non-gold field area

Family name	Genus name	Species name
Jungermanniaceae	*Jungermannia*	*J. atrovirens* Dum.
	Cephalozia	*C. lacinulata*(Jack.) Spr.
Cephaloziaceae	*Ditrichum*	*D. pallidum*(Hedw.) Hamp.
Ditrichaceae		*D. tortuloides* Grout.
	Dicranella	*D. heteromalla*(Hedw.) Schimp.
		D. grevilleana(Brid.) Schimp.
	Campylopu	*C. atrovirens* DeNot. var. *cucullatifolius* J.-P. Frahm
		C. fragilis (Brid.) B. S. G. ssp. *zollingerianu*
		s(C. Muell.) J.-P. Frahm
	Dicranodontium	*D. attenuatum*(Mitt.) Wils.
		D. decipiens(Mitt.) Mitt.
	Barbula	*B. arcuata* Griff.
Pottiaceae	*Hyophila*	*H. propagulifera* Broth.
	Weisiopsis	*W. plicata*(Mitt.) Broth.
	Pohlia	*P. drummondii* (C. Muell.) Andr.
Bryaceae	*Brachymenium*	*B. exile*(Doz. et. Molk.) Bosch et Lac.
	Bryum	*B. capillare* Hedw.
	Brachythecium	*B. glaciale* B. S. G.
Brachytheciaceae	*Plagiothecium*	*P. denticulatum*(Hedw.) B. S. G.
Plagiotheciaceae	*Brotherella*	*B. integrifolia* Broth.
Sematophyllaceae Hypnaceae	*Isopterygium*	*I. bancanum*(Lac.) Jaeg.

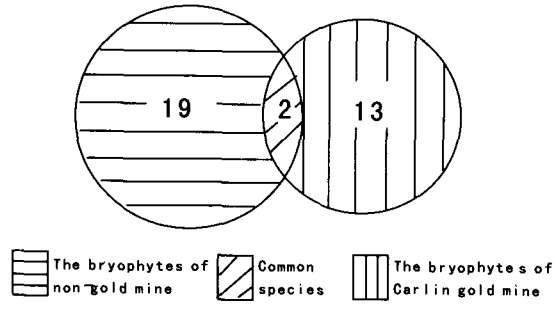

Fig. 1 The comparison between Carlin gold mine and non-gold field area

some relation with the substrates. Base on this theory, people found the "copper mosses" which had mainly members of the genera *Merceya* and *Mielichhoferia* (Brooks, 1971), and Persson (1948) reported on the use of *M. mielichhoferi* (Hook.) Wijk et Marg. in prospecting for copper(Brooks & Yates, 1972). So we thought that it was possible to find the bioindication of mosses of Carlin gold. We can find less report with the bryophytes on Carlin gold mine and nobody found the "gold mosses". The study of bryophytes(*Trematodon longicollis*, *Didymodon rufidulus*, *Hyophila spathulata*, *Pohlia drummondii* and so on) on Carlin gold mine can provide some clues for researching the relation between bryophytes and Carlin gold deposit.

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贵州泥堡卡林型金矿区与非金矿区苔藓植物比较研究

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摘 要：首次报道了贵州普安县泥堡村韭菜烂滩的卡林型金矿区和非金矿区的苔藓。记录了泥堡韭菜烂滩卡林型金矿生苔藓3科8属15种，非金矿生苔藓9科15属20种。通过比较我们得到韭菜烂滩卡林型金矿区和泥堡非金矿区苔藓的相似性系数为11.4%。这表明这两个生境下的苔藓组成差异极大。在这个地区有13种苔藓植物(包括异芽丝瓜藓 *Pohlia leucostoma*、卵蒴丝瓜藓 *P. proligera*、长蒴藓 *Trematodon longicollis* 等)只生长在卡林型金矿上，这表明有一些苔藓植物适应卡林型金矿这种基质。也许，在泥堡地区某些苔藓植物的分布与卡林型金矿存在一定的关系。

关键词：苔藓植物；卡林型金矿；相似性系数；泥堡金矿