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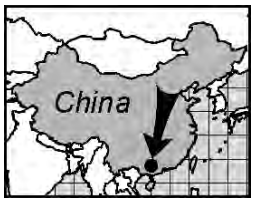
Environmental Reconstruction of Karst using a *Honeysuckle* species widely used in Traditional Chinese Medicine.

Case Study: Lower Donggangling Formation in Mashan County, Guangxi Province, Southwestern China.



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Abstract

As in the deserts of Northwestern China, there is a need to reconstruct the fragile karst of Southwestern China using sustainable techniques that protect the environment and develop the economy. One means of achieving this is to plant species used in traditional Chinese herbal medicine. The characteristics of Honeysuckle used in traditional Chinese medicine, when produced on the Donggangling Formation at Nongla Village in Mashan County, in Guangxi Province of Southwestern China, match those of Honeysuckle grown in traditional production areas of China, and comply with the specification set for the Honeysuckle by the P.R. China Codex. Added properties of the Honeysuckle are the accumulation of phosphorus and potassium, in addition to the accumulation of elements such as calcium, magnesium, copper, zinc and so on. Further discussion considers extending the areas in which this Honeysuckle is currently grown, and its limitations in the karst region of Southwestern China where 60% - 70% of calcareous soil may be suitable for its cultivation.

Keywords: karst, environmental reconstruction, Honeysuckle used in traditional Chinese medicine, Donggangling Formation.

Introduction:

The karst of Southwestern China is as fragile as the desert of Northwestern China, where rocky desertification in karst and desertification in desert comprise the two main environmental problems. The restoration and reconstruction of the karst environment has become one of the most important aims of the people who live and work there. If the protection and conservation of karst can be linked to the economy and to the improvement of living standards, then local people have an excellent incentive to preserve their natural environment. To be successful, it is important to select plant species that will provide both ecological and economic advantages.

For mountainous karst peak-depression areas which are deficient in both water and soil, it is important to select species with above-ground stems and leaves which will protect the limited soil resources. At present, there are a number of species of *Honeysuckle* (*Lonicera spp.*) which are being planted to protect karst environments. However, the question of which species of *Honeysuckle* is appropriate for each particular area is a problem which has been long neglected. One species of *Honeysuckle* as a component of understory has been used successfully to restore the environment which is in secondary forest stage now at Nongla Village, Mashan County, Guangxi Province, Southwestern China. This area has typical karst peak-depression landforms shaped by combined limestone and dolostone of the Lower Donggangling Formation (DGLF) of the Middle Devonian. Growing in the fissure soils among carbonate rock blocks, *Honeysuckle*'s vines stretch 5–6 metres long and cover up to 3–4 metres wide (Figure 1). In May, *Honeysuckle* flowers are picked but its other parts, especially roots, are not used, which keeps the soils undisturbed.

Figure 1: *Honeysuckle* growing in the fissure soil and covering the carbonate surface

Table 1: Characteristics of Honeysuckle from TPA

Traditional production area	Shandong, Henan Provinces
Ingredients of flower	
Chlorogenic acid in buds	≥2.2–2.46% (>1.5 % in the Codex)
Total flavonoids	2.14% (Not in untraditional production area)
Elements	High Ca, low Cr and Pb, accumulation of Zn and Cu
Ecological environment	
Climate	Semiarid
Precipitation	≤1000 mm
Sunshine time and temperature	2400–2600 hours and10-15 ºC
Soil	
texture	Sandy loam
pH	7–8.5
Salinity saturation	>85%
CEC	>10 me/100g
Elements	High K, Na, Ca and Mg
DNA fingerprint	Genetic distance 1.2% among traditional species

The aim of this paper is to discuss why *Honeysuckle* can be successfully used in the reconstruction of the karst environment.

Materials and Methods

The characteristics of *Honeysuckle* used in traditional Chinese medicine are summarized from published references in Table 1 (Shi, J.Y. et al., 2001; Li, P. et al. 2001; Tian, J et al. 2002, Zhang, Z.Y. et al. 2003; Liu, Y.E. et al. 2003, Zhang, Z.Y. et al. 2003). The *Honeysuckle* species traditionally recognized for their role in Chinese medicine are *Lonicera japonica* Thunb. mainly distributive in Northern China, *Lonicera confusa* D.C. mainly in Southern China, *Lonicera dasystyla* Rehd. and *Lonicera hypoglauca* Mig. all over China. They are grown in traditional production areas (TPA) and have been shown to be effective in medicine, as recognized by P.R. China Codex (P.R. China National Pharmacopoeia Committee, 2000) TPA are found in Shandong Province and Henan Province of Northern China. Fenqiu County of Henan province has already been awarded the Certificate of Origin by General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China.

The composition of flowers of *Honeysuckle* grown at Nongla Village was compared to that of flowers from TPA (Table 3).

At the Centre for Analysis in the Henan College of Chinese Medicine, chlorogenic acid in the flowers of *Honeysuckle* was tested with LC-10AD and SPD-10A. It is an effective ingredient for resisting pathogenic microorganisms, enhancing immunity, diminishing inflammation, detoxification and stopping bleeding and so might become a hopeful pioneering compound against HIV virus. So, *Honeysuckle* flowers as a form of traditional Chinese medicine played a significant role in fighting SARS in the Spring of 2003.

The elements of *Honeysuckle* flowers and their soil at Nongla village, including Ca, Mg, P, K, Na, S, Si, Fe, Mn, Cu, Zn, Ba, Co, Sr, Ni, Li, Ti, Ge, REE, Cd, As, Cr, Pb, Hg, were respectively analyzed by the National Laboratory of Environmental Geochemistry of Institute of Geochemistry of Chinese Academy of Sciences and the National Research Centre of Geo-analysis of Chinese Academy of Geological Sciences.

Results

Comparison of environments

Nongla Village has a humid monsoon climate with annual precipitation of 1,246–2,063mm, averaging 1,667 mm. After the end of September each year, there is a pronounced dry season, and because karst reduces retention of surface water, the effective rainfall can be in the vicinity of 1,000 mm per annum or less. The area receives 1,600–2,000 hours of sunshine per year, and has an average annual temperature of 21.3ºC, the figures of which are lower and higher respectively than those of TPA (see Table 1). The properties of DGLF soil basically meet the requirements for cultivation of *Honeysuckle* (Table1), except for the lower level of potassium in DGLF soil than in the soil of TPA (Zhang, Z.Y. et al. 2003). Thus DGLF soil is suitable for planting *Honeysuckle,* but growth may be limited on the northern slopes of peaks where temperatures are lower than elsewhere.

Selection of *Honeysuckle* species

The *Honeysuckle* planted at Nongla Village is *Lonicera hypoglauca* according to the listing in the P.R.

Table 2: Comparison of the Honeysuckle soils of the DGLF and TPA (ppm)

Elements	Ca	Mg	P	K	Cu	Zn	Fe	Mn	Pb	Co	Al
DGLF	5257	18230	577	8270	24.9	138	67352	1383	56.9	23.9	134471
Traditional	27405	9380	733	18200	25.6	69.8	33950	405.7	13.0	10.3	69647

Table 3: Analysis of flowers of *Lonicera hypoglauca* growing in DGLF Soil and its comparison to TPA's (ppm)

Elements	Ca	Mg	P	K	Cu	Zn	Fe	Mn	Pb	Cr	Sr	Ni	Ti	Co	Ba
DGLF	4600	2930	2610	20700	19.2	26.5	277	42.3	0.44	0.66	5.1	1.4	26	4.9	5.4
Traditional	3733	2603	3446	22520	14.5	18.8	351	37.6	0.29	0.85	23.6	3.9	5.4	0.21	15

China Codex. It has a high content of chlorogenic acid (1.9%) in the flower, determined from the analysis of samples that included about one third flower buds. More than 30 elements were tested (Table 3) with the results matching those obtained for *Honeysuckle* grown in TPA (Zhang, Z.Y. et al. 2003).

Discussion

Suitability of *Honeysuckle* for cultivation on karst peak-depressions at Nongla Village

As indicated previously, the DGLF soil is suitable for the cultivation of *Honeysuckle*. We were informed by local people that *Honeysuckle* grown on the southern slopes of peaks where radiation is higher and hours of sunlight longer than on northern slopes, is likely to die several years after planting, and thus often needs to be replanted. This appears to indicate a relationship between temperature and the growth of *Honeysuckle*. However, availability of moisture and temperature are usually related. High temperatures increase both evaporation from the soil and the rate of water loss through transpiration from plants leaves. Although *Honeysuckle* can cope with a certain level of aridity, it is likely that the plants are stressed by the combination of high temperatures and associated increase in evaporation of moisture from the soil.

Limitations to the extension of the area planted with *Honeysuckle*

Extension of the area in which *Honeysuckle* can be planted is evidently controlled by the combination of the availability of water (effective precipitation), temperature range and soil characteristics. For the karst region of Guangxi Province in the southern subtropical to tropical zones, temperature will be a more limiting factor than soil. In Guizhou Province in the subtropical zone and along the Upper Yangtze River, soil and water are the dual factors affecting the production of *Honeysuckle.* The soils most suited to production of *Honeysuckle* in Guizhou Province are yellow and black calcareous soils of about 255×10^4 km^2, in Guangxi Province brown calcareous soils of about 79×10^4 km^2 and in Yunnan Province red and black calcareous soils of about 76×10^4 km^2, accounting for 65.4%, 61.8% and 69.7% of the area of calcareous soils respectively.

Suitability of *Honeysuckle* for cultivation in karst regions of southwestern China.

Levels of K and P are very high, up to 2.07% and 0.261% respectively**,** in the flowers of *Lonicera hypoglauca* indicating that *L. hypoglauca* may accumulate P and K elements, with high absorption coefficients of 4.5 and 308 for total and available P, and 2.5 and 30 for total and available K (Table 4). When managing *Honeysuckle*, local people of Nongla village generally don't apply fertilizer, but usually gather its fallen leaves and withered branches and then use them to cover the ground around the *Honeysuckle*. So, maybe it is the return of P and K from *L. hypoglauca* litter to the soil

Table 4: Absorption coefficients of elements in the flowers of *Lonicera hypoglauca* growing in DGLF soils.

P	K	N*	Mg	Ca	As	Cu	Fe	S
4.5*(308)	2.5*(30)	5.4(81)	0.16(43)	0.88(31)	0.01(22)	0.35(19)	0.004(17)	(15)

Zn	Cd	Si	Co	Na	Mn	Sr	Hg	Ge	Ba	Ni	Pb	Cr
0.09(7.6)	0.07 (3.3)	(1.8)	0.16	0.16	0.03(0.13)	0.12	0.10	0.08	0.03	0.01	0.01	0.01

The numbers in round brackets show the available forms of elements in soil.
*Data from Li Wei, Zhang Cheng and Li Enxiang

that can compensate the P and K removed by harvesting the flowers and needed in next growing season. In the topsoils where *Honeysuckle* had been planted, available P and K increased from the background of 7.05 μg/g, 47.1 μg/g, to 8.28 μg/g and 137.2 μg/g respectively. In other places near to the north of Nongla village, some persons ever fertilized the *Honeysuckle* to raise the production. It resulted in yield improvement within 1–2 years as they had wished, but subsequent death of the plant. This shows that *Honeysuckle* can grow well with its strong accumulation of P and K in karst deficient of P and K. Thus the accumulation of P and K by *Honeysuckle* could be listed as one of the benefits of the cultivation of *Honeysuckle.* This point is significant. It is well known that karst regions lack macro-elements, such as P and K, especially in their available forms and this may be one of the major causes impacting the successful reconstruction of karst ecosystems. Because of 54×10^4 km^2 karst in Southwestern China, where most people are still very poor, fertilizing the soils is unrealistic and not economically permitted. It is suggested that the identification, cloning and transfer of genes controlling the uptake of P and K into other plant species which have been growing slowly on karst and can conserve soil and water, could well accelerate the restoration of karst ecosystems in southwestern China.

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