



Conservation status of *Maianthemum* species in the Hengduan Mountains: A case study analyzing the impact of new policies on wild collected plant species

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Research

Abstract

Maianthemum G. Weber ex Wigg. (Liliaceae) is a popular wild vegetable in Southwest P.R. China, the consumption and trade of which has recently been stimulated by local government policies and increasing tourism. We interviewed 68 stakeholders in Northwest Yunnan to document uses, harvest methods and amounts, and locally perceived conservation status of the species. Mainly *M. atropurpureum* (Franch.) LaFrankie, an endemic of the region, is consumed and collected for trade. Harvest methods and amounts differ significantly between different regions. Major regional markets in Northwest Yunnan are supplied with plants collected around Fugong, Nujiang Prefecture, where the intensive harvest is facilitated by trucks. In Zhongdian, Diqing Prefecture, all harvest is transported by men and sold locally. Only collectors in the latter area perceive a decrease of population sizes in recent years. In that area *Maianthemum* is decreasing due to several factors, such as relative scarcity of the species, habitat destruction, harvest methods, and increasing demand by tourists. Thus, local harvest strategies, which allow a sustainable use of the populations, need to be developed.

Introduction

Policies concerning natural resources in P.R. China

Gathering of wild plants plays an important role for subsistence and primary health care of millions of people, especially in developing countries (e.g., Hamilton 2003). With a growing number of people, changing human needs, and the development of commercial trade the demand for a wide variety of species is increasing, with the effect that some wild species are overexploited (e.g., Kala 2000, 2005).

In P.R. China, the over exploitation of natural resources such as timber, but also the selective collection of certain wild species for food or medicine recently caused severe environmental problems such as soil erosion and flooding. This resulted in the implementation of several new policies by the central government. For example, the collection of **facai** (*Nostoc flagelliforme* Berk. & Curt.), which caused serious erosion problems in north and northwest P.R. China, has been completely banned (But *et al.* 2002). In order to stop erosion and subsequent flooding a logging ban has been implemented in the upper reaches of the Yangtze and the Yellow river. This policy is part of the comprehensive “Western Development Program” (**xibu da kaifa**), which aims a sustainable development of the poor western mountain regions. A central part of this program, however, is the economic development of the west. In this context, diverse regional policies have been developed to support the local economy, which might also affect the collection of wild plant species. For example, officials in Northwest Yunnan have promoted the consumption of *Maianthemum* species since 1998 as a healthy

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vegetable as well as its distribution to markets all over the country (government officials, personal communication). As a consequence, and with the increase of tourism, *Maianthemum* became one of the most favored vegetable dishes in the area. In the same time, the infrastructure has been improved and additional roads entering remote areas have been built, allowing more efficient and broad collection of the species. We assume, that this massive increase of the *Maianthemum* collection results in a rapid depletion of local populations. The present study therefore aims to estimate the impact of the new policies on *Maianthemum* species as perceived by local people in Northwest Yunnan. Interviews conducted with various stakeholders and participant observation were used to (1) document the collection, utilization, and trade of *Maianthemum* species, and (2) determine the impact of the changing economic conditions and the trade promotion on the harvest of the species.

***Maianthemum* species and their uses**

The Hengduan Mountains at the Himalayan foothills of Southwest P.R. China are one of the biodiversity hot spots of the earth, characterized by a huge number of vascular plants (Wang *et al.* 1995). *Maianthemum* G. Weber ex Wigg. (Liliaceae) has its center of diversity in the Hengduan Mountains, which harbor twelve of approximately 35 species, nine of which are endemic (Li 1990).

Maianthemum species occur in temperate areas of the northern hemisphere, mainly in North America and East Asia, and form rhizomatous, perennial herbs (Flora of China 1994 to present). At least one third of the species are locally used as wild collected food (fruits, leaves and young shoots) and medicine. *Maianthemum canadense* (Desf.) Farw., *M. dilatatum* (Alph.Wood) A.Nelson & J.F.Macbr., *M. racemosum* (L.) Link, and *M. stellatum* (L.) Link are used in North America as wild vegetables and to treat various complaints (Moerman 1998); *M. japonicum* (A. Gray) LaFrankie is known from Japan and Korea, where it is consumed as a vegetable (Kunkel 1984).

In P.R. China, *Maianthemum* species (**zhuyecai**; lit. bamboo-leaf vegetable) were used as medicine since ancient times (Wu 1991). For example, *Maianthemum japonicum* and *M. henryi* (Baker) LaFrankie are used by herbalists all over P.R. China to treat kidney diseases, activate blood circulation and alleviate pain (Wu 1991). *Maianthemum* species are also consumed as a healthy vegetable mainly in Yunnan Province, Southwest P.R. China. The plants are known to contain high amounts of minerals and essential amino-acids, and a variety of steroidal saponins and nucleosides, which may possess anti-cancer activities (Gui *et al.* 2000a, 2000b, Liu *et al.* 2003, Yang & Liu 2003, Zhang *et al.* 2002).

In Northwest Yunnan so far six species, *Maianthemum atropurpureum* (Franch.) LaFrankie, *M. fuscum* (Wall.) LaFrankie, *M. henryi*, *M. oleraceum* (Baker) LaFrankie, *M. purpureum* (Wall.) LaFrankie, and *M. tatsienense* (Franch.) LaFrankie, have been recorded as wild vegetables consumed by Tibetan, Lisu, Nu and Naxi people (Dao *et al.* 2003, Pu & Yang 1998). Traditionally, they have been collected and consumed at household levels to meet family needs.

Study Area

Fieldwork for this study was conducted in two prefectures of Northwest Yunnan, Nujiang and Diqing, respectively (Figure 3). Nujiang Prefecture has an elevation of 750-5100 m and is located in the uttermost northwest of Yunnan, bordered by Tibet in the north and Myanmar in the west. Lisu are the dominating ethnic group, practicing mixed and swidden agriculture for subsistence (Huang *et al.* 2004). To represent the prefecture, three county capitals were chosen as field sites, i.e., Gongshan (98° 39' E; 27° 45' N; 1300 m) in the north, Fugong (98° 51' E; 26° 55' N; 1200 m) in the center, and Liuku (99° 51' E; 25° 51' N; 880 m) in the south of the prefecture. The southern regions are characterized by a sub-tropical climate,



Figure 1. *Maianthemum atropurpureum*.



Figure 2. *Maianthemum atropurpureum*.



Figure 1. Yunnan, P.R. China with locations of research sites in Nujiang and Diqing Prefectures.

while the northern parts are affected by the colder, moister climate of Southeast Tibet. The vegetation ranges from subtropical rainforest at the lowest altitudes, subtropical evergreen forest and pine forests, to alpine forest, and alpine meadow.

Diqing Prefecture borders Nujiang Prefecture in the east. The elevation ranges from 1500–6750 m and Tibetans and Lisu are the main ethnic groups. Beside mixed agriculture, animal husbandry plays a major role for subsistence. Two county capitals Zhongdian (99° 41' E; 27° 49' N; 3000 m) and Weixi (99° 16' E; 27° 11' N; 2300 m) were chosen as field sites. The former is mainly inhabited by Tibetans, the latter by Lisu people. The vegetation in the area ranges from subtropical shrub near the valley bottom

to pine mixed forest, alpine forest, and alpine meadows at high altitudes.

Methods

Field investigation was conducted in June 2004 and in May 2005. The field investigation consisted of interviews, participant observation and the collection of plant voucher specimens. A total of 68 informants, mainly collectors, vendors and restaurateurs, were interviewed in the five county capitals: Gongshan (12 collectors and collector's wives; 2 restaurateurs), Fugong (16 collectors and collector's wives; 2 restaurateurs; 2 retailers), Liuku (5 restaurateurs; 4 retailers; 1 wholesaler), Zhongdian (16 collec-

Table 1. *Maianthemum* species used and collected in different areas of Northwest Yunnan, P.R. China.

		Gongshan	Fugong	Liuku	Zhongdian	Weixi
Species	<i>M. atropurpureum</i>	X	X	X	X	X
	<i>M. forrestii</i>					X
	<i>M. henryi</i>					X
	<i>M. purpureum</i>	X*	X*	X		X
	<i>M. tatsienense</i>					X
Local names	Tuwa (Lisu)	X	X	X		
	Wobu (Tibetan)				X	
	Wuqijian (Lisu)					X
	Zhuyecai (Bai, Han)	X		X	X (Bai)	X (Han)
Main collection time: (April) May – June (July)		X	X	X	X	X
Length of collected shoots (cm)		10-20	10-20	10-20	30-45	10-15
Collection sites	Beluo Mountain	X	X			
	Gaoligong Mountains	X	X			
	Varous places around Weixi					X
	Xiao Zhongdian				X	
Habitat	Spruce and fir forest	X	X		X	X
	Rhododendron or bamboo shrub	X	X			
	Alpine meadow	X	X			
	Moist woodland				X	X
	Preferentially moist places	X	X			
Altitude (m)		2,800-3,400	2,800-3,400	-	3,600-3,800	n.d.
Resource abundance		Abundant	Abundant	-	Declining	Abundant
Collector gender (Male/Female)		M	M	-	M/F	M/F
Collector age (years)		19-50	20-48	-	18-50	19-45
Yield per day and person (kg)		20-30	10-45	-	7-10	2-10

* Mentioned by fewer than 3 informants.

tors; 1 restaurateur), and Weixi (7 collectors). They were found by snowball sampling in market areas. Data were collected through semi-structured interviews, with both male (26) and female informants (42), including extended open-ended interviews with three key informants in every study site. Interviews were carried out in Chinese. The interviewees were 18-65 years old with an average age of 34.

The semi-structured interviews covered the utilization of the species, harvest methods, trade mechanisms, and changes of resource availability during the last years. In Fugong a two-day collection trip was joined and the harvesting methods were documented.

The plant specimens were identified at the herbarium of the Kunming Institute of Botany, Chinese Academy of Sci-

ences (KUN), where they are also deposited. Nomenclature follows the Flora of China (1994 to present).

A t-test was conducted to determine significant differences of harvest amount and prices between different regions. Prices are given in China Yuan Renminbi (CNY). At the rate of exchange during field research one US Dollar equaled 8.8 CNY.

Results

Utilization of Maianthemum species

Table 1 shows the species used in the different areas and gives their local names. All species are prepared as vegetables. They are cooked in a soup, fried, or eaten raw as a salad. Interestingly, they are not used as medicine.

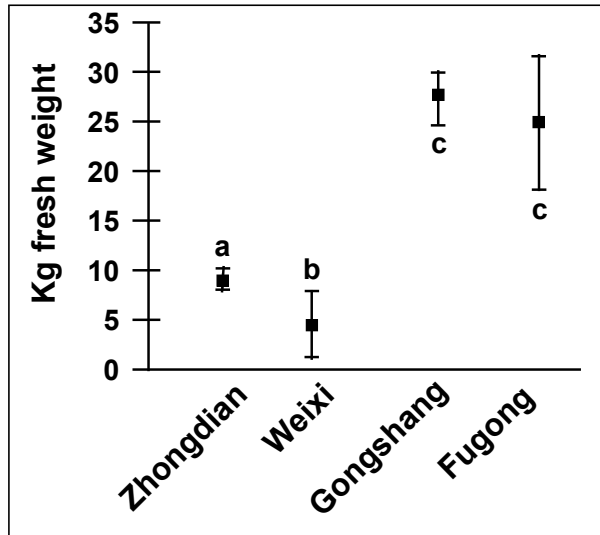


Figure 4. Average harvest amounts of *Maianthemum* species in different areas of Northwest Yunnan. Bars show standard deviation. Letters indicate significant differences ($p < 0.001$) in harvest amounts.

In Nujiang Prefecture the local people separate *Maianthemum atropurpureum* plants into three different morphotypes based on the color of the young shoots, i.e., green, purple-speckled, and purple. The green and the purple-speckled forms are preferentially consumed, since they are less bitter than the purple ones. The purple ones, however, are also collected.

Harvest of *Maianthemum* species

Main harvest season, collectors and harvest amount, collection sites, length of collected shoots, and assessment of resource abundance by the interviewees are given in Table 1. Harvest amounts differ significantly between the field sites of Nujiang and Diqing Prefecture ($p < 0.001$), but also between the two field sites within Diqing Prefecture, Zhongdian and Weixi, respectively ($p < 0.001$; Figure 4).

Collection sites are chosen according to their accessibility and abundance of species. The young, tender *Maianthemum* shoots are gathered by hand, collected in baskets and bundled at home. The bundles can be stored for a few days. In Nujiang Prefecture, only very young shoots are collected. As soon as the leaves start spreading, the shoots are not harvested anymore, since bitterness increases. Instead, younger shoots in habitats at higher altitudes are sought. In Diqing Prefecture, however, shoots with up to five developed leaves are collected. In Weixi, “small” and “big” *zhuyecai* are differentiated. “Small” *zhuyecai* includes young shoots of *M. forrestii* (W.W.Sm.) LaFrankie, *M. henryi*, *M. purpureum*, and *M. tatsienense*, which are collected in April and May, before the preferred “big” *zhuyecai*, *M. atropurpureum*, is available.



Figure 4. Lisu woman.

Trade with *Maianthemum* species

The large markets in Northwest Yunnan are mainly supplied via Liuku, with plant material collected around Fugong. Although *Maianthemum atropurpureum* also occurs around Liuku, it is not harvested in that area. Collectors in Fugong, who usually deliver their harvest by truck, sell it mainly to middlemen of retailers and wholesalers in Liuku. During the main season, they are able to collect an average harvest of 20-30 kg per day; wholesalers in Liuku sell around 1000 kg per day, retailers up to 500 kg. They supply the markets in Liuku and other towns in Northwest Yunnan, such as Dali and Baoshan, where up to ten tons per day are sold during the main season.

The collectors in Gongshan, who also deliver the harvest by truck, mainly sell it in the local market, more rarely to retailers and wholesalers. During peak seasons up to one ton per day can be sold locally, which is usually done by the wives or mothers of the collectors. Consumers are local people and restaurateurs. In Zhongdian and Weixi all



Figure 4. Market in Fugong.

harvest is carried by the collectors and sold in the local markets to restaurateurs and local people. Restaurateurs are generally able to sell 1-4 kg per day. Customers are local people, but mainly tourists in Zhongdian.

Average selling prices per kilogram during the main season differ significantly between collectors in Nujiang and Diqing Prefecture (1.5 (± 0.5) CNY and 5.5 (± 0.3) CNY, respectively; $p < 0.001$). Prices vary considerably during the season but have been generally stable over the last few years. During the main season, retailers in Liuku pay 1.7 (± 0.2) CNY per kilogram and sell it for 2.9 (± 0.3) CNY. In Fugong they pay 1.0 (± 0) CNY and sell it for 1.4 (± 0.3) CNY. The wholesaler interviewed in Liuku usually pays 1.0 CNY per kilogram and sells it for 2.4 CNY. At the beginning and end of the season, when the supply is getting scarce, prices increase substantially (up to 12 CNY per kg in Nujiang Prefecture and up to 16 CNY in Diqing Prefecture). A restaurateur gets an added value of 200-300%, i.e., during the main season one dish (prepared from 500 g) costs 4-5 CNY in Nujiang Prefecture and around 10 CNY in Zhongdian.

Discussion

Utilization and harvest of Maianthemum species

We documented five different species harvested and consumed in Northwest Yunnan, of which *M. forrestii* is recorded for the first time (cf. Dao *et al.* 2003, Pu & Yang 1998). But it is *M. atropurpureum*, an endemic of the Hengduan Mountains, and to a lesser extent *M. purpureum*, which are mainly harvested. Only in Weixi, additional species are traditionally collected for the market, i.e., *Maianthemum forrestii*, *M. henryi*, and *M. tatsienense*. The Tibetan people in Zhongdian exclusively collect *M. atropurpureum*, as they believe that the other species are not edible.

Harvested amounts per person and day are significantly higher in Nujiang Prefecture than in Diqing Prefecture. The collectors of the former area have access to habitats with abundant *Maianthemum* populations. Furthermore, the transportation of collectors and delivery of the harvest is carried out by trucks, which allows more efficient harvesting. Within Diqing Prefecture, the collectors in Zhongdian harvest significantly more per day than in Weixi. However, this might be an artifact. The data from Weixi were collected at the end of May, when *M. atropurpureum* was not fully developed yet. Thus harvest amounts may still increase during June.

In Nujiang Prefecture harvesting is exclusively done by men, while in Diqing Prefecture women and men collect *Maianthemum* for the local markets. This is probably due to the distance between the households of the collectors and the collection sites. In Zhongdian, people live close to

the habitats of the plants and there is no need for transportation by trucks.

Interestingly, all the interviewees in Zhongdian had the impression that the *Maianthemum* populations are becoming rare. This might have several reasons: First, *M. atropurpureum* has its main distribution between 1500 and 3000 m (Flora of China 1994 to present). Zhongdian thus lies at the upper distribution limit and populations might never have been as abundant as they are in Nujiang Prefecture at lower elevation. Additionally, fir forest sites, the main habitat of the species, were destroyed in recent years. Second, increasing tourism raised the demand for *Maianthemum* dishes and consequently its harvest. Third, collectors in Zhongdian not only collect the very young shoots but also larger shoots up to 45 cm with developed leaves. This intensifies harvest pressure on populations since the same population is harvested repeatedly within one season. All these factors might contribute to a decrease of population sizes in Zhongdian.

Although gathering is very intensive around Fugong, the resources there still seem to be abundant. Neither the retailers and wholesaler in Liuku nor the collectors in Fugong have the impression that the populations are decreasing. Beside the relative abundance of the populations, this might also be due to the harvest methods, which consider each population once per season and only include the very young shoots. This might allow sufficient re-growth of the plants.

Trade with Maianthemum species

The main trade routes range from Fugong via Liuku to the markets of other major towns of Northwest Yunnan. Thus, extensive harvest is mainly carried out in the Fugong area. In Zhongdian and Weixi, however, the species are collected and sold locally. In Gongshan both can be observed being locally sold and traded with middlemen. Although Gongshan has high *Maianthemum* resources, it is less accessible than Fugong, which makes the delivery of the harvest to regional markets more difficult and costly. Sometimes harvests may even rot.

The main collection season lasts from May to June with shoulder seasons in April and July. Prices in Diqing Prefecture are significantly higher than in Nujiang Prefecture, which can be explained with the relative abundance/scarcity of the species, market demands and tourism, which bulls the market.

Conclusions

Maianthemum atropurpureum, an endemic of the Hengduan Mountains, is a very popular wild collected food plant in Northwest Yunnan. As a consequence of a new policy in Northwest Yunnan, which promotes the consumption

Meng *et al.* - Conservation Status of *Maianthemum* species in the Hengduan Mountains 173

of *Maianthemum* species as a healthy vegetable as well as its distribution on markets all over the country, gathering of the species has increased. Harvest methods and amounts, however, differ significantly between different regions. In Nujiang Prefecture intensive harvest is carried out providing the supply of major regional markets. Trucks facilitate the transportation of the collectors and harvest delivery. In Diqing Prefecture, Zhongdian area, all harvest is transported by men and sold locally. However, it is only in Zhongdian where the collectors recognize a decrease of the *Maianthemum* populations, which might be due to regional harvest methods and a relative scarcity of the species. Thus, tourism and commercialization among other factors seem to pose a threat in this area. This raises the question, whether local harvest should be restricted in order to guarantee sustainable use of the populations. Studies on the population ecology are needed to estimate the exact impact of different harvest methods and to develop sustainable use strategies.

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