Population Age Structure of Malus sieversii (Ledeb.) Roem. in Yili, Xinjiang and Kazakhstan Postprint

Authors: Zhang Ping, Lü Zhaozhi, Zhang Xin, Zhao Xiangping, Zhang Yongguang, Gulzhanat Tanabekova, Maisupova Bagila, Adilbayeva Zhanera, Cui Zhijun

Date: 2019-09-10T00:00:00+00:00

Abstract

Anthropogenic activities and natural environmental stressors have accelerated habitat loss for Malus sieversii (Ledeb.) Roem. populations in Central Asia, leading to declining population size and viability. This study systematically investigated the current status of wild apple populations through field surveys, comparing age structure and fruit yield between populations in Yili, Xinjiang and Kazakhstan, and analyzed population dynamics in both regions. Results indicate that the age structure of current Yili populations and Kazakhstan populations from the 1970s is dominated by middle-aged trees (15–50 cm), with relatively few young (0–15 cm) and old (50–75 cm) individuals. In 1969–1970, Kazakhstan populations exhibited the weakest viability, representing a declining population (Deevey III), yet with relatively high fruit yield; in 2016–2017, Yili populations showed relatively weak viability, trending toward decline (Deevey III) with low yield; in 2013, Kazakhstan populations displayed the strongest viability and greatest stability (Deevey II). The deficiency of young individuals is the critical factor driving population decline. Currently, moderate grazing disturbance within Kazakhstan' s wild apple reserves is needed to enhance seed dispersal and germination; in Xinjiang, priority should be given to establishing protected areas, prohibiting wild apple harvesting, and reducing mowing intensity in wild fruit forests to protect seedling survival, increase the seed bank, and accelerate population regeneration.

Full Text

Preamble

ARID ZONE RESEARCH (ChinaXiv Partner Journal)
doi:10.13866/j.azr.2019.04.07

Authors: ZHANG Ping[1,2], LYU Zhao-zhi[1,3], ZHANG Xin[1,3], ZHAO Xiang-ping , ZHANG Yong-guang[1,3], Gulzhanat Tanabekova , Maisupova Bagila , Adilbayeva Zhanera , CUI Zhi-jun

[1] Xinjiang Institute of Ecology and Geography, Chinese Academy of Sciences, Urumqi 830011, China
[2] University of Chinese Academy of Sciences, Beijing 100049, China
[3] Key Laboratory of Biogeography and Bioresources, Xinjiang Institute of Ecology and Geography, Chinese Academy of Sciences, Urumqi 830011, China
Shihezi University, Shihezi 832003, China
Al-Farabi Kazakh National University, Almaty 050040, Kazakhstan
Almaty Branch of "Kazakh Research Institute of Forestry"LLP, Almaty 050000, Kazakhstan
Kazakh National Agrarian University, Almaty 050010, Kazakhstan
Gongliu Forestry Bureau, Gongliu 835400, China

Abstract

Environmental and human-induced stresses are accelerating the loss of wild apple habitats in Central Asia, causing population decline and reduced viability of wild apple species. This study investigated the population dynamics of the tertiary relict plant *Malus sieversii* (Ledeb.) Roem. through systematic surveys comparing the age structure, fruit yield, and population dynamics of wild apple populations in the Ili River Valley of Xinjiang, China, and Kazakhstan.

The results revealed that both populations were dominated by middle-aged trees (15–50 cm DBH) in the 1970s and currently, with low proportions of young (0–15 cm) and old (50–75 cm) individuals. Compared to the Xinjiang population, the Kazakhstan population exhibited weaker vitality but relatively higher fruit yield and was in severe decline (Devey-III type) from 1969–1970. By 2013, however, the Kazakhstan population showed strong vitality and a stable population structure (Devey-II type). The key factor driving wild apple population decline was the lack of young individuals.

Detailed conservation and regeneration recommendations are proposed. For Kazakhstan, appropriate grazing levels should be maintained to enhance seed dispersal and germination. For the Ili region of Xinjiang, protected areas should be established, and wild apple fruit collection and mowing in wild apple forests should be prohibited or strictly controlled to protect seedlings and the natural seed bank.

Keywords: *Malus sieversii* population; static life table; age structure; Ili of Xinjiang; Kazakhstan

2. Methods

2.1 Data Collection

Field surveys were conducted using 20 m × 20 m sample plots covering a total area of 0.755 hm². Forty-two plots were established, within which 545 individual trees were measured for diameter at breast height (DBH), height, and crown width.

2.2 Data Processing

In 2013, seven sample plots (0.25 hm² total area) were surveyed in the Ili National Natural Park (77.68°E, 43.38°N), established in 1996 with an area of 19,967.5 hm². One hundred fifty-eight individuals were measured for height, crown width, and DBH. For historical comparison, data from 130 individuals measured in 1969–1970 were obtained from the literature [**?**].

Static life tables were constructed following standard methods [**?**]. DBH values were used to estimate age structure, with regression analysis performed using Origin 9.0 software. The regression equation between DBH and age was established as:

$$DBH_i = a \cdot DB_i + b$$

where DBH_i is the diameter at breast height, DB_i is the age, and a and b are regression coefficients.

2.3 Age Structure Classification

Age structure was classified based on DBH classes following established methods [**?**, **?**, **?**]. According to the size-class method [**?**], individuals with DBH 5 cm were counted as trees. The population was divided into 15 DBH classes: Class I (0 cm < DBH 5 cm), Class II (5 cm < DBH 10 cm), ···, Class XIV (65 cm < DBH 70 cm), and Class XV (DBH > 70 cm). The number of individuals in each class was counted, survival curves plotted, and analysis performed using Origin 9.0.

3. Results

3.1 Age Structure and Life Table Analysis

The Devey curve analysis revealed the population survival pattern. The regression equation between DBH and age for the 1969–1970 population was:

$$DBH_i = 0.63 \cdot DB_i + 4.45 \quad (R^2 = 0.74, P < 0.05)$$

where DBH_i is diameter at breast height (cm) and DB_i is age (years). This regression was used to construct the static life table for the 1969–1970 wild apple population.

References

[?] ZHANG Xinshi. On the eco-geographical characteristics and classification problems of wild fruit trees in the Ili valley of Sinkiang [?]. *Acta Botanica Sinica*, 1973, 15(2): 239–253.

[?] YAN Guorong, XU Zheng. Study on the wild fruit trees in Xinjiang, China [?]. Beijing: China Forestry Publishing House, 2010: 108–109.

[?] Volk G. *Malus sieversii*: A diverse central Asian apple species in the USDA-ARS national plant germplasm system [?]. *Hortscience*, 2013, 48(12): 140–144.

[?] LI Feifei, CUI Dafang, LIAO Wenbo, et al. Geographic distribution pattern and genetic relationship of *Malus sieversii* (Ldb.) Roem. in China [?]. *Arid Land Geography*, 2011, 34(6): 926–932.

[?] [Reference text garbled - original unclear]

[?] [Reference text garbled - original unclear]

[?] FU Liguo. China Plant Red Data Book [?]. Beijing: Science Press, 1991.

[?] [Reference text garbled - original unclear]

[?] Tripathi RS, Khan ML. Regeneration dynamics of natural forests: A review [?]. *Proceedings of the Indian National Science Academy*, 2007, 73(3): 167–195.

[?] Singh SP, Tewari JC, Yadav S, et al. Population structure of tree species in forests as an indicator of regeneration and future stability [?]. *Plant Sciences*, 1986, 96(6): 443–455.

[?] Good NF, Good RE. Population dynamics of tree seedlings and saplings in a mature eastern hardwood forest [?]. *Bulletin of the Torrey Botanical Club*, 1972, 99(4): 172–178.

[?] QIN Wei, SHA Hong, LIU Liqiang, et al. SSR analysis for genetic diversity of *Malus sieversii* [?]. [Journal name garbled], 2012, 29(2): 161–165.

[?] ZHAO Pei. Characters of reproduction and molecular phylogenetic analysis of *Malus sieversii* [?]. Tianjin: Tianjin Agricultural University, 2013.

[?] [Reference text garbled - original unclear]

[?] [Reference text garbled - original unclear]

[?] FENG Tao, ZHANG Yanmin, CHEN Xuesen. Study on the age structure and density of the wild apple forest of *Malus sieversii* [?]. *Journal of Fruit Science*, 2007, 24(5): 571–574.

[?] [Reference text garbled - original unclear]

[?] [Reference text garbled - original unclear]

[?] LIU Zhongquan, CHEN Weiming, XU Zheng, et al. *Malus sieversii* forest distribution and *Agrilus mali* Matsumura status of damage in the west part of Tianshan Mountains [?]. *Northern Horticulture*, 2014(17): 121–124.

[?] MA Chuang, YANG Meiling, ZHANG Yunxiu, et al. Age composition and dynamic characteristics of the main populations of endangered *Malus sieversii* [?]. *Arid Zone Research*, 2018, 35(1): 156–164.

[?] [Reference text garbled - original unclear]

[?] [Reference text garbled - original unclear]

[?] [Reference text garbled - original unclear]

[?] ZHAO Pei. Characters of reproduction and molecular phylogenetic analysis of *Malus sieversii* [?]. Tianjin: Tianjin Agricultural University, 2013.

[?] Khatry Chhetri DB, Fowler GW. Estimating diameter at breast height and basal diameter of trees from stump measurements in Nepal [?]. *Forest Management*, 1996, 81(1–3): 75–84.

[?] WU Chengzhen, HONG Wei, XIE Jinshou, et al. Life table analysis of *Tsuga longibracteata* population [?]. *Chinese Journal of Applied Ecology*, 2000, 11(3): 333–336.

[?] [Reference text garbled - original unclear]

[?] ZHANG Wenhui, ZU Yuangang, LIU Guobin. Population ecological characteristics and analysis on endangered cause of ten endangered plant species [?]. *Acta Ecologica Sinica*, 2002, 22(9): 1512–1520.

[?] LIU Lu, LIU Ping, LIU Shuangcheng. Species composition and space distribution characteristic of soil seed bank of *Malus sieversii* in Xinjiang [?]. *Hebei Journal of Forestry and Orchard Research*, 2015, 30(2): 146–150.

[?] CUI Zhijun, ZHANG Yanlong, LUO Zhaohui, et al. Damage of *Agrilus mali* Matsumura in wild apple forest and its assessment [?]. *Arid Zone Research*, 2018, 35(5): 1153–1159.

[?] YANG Lei, LIAO Kan, TONG Le, et al. Primary report on effect of related factors on germination of *Malus sieversii* (Lede.) Rome. seed [?]. *Xinjiang Agricultural Sciences*, 2008, 45(2): 231-235.

Note: Figure translations are in progress. See original paper for figures.