BRIEF COMMUNICATION

A comparison of photosynthesis in endangered and non-endangered plants *Changium smyrnioides* and *Anthriscus sylvestris*

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Abstract

Changium smyrnioides Wolff. and *Anthriscus sylvestris* (L.) Hoffm. have similar photosynthetic characters; they use radiant energy in winter and early spring effectively, but cannot take full advantage of higher irradiance after spring. The specific leaf area (SLA), leaf area ratio (LAR), and leaf mass ratio (LMR) of *C. smyrnioides* were lower than those of *A. sylvestris*. The photosynthetic period of *C. smyrnioides* was about 160 d shorter than that of *A. sylvestris*, causing the total photosynthetic production of *C. smyrnioides* to be lower than that of *A. sylvestris*. Hence if *C. smyrnioides* is disturbed, it could not recover within a short period.

Additional key words: leaf area ratio; leaf mass ratio; net photosynthetic rate; specific leaf area.

Changium smyrnioides Wolff, a monotypic species of family *Umbellaceae*, has a narrow distribution area: it is found only from the middle to the eastern part of the drainage basin of the Yangtze River in China. Because its fleshy root is prized in Chinese medicine, and because of the land use, its natural population has been seriously disturbed by human activity, and its population has decreased in recent years. It has now become an endangered species (Qiu *et al.* 2001). *Anthriscus sylvestris* (L.) Hoffm., however, belongs to the same family and has a similar life form as *C. smyrnioides*, but has a wider distributing area than *C. smyrnioides*, ranging from the North Temperate Zone of China, Europe, and North America to the north edge of the tropical zone, in addition to the overlapping area of *C. smyrnioides* in the Yangtze River drainage basin. Although *A. sylvestris* is also a medicinal herb and is harvested for this purpose, it is not a rare species. A comparative study of photosynthesis in the two species has been conducted in the field, in order to compare the resource utilisation (Rajendrudu *et al.* 1999, Wang and Gao 2001) and find out the reasons for the endangerment (Chang *et al.* 1999) of *C. smyrnioides* from the point of view of plant physioecology.

Research was conducted at the South Peak near Hangzhou city in eastern China (120°10'E, 30°15'N). *C. smyrnioides* is mainly distributed in forests and adjacent roadsides. *A. sylvestris* is mainly found at the forest edge or catchment area of mountains and near streams. The dominant species and main companion species in the tree layer of the community were *Quercus acutissima, Quercus fabri, Liquidambar formosana, Koelreuteria paniculata,* and *Ulmus gaussenii.* From May 2000 to June 2001, the 20 marked individuals of each species experienced two periods of dormancy and regenerated once. Intensive field measurements were carried out in January (frondescence of *C. smyrnioides*) and March (full growth). The number, mass and area of leaves and the root mass of ten chosen individuals of each species were measured, and leaf area per unit leaf mass (specific leaf area; SLA), leaf area per unit of total mass (leaf area ratio; LAR), and leaf mass per unit of total mass (leaf mass ratio; LMR) were determined (Hunt 1978). Net photo-

Received 27 February 2002, *accepted* 10 June 2002.
Abbreviations: LAR – leaf area ratio; LMR – leaf mass ratio; P_N – net photosynthetic rate; PAR – photosynthetic active radiation; RH – relative humidity; SLA – specific leaf area; T – leaf temperature.
Acknowledgements: We are grateful for the funding provided by the National State Key Basic Research and Development Plan (973) (No. G2000046805) and National Science Foundation of China (No. 39970058).
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synthetic rate (P_N) was measured by using a CO_2 analyser (*GHX305*, Beijing, China) in the close system. From early morning to late evening on clear days, measurements were conducted hourly in triplicate, with minor adjustment of the time interval based on solar irradiation conditions. Photosynthetically active radiation (PAR), leaf temperature (T), and air relative humidity (RH) were measured simultaneously with P_N using a *Li-1600* portable steady porometer (*Li-Cor*, Lincoln, USA).

In January, the compensation irradiance of *C. smyrnioides* and *A. sylvestris* was 6.9 and 6.5 µmol m^{-2} s^{-1}, respectively, and saturation irradiance was 300 µmol m^{-2} s^{-1} for both species. The P_N of the two species was similar, with the mean maximum P_N being 9.5 µmol(CO_2) m^{-2} s^{-1}. The P_N of *C. smyrnioides* in March, however, was slightly higher than that of *A. sylvestris* (Fig. 1). Irradiance and temperature in March were higher than in January ($p < 0.001$) and the irradiance was higher than the saturation irradiance for both species. The differences in P_N were not as high as those in irradiance and temperature, probably due to low air RH in March. These results indicate that the two species have similar photosynthetic characters: they use photons in winter and early spring effectively, but cannot take full advantage of the higher irradiance after the spring season.

Although both plants have similar P_N, the SLA, LAR, and LMR of *C. smyrnioides* were lower than those of *A. sylvestris* (Table 1). This indicated that the total photosynthetic production of *C. smyrnioides* was less than that of *A. sylvestris*.

C. smyrnioides germinates in December and *A. sylvestris* in September. They both begin dormancy in June and bear fleshy storage roots. The growing season of

Table 1. Specific leaf ratio (SLA), leaf mass ratio (LMR), and leaf area ratio (LAR) of *Changium smyrnioides* and *Anthriscus sylvestris* (mean ± SE). Differences between means (*ANOVA*) of three parameters are all significant ($p < 0.001$, $n = 25$).

Species	SLA	LMR	LAR
C. smyrnioides	185.16 ± 51.66	0.22 ± 0.18	35.30 ± 29.20
A. sylvestris	311.48 ± 125.46	0.61 ± 0.12	140.68 ± 27.16

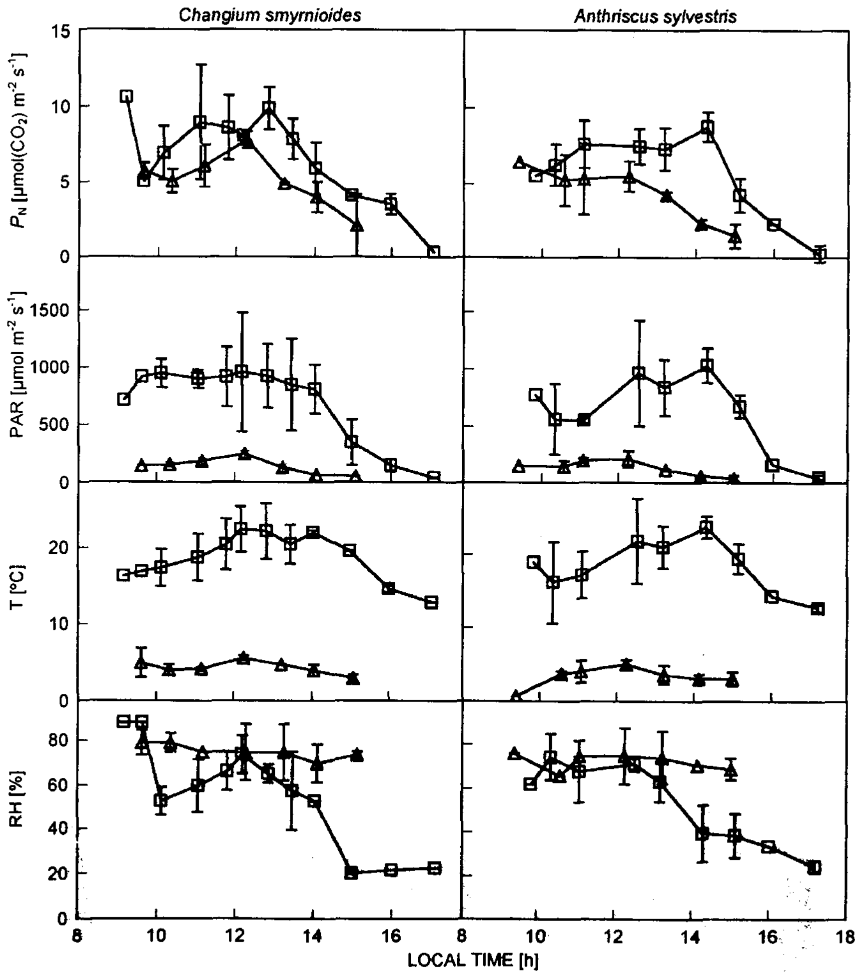

Fig. 1. Diurnal variations of the net photosynthetic rate (P_N), photosynthetically active radiation (PAR), leaf temperature (T), and air relative humidity (RH) for *Changium smyrnioides* and *Anthriscus sylvestris* in January (*triangles*) and March (*squares*). Means ± SE.

A. sylvestris is therefore about 120 d longer than that of *C. smyrnioides*. In addition, the cauline leaf of *C. smyrnioides* retrogresses severely on the stem (almost equal to scape), and there are only the basal leaves distributed within 20 cm above the ground surface during the whole growing season. In late spring, other plants accompanied in the herbaceous layer grow rapidly, and begin to shade off *C. smyrnioides*. Leaves of *C. smyrnioides* perished gradually under low irradiance. In contrast, the stem of *A. sylvestris* started growing rapidly after spring, with leaves extending to different heights, from ground soil surfaces to about 100 cm of stem (some individuals can reach 150 to 165 cm). *A. sylvestris* individuals captured PAR effectively, and their green leaves photosynthesised until the end of reproduction (early June). So, P_N of *A. sylvestris* lasted about 40 d longer than *C. smyrnioides* after late spring, and it was 160 d longer than that of *C. smyrnioides* in total.

In conclusion, although both species had similar P_N, the total photosynthetic production of *C. smyrnioides* was much lower than that of *A. sylvestris,* which should be the major reason that naturally occurring *C. smyrnioides* cannot recover easily in a short time if it is disturbed, compared to *A. sylvestris*.

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