The Biology and Cultivation of Red Australian *Aldrovanda vesiculosa*

Lubomír Adamec • Academy of Sciences of the Czech Republic • Institute of Botany • Dukelská 145 • CZ-379 82 Trebon, Czech Republic • adamec@butbn.cas.cz

Keywords: cultivation: *Aldrovanda*.

Aldrovanda vesiculosa L. (*Droseraceae*) is an attractive but very rare aquatic carnivorous plant from the Old World. In the last five years, Australians have been trying to grow two "red" strains of *Aldrovanda* endemic to their country (Wilson, 1995; Daly, 1997a, 1997b, 1997c, 1998; Schell, 1997). Among other desirable attributes, these varieties do not require a winter dormancy. In this paper I present notes pertaining to these Australian plants—a more general discussion of *Aldrovanda* can be found elsewhere (cf. Breckpot, 1997; Adamec, 1997).

In Australia, *Aldrovanda* is far less common than it once was, and it is designated a rare and threatened plant. In this article I discuss specimens from a poor site at Girraween Lagoon, approximately 30 km southeast of Darwin (Wilson, 1995), and a swamp near Batemans Bay at the East Coast, approximately 110 km southeast of Canberra (S. Jacobs, personal communication). In contrast with most European sites, dense growths of other aquatic plants grow with *Aldrovanda* at Australian sites (Wilson, 1995; S. Jacobs, personal communication).

Biological particulars

There are four main differences between the European temperate and the Australian (sub)tropical strains of *Aldrovanda* I have studied: the colors of the plants, their overwintering characteristics, the particulars of their of axillary buds, and their different sensitivities to boron. I discuss the first three below. The details of the boron sensitivities are described in the next section.

Color: The European and Japanese plants are light green and contain a great deal of plumbagin (a sulphur-yellow pigment) but no anthocyanins. The color of Australian plants may be the same green, or slightly rose to deep purple (Figure 1) because they contain anthocyanins as well as plumbagin. Irradiance is the main factor regulating the color of the Australian plants—if the plants are exposed to sunshine for at least two hours a day they become red in summer and rose in winter. If grown indoors, supplemental fluorescent lights help the plants become red.

Overwintering Characters: In contrast with the European and Japanese *Aldrovanda*, strains from both Australian sites can grow year round under natural light at a daily temperature of about 18°C or higher (at 18-19°C, the growth is very slow and the plants are in the winter growth form). In an indoor aquarium under natural light, the growth rate of east coast plants in June (spring) is approximately 0.7 new leaf whorls per day. The plants average 23-26 cm long, with 31-35 adult leaf whorls. During the winter, the plants are much shorter (3.3-12.4 cm, 10.5-19 whorls) and their growth rates are only approximately 0.2-0.5 whorls per day.

Even though they may be grown continuously, Australian *Aldrovanda* can be stimulated into producing turions if the plants are subjected to daily temperatures below approximately 18°C (cf. Adamec, 1999). In my outdoor culture, Australian plants started forming turions in early October (autumn), one month later than the temperate strains did. Shoots died very slowly (even at 8-10°C) and were still attached very firmly to the turions. At the end of October, shoots with turions sank to the bottom.

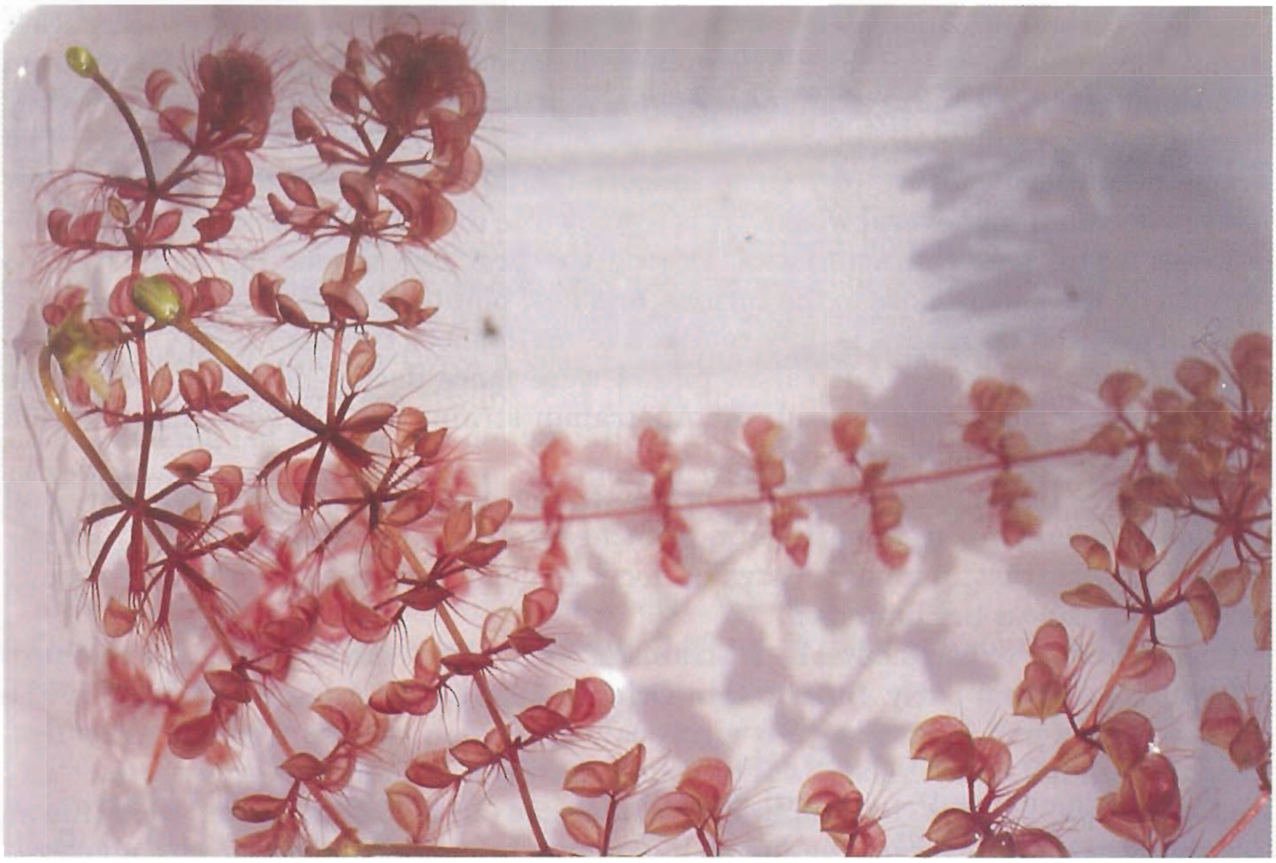


Figure 1: Flowering *Aldrovanda vesiculosa* from north Australia grown in indoor aquarium, September 1998.

Figure 2: *Aldrovanda vesiculosa* from southeast Australia in a 3-liter aquarium, October 1998.

The turions of Australian strains are more weakly dormant than temperate strains are (cf. Adamec, 1999). When plants forming turions were transferred from the Domanínsky wetland to an indoor aquarium at 19-24°C (on 27 September), they immediately resumed growth. However, when Australian strains were transferred from the outdoor culture (6-7°C) to indoors (18-20°C) at the end of October they stayed dormant for several weeks. (It is worthwhile to note that these plants demonstrated interesting characteristics. During the first two weeks, big axillary buds formed on the shoots close to the turions, and new plants started growing from these buds. Thus, the dormancy is only confined to main-shoot turions.) In summary, the turions of north Australian plants were more deeply dormant than those from the east coast, and overall, the Australian strains are not as adapted to cold overwintering as the temperate ones are.

Axillary Buds: Long specimens of Australian plants growing both indoors and outdoors in summer frequently form branches from axillary buds (i.e. 1-6 buds per plant). In contrast, temperate strains form axillary branches poorly, and mainly when their apices are damaged.

In outdoor experiments, both strains of Australian *Aldrovanda* grew and proliferated well from early June to late October 1998 (after Adamec & Tichy, 1997). Plants from north Australia grew vigorously in a nylon enclosure in a shallow dystrophic wetland near Trebon, where Polish *Aldrovanda* had been grown previously (Adamec, 1995). While the doubling time of apices (15.5-26.0 days) was the same as for the Polish *Aldrovanda,* the Australian plants branched much more frequently—branches were formed every 3.3-4.5 leaf whorls, as opposed to approximately every 6 whorls as in the Polish plants. Branch proliferation almost stopped in late August and the plants shortened gradually to approximately 1.8 cm.

How to grow Australian *Aldrovanda*

To grow Australian *Aldrovanda* successfully you must modify the methods that are appropriate for temperate strains (see Adamec, 1997; also Wilson, 1995; Daly, 1997a, 1997b, 1997c, 1998; Schell, 1997). In summary, the Australian strains can be grown outdoors in big containers or small aquaria as normal (Figure 2), from May to October (i.e. spring to autumn), and then transferred to indoor aquaria. Turions can probably overwinter in water in a refrigerator at 3-5°C. It is convenient to grow them indoors in small aquaria (3-20 liter) under natural light at temperatures exceeding 18°C for the whole year. It is the best if the aquaria stand close to an east or southeast oriented window so the plants are irradiated by direct morning sunlight for a few hours each day. This should be supplemented by diffuse light for the rest of the day. A 10-Watt fluorescent lamp can help. Australian *Aldrovanda* tolerate less irradiance but higher temperatures (optimum 25-29°C; maximum 34°C) than do temperate strains. In order to reduce the growth of filamentous algae, the aquarium wall facing the sun should be shaded by a sheet of paper from about 2 cm below the water surface to the bottom. During the summer, the aquarium should be shaded with a sheet of fine paper to keep it cool.

In indoor aquaria, Australian *Aldrovanda* flower richly in summer at 20-29°C. The flower stalks of the Australian ones were red (Figure 1). No flower set seeds, but they do in the wild (S. Jacobs, D. Wilson, personal communication).

Robust sedge or reed litter (i.e., dry dead leaves or straw collected in late winter) is the required substrate. The optimum amount of dry litter is approximately 4±0.5 g per three-liter aquarium. A dose of fresh litter lasts for 2-3 months. The water pH should be 6.0-7.5. A high CO_2 concentration >0.1 mmol/l is necessary for vigorous growth of *Aldrovanda*, and you may wish to add CO_2 to the water (see the article about CO_2 generators in this issue, on page 132).

As described for temperate *Aldrovanda* (Adamec, 1997) the cultivation water should be rather poor in N and P to control algal growth. In one aquarium, very low concentrations were measured (e.g., in µg/l: PO_4-P, 10.2; NH_4^+-N, 0.0; NO_3^--N, 11.8; NO_2^--N, 6.5). You may add 1-2 small water snails (e.g. *Planorbis*) to a three-liter aquarium, but too many foul the water (Underwood, 1991).

In a previous paper (Adamec, 1997), I described how a disorder commonly exhibited by cultivated *Aldrovanda* was determined to be a boron deficiency. It has been confirmed recently that an addition of 0.05 ml/l of complete microelement solution (see Table I) once or twice a year cures the plants. I have often observed this disorder in the Australian strains, but these plants are rather sensitive to boron—adding 0.5 mg/l of H_3BO_3 can damage them. However, the addition of 0.03-0.05 ml/l of the new, complete microelement solution will cure the plants of this disorder. Symptoms of iron deficiency (yellowish but healthy apices) are suppressed by an addition of 1-2 mg/l of $FeSO_4.7H_2O$ or 2-3 mg/l of Fe-EDTA.

Table I. Composition of the Gaffron microelement solution and final concentrations of salts and elements after an addition of 0.05 ml of the stock solution to one liter of water.

	Stock solution	Final concentration of ...	
Compound	(mg/l)	...the salt (µg/l)	...the element (nmol/l)
H_3BO_3	3100	155	B: 2500
$MnSO_4.4H_2O$	2230	111	Mn: 563
$ZnSO_4.7H_2O$	287	14.4	Zn: 50
$CuSO_4.5H_2O$	125	6.3	Cu: 25
$(NH_4)_6Mo_7O_{24}$	88	4.4	Mo: 26.5
$Co(NO_3)_2.6H_2O$	146	7.3	Co: 25

Acknowledgements: I am very grateful to Dr. Surrey Jacobs and Mr. Denis Daly for sending me the Australian plants of *Aldrovanda* and providing interesting data.

References

Adamec, L. 1995, Ecological requirements of *Aldrovanda vesiculosa*. Testing of its new potential sites in the Czech Republic, Acta Bot. Gall., 142: 673-680.

Adamec, L. 1997, How to grow *Aldrovanda vesiculosa* outdoors, Carniv. Pl. Newslett., 26, 85-88.

Adamec, L. 1999, Turion over-wintering of aquatic carnivorous plants, Carniv. Pl. Newslett., 28, 19-24

Adamec, L. and Tichy, M. 1997, Flowering of *Aldrovanda vesiculosa* in outdoor culture in the Czech Republic and isozyme variability of its European populations, Carniv. Pl. Newslett., 26, 99-103.

Breckpot, C. 1997, *Aldrovanda vesiculosa*: Description, distribution, ecology and cultivation, Carniv. Pl. Newslett., 26, 73-82.

Colbourn, D. 1993, In search of *Aldrovanda vesiculosa*. Part I - Description of *Aldrovanda*, FlyTrap News, 7(2): 5-9.

Daly, D. 1997a, Trying to grow *Aldrovanda vesiculosa*, FlyTrap News, 10(3): 13-21.

Daly, D. 1997b, Update on growing *Aldrovanda vesiculosa*, FlyTrap News, 11(1): 16-25.

Daly, D. 1997c, Change of method of growing *Aldrovanda vesiculosa*, FlyTrap News, 11(2): 17-21.

Daly, D. 1998, Update on growing *Aldrovanda vesiculosa*, FlyTrap News, 11(3): 14-16.

Schell, C. 1997, Growing *Aldrovanda vesiculosa*. A simple method for its captive propagation, FlyTrap News, 11(2): 15-17.

Underwood, G.J.C. 1991, Growth enhancement of the macrophyte *Ceratophyllum demersum* in the presence of the snail *Planorbis planorbis*: The effect of grazing and chemical conditioning, Freshwat. Biol., 26: 325-334.

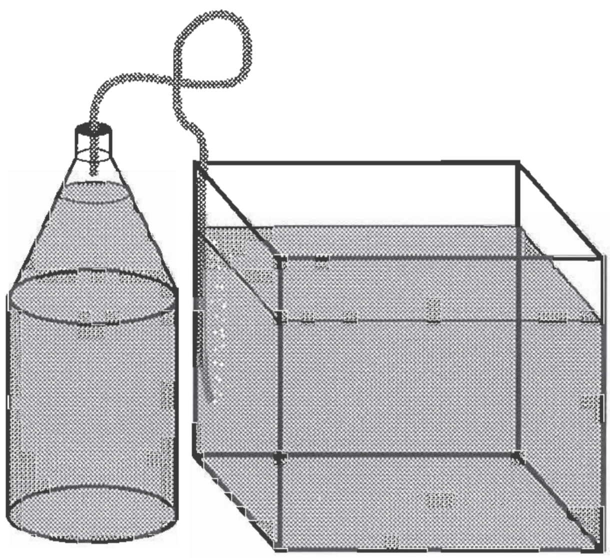
Wilson, D. 1995. Waterwheel-*Aldrovanda vesiculosa* in the Northern Territory, Bull. Aust. Carniv. Plant Soc., 14(3): 11-13.

An Economical Carbon Dioxide Generator

Tony Camilleri • PO Box 42853 • Casuarina 0811 • Northern Territory • Australia

Keywords: Cultivation: *Aldrovanda vesiculosa*, carbon dioxide.

In his article, Dr. Adamec mentions that *Adrovanda vesiculosa* appreciates the infusion of carbon dioxide in its water. You can create your own carbon dioxide generator of only a few cents per week. I have been using this method for some time with certainly noticable improvements in the growth rate of *Aldrovanda vesiculosa*.



Equipment required:
Five litre or 1 gallon container with sealed lid,
250 grams or 9 ounces sugar,
1 teaspoon yeast,
A length of hose to reach from the generator to the *Aldrovanda vesiculosa* tank.

Prepare the container by drilling or cutting a hole into the lid. Make the hole large enough so the hose fits snugly into it. Insert the hose into the hole and carefully seal it in place to prevent gas leaks (any sealant, such as silicone, will do). When the container is ready, fill it with three litres of water, then add the sugar and yeast. Seal the lid with the hose attached and submerge the other end of the hose in the *Adrovanda* tank.

Depending on the temperature, the reaction may take up to eight hours to begin. The generator will produce carbon dioxide for up to two weeks. At that point, clean out the generator, add a new mix of water, sugar, and yeast, and it will resume its production of carbon dioxide.