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ECOLOGY, MORPHOLOGY AND ANATOMY OF *ALDROVANDA VESICULOSA* L. (DROSERACEAE) FROM BANGLADESH

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Abstract

Ecology, morphology and anatomy of *Aldrovanda vesiculosa* L. collected from Chalan beel wetland of Rajshahi district in 1987 have been studied. An illustrated account is presented with a review of literature.

Introduction

Aldrovanda vesiculosa L. (Droseraceae) is a rare monotypic floating aquatic carnivorous plant. The genus was established by Linnaeus in 1753. *A. vesiculosa* was first reported from this subcontinent by Roxburgh (1832) and much later by Prain (1903) from the same habitat of salt lakes south of Calcutta, India. Basak (1975) reported that since then the occurrence of this plant was not known until Sen Gupta collected it in 1937 from Dhaka, Bangladesh and Deb from Imphal, Monipur state in India in 1961.

A. vesiculosa was of enormous interest to the 19th century Botanists and naturalists (Monti 1747, Hausleutner 1850, Caspary 1858, Chatin 1858, Maisonneuve 1859 and Schoenefeld 1860, Lassu 1861) who studied the plant including its morphology, food habit, mode of reproduction and distribution in nature. Cohn (1850) gave a comprehensive description of the taxon with reference to its morphology, anatomy and carnivorous food habit. Darwin (1875) also took the plant with interest and wrote a chapter in his book "INSECTIVOROUS PLANT." Mori (1876), Cohn (1875), Korzchinsky (1886), Fenner(1904), Ashida (1934, 1935) and De Wit (1964) worked on the irritability of trap leaf and described the mode of its vegetative propagation.

Many workers including Monti (1747), Caspary (1858), Lassu (1861), Mori (1876), Roxburgh (1832), Schoenfeld (1860) and Arber (1972) recorded the generic name of this plant as *Aldrovandia* while Linnaeus (1753), Hooker (1872), Prain (1903), Sculthrope (1971), De Wit (1964), Heywood (1978), Rendle (1971), Aston (1983) and many other modern botanists call it *Aldrovanda*. During the recent few years a number of significant works have been done in Japan, Australia and many European countries on various aspects of *A. vesiculosa* and have regarded it as critically endangered globally. Scientists are working on the ecology, physiology and mode of propagation in nature and also in laboratory conditions. Efforts are being made to bring the plant back to nature by tissue culture methods in Japan and elsewhere. Noteworthy works were done by Adamec (1995, 1997, 1999 and 2000) on the ecology, photosynthetic characteristics, seasonal growth dynamics, physiological polarity and mineral nutrition of *A. vesiculosa*. Adamec and Lev (1999) have been working on the introduction of this plant in potential sites of the Czech Republic.

Kaminski (1987) worked on the role of chemical factors on the distribution, and Komiya and Shibata (1998) worked on the environmental changes and their effect on growth of *A. vesiculosa*. Kondo *et al*. (1997) in Japan have been working on the conservation of *A. vesiculosa* by tissue culture. Atsuzawa *et al*. (2003) studied the fine structure of *A. vesiculosa* by electron microscopic techniques. Nitta *et al*. (2003) have been working on the *in-vitro* propagation and *ex vitro* conservation of this endangered plant in Japan.

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Morphology, ecology and distribution of *A. vesiculosa* reported from Bangladesh is limited which may be due to its rare occurrence in the country. The present communication deals with the physical, chemical and biological conditions of the *Aldrovanda* habitat and on the morphology of specimen collected.

Materials and Methods

Chalan beel is one of the largest wetland in Bangladesh and lies between 23º24′ to 24º35′ N and 89º05′ to 89º18′ E and 10 m above the sea level. An area of 107500 ha is presently reduced to about 26,000 ha of which about 2000 ha retains water in summer till the next monsoon. The rest of the area has been reclaimed for rice cultivation. The plant was collected from a marsh land 10 Km east of Rajshahi in 1974 by a group of Botanists from Dhaka University (Sayed Hadiuzzaman) and Rajshahi University (ATM Naderuzzaman, Mozahed Hossen, S.U Ahmed and M Zaman). The plant was collected again in1987 by the first author from Chalan beel wetland 50 Km east of Rajshahi, during a regular phycological and limnological investigations. The plant material was collected by using hand net from deep clear water shaded by reeds and thickets of *Nymphaea*, *Ricciocarpus natans* L. and *Riccia fluitans* L.

The specimen was preserved in 4% formalin and also in Transeau's (1951) solution and kept in the Phycology and Limnology Laboratory, Department of Botany, University of Rajshahi, Bangladesh. pH, Redox potential, Conductivity and DO of the water body were measured using relevant meters and other chemical conditions were determined by following standard methods described in APHA (1989), Welch (1948), Mishra *et al*. (1992) and Gautam (1990). Necessary microscopic studies, camera lucida drawings and photography have been made in the laboratory.

Results and Discussion

Taxonomic and some anatomical features with illustrations are presented in Figs 1-9 while data on physical, chemical and biological conditions are given in Table 1.

Aldrovanda vesiculosa L. Carl. Lin. 1753. SP. Pl., Hooker 1878. Fl. Br. Ind., Roxburgh 1832. Fl. I, Vol. II, Prain 1903. Bengal plants. Vol. I & II.

English name: Water fly trap.

Bangla name: Pata jhanjhi

Collection No. C.B. *Aldrovanda*-0123. Date- 19.01.1987

A submerged rootless floating herb with jointed succulent and glabrous stem, leaves in whorls of 7-10, connate at the base, lamina contorted, bladder like, petiole swollen lacunose, the segment dentate, flowers solitary, stalked, axillary, sepals 5, petals 5, stamen 5, hypogynous, ovary unilocular, style 5, stigma branched, fruit a capsule, 5 valved, seeds many, shining black.

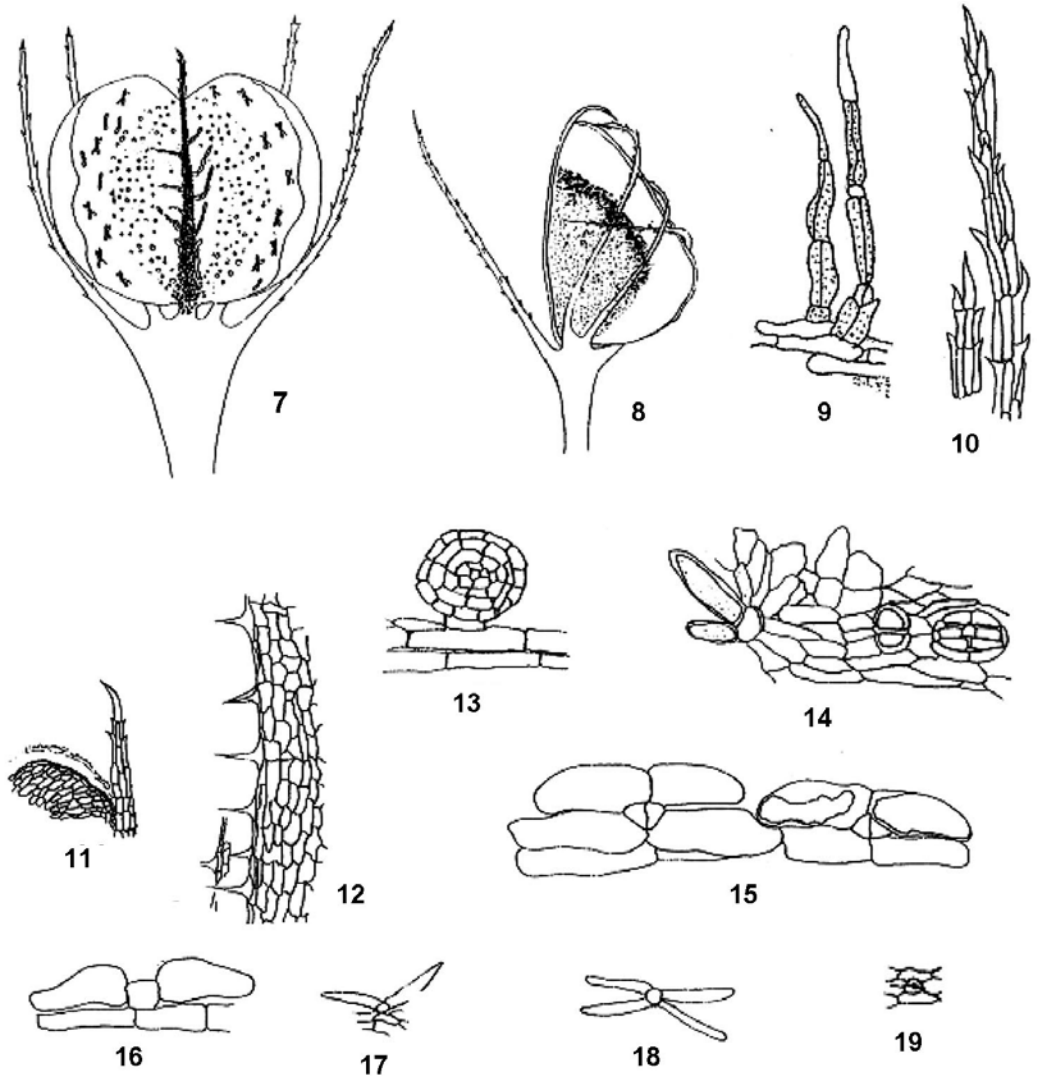
The slender jointed main axis is sparsely branched towards the basal region; the apical region profusely branched to give a dense crowded appearance (Figs 1-3). Each of this apical dense cluster of crowded whorls of leaves (Figs 4-5) become compact to form turions. The turion is a special structure for vegetative propagation (Mainsonneuve 1859, DeWit 1957, Caspary 1858). Roxburgh (1832) noted the plant growing vegetatively without forming turions and the basal end dies away gradually. However, the present Chalan beel material was found with turions (Fig. 3). The stem is round and bears many bifid processes. The leaves in the whorl are equal in size. The broad petiole of each leaf terminates into a more or less circular bi-lobed lamina (Fig. 7). The petiole also produce four rigid projections on either side of the lamina lobe (Fig. 6). These stiff projections appear like tentacles, the tips of which are transformed into shaggy hair (Figs 8-10).

The midrib is projected beyond the lamina lobe and terminates into a shaggy hairy projection. The lobes are made of very delicate tissue with two layers of cells. When wide open the lobes give are almost circular appearance (Fig. 7). The midrib is few celled thick, rigid and holds the lamina like a strong hinge, similar to the trap of *Dionaea* (Droseraceae). The upper side (inner surface) is found to have a large number of multi-cellular circular shaped colorless glands (Figs 13-14). These glands are either sessile or with short stalk. The gland appears densely on either sides of the midrib. The lower side of the lobe is flat and broad and made of two layers of long cylindrical cells and bear few gland cells and a large number

Figs 1-6 *Aldrovanda vesiculosa* L. 1.Whole plant, 2. Tip portion of the plant with Turions, 3. Mid portion of the plant with Turions (arrow), 4-5. Whorls with 7 and 8 leaves, 6. A single leaf with 4 tentacles.

of quadrifid, bifid and monofid processes (Figs 15-18) which probably act as absorptive organs (Arber 1920). The mid rib bears many multi-cellular filamentous projections sensitive in nature (Cohn-1850, Arber-1920, and De Wit 1957). As soon as any infusorian touches these hairs, the lobes close and the prey is imprisoned inside. According to Heywood (1978) the lobes can close

rapidly in about 1/50th of a second to trap small aquatic animals which are subsequently digested and absorbed by secretary glands. A few reduced stomata were found to occur on the abaxial surface (Fig. 19).



Figs 7-19. Anatomical structures of *A. Vesiculosa*. 7. Leaf with open blades showing tentacles, midrib with sensitive hairs, digestive glands and absorptive cells, 8. A closed leaf with prey inside tightened with bent tencacles, 9. Sensitive multicellular filaments or hairs on the inner side of the midrib, 10. Tips of tentacles converted into shaggy hairs, 11. Tip of the midrib converted into a shaggy hair, 12. Margin of the leaflets (traps) with short strong spines, 13-14. Sessile and one-cell stalked digestive glands on the inner side of midrib and lamina. 15- 16. 1-2 celled pillow like swollen absorptive bodies with one cell stalk on the inner side of midrib, 17- 18. Two and 4 celled absorptive organs on the inner surface of leaflets (traps), 19. A reduced stoma on the outer surface of a leaflet. Figs. 10, 12-16: ×20, Fig. 11: ×150.

The limnological data were obtained from the spot of collection of *A.vesiculosa* and the angiosperms were collected from the whole wetland zone. The physical, chemical and biological data clearly indicate the drastic changes in aquatic ecology of the *Aldrovanda* habitat (Table 1). The redox characteristics including the DO, BOD, COD, Eh, rH_2 indicate that in 1987 the beel water had minimum organic load which is supported by the lower value of electrolytic conductivity. The water was unpolluted and eutrophic in nature. The abundance of phytoplankton, zooplankton and other hydrophytes also support this fact. As mentioned earlier, the specimen was collected from a single habitat consisting of reeds and *Nymphaea* which probably created a suitable temperature regime for *Aldrovanda*. The redox characteristics and electrolytic conductivity in 1997 have changed indicating moderate organic load and moderate pollution of the

Table 1. Physico-chemical and biological conditions of the *Aldrovanda vesiculosa* L. habitat in Chalan beel at the time of its collection in January 19, 1987 and compared at 10 years intervals.

Limnological conditions	19-01-1987	19-01-1997	19-01-2007
Air temperature ^{o} C	26	28	27
Water temperature ^{o} C	13.5	20.4	18.5
Average depth of water (meter)	2.32	1.23	0.58
Transparency of water (cm)	65	17.4	10
TSS(mg/l)	52	276	113
TDS(mg/l)	160	176.6	268
E. conductivity (μmoh/s)	180	211	1413
pH	7.9	7.7	7.1
Free CO_2 (mg/l)	9.3	14.12	18.3
Total alkalinity (mg/l)	87	95	122
DO (mg/l)	10	6.5	6.5
Saturation O_2 %	140	71.5	85
BOD (mg/l)	1.85	3.57	6.75
COD (mg/l)	3.82	37.62	18.85
Oxidation reduction potential (Eh–mv)	0.321	0.331	0.168
Oxidation reduction index (rh_2)	28.4	26.7	22.5
Chloride (mg/l)	31	53.9	59.5
Total hardness (mg/l)	94	109.31	119
Silicate (mg/l)	0.0023	0.0021	0.0018
Total Nitrogen (mg/l)	0.35	0.85	1.003
PO_4 (mg/l)	0.051	0.047	0.066
Soluble salt (g/l)	0.05	0.125	o.122
Total Phytoplankton (unit/L)	59464	38800	26534
Total Zooplankton (unit/L)	21734	13244	11201
Total genera of Angiosperms	97	84	76

water which have undergone enormous change in 2007. These conditions were probably absolutely in congenial for this plant. The Chalan beel wetland have silted up considerably during the recent years and turned into an annual flood plain and remains almost dry during period from late winter to mid-summer months. Like eurytopic *Utricularia*, the stenotopic *Aldrovanda* is extremely sensitive to the changes in the limnological conditions (Chowdhury and Zaman 2006) and thus *Aldrovanda* has lost its habitat. Adamec and Kovarova (2006) held similar views.

Utricularia in similar other habitats in the country survived the drastic environmental changes but *Aldrovanda* probably failed to cope with these changes and became critically endangered in this region also. A rigorous search should be undertaken to find live *Aldrovanda* plant and through biotechnological methods it may be brought back to nature again.

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