5.7 MACROPHYTES

(by U. Wychera-Cenker and G.A. Janauer)

5.7.1 Introduction

The macrophytes in the Danube grow along the river bank where the water depth is less than 2.5 metres (Fig. 3.1). The main work was to estimate the standing crop biomass, to observe seasonal changes in grówth and to measure the light conditions within the weedbeds. Therefore the whole area, from the Altenwörth power station (river kilometre 1980.4) up to Krems (river kilometre 2004) was mapped, macrophytes were harvested and light was measured within the weedbeds.

5.7.2 Mapping macrophytes

Every month from the beginning of July until the end of October in 1986 and 1987,the macrophytes in the Danube were mapped.
A 50 m-long measuring tape was laid along the riverbank and the length of the weedbed and the distance from the nearest hectometre were measured.To measure the widths of the weedbeds, a scaled rod, 5 m long, was held above them. The sizes of the weedbeds and their positions could then be drawn onto a map (1:200; Fig. 5.7.1). If those measurements were not sufficient to draw the right outline of the weedbed, additional data were determined from the boat or by wading into the water.

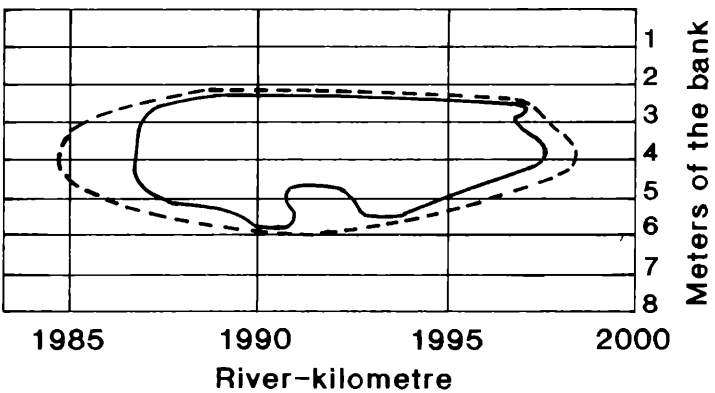

Fig. 5.7.1. Example for mapping macrophytes shown for the third hectometre. —— = surface of a weedbed in July. --- = surface of the weed bed in August. Scale 1:200.

In the laboratory, the real surface of the weedbeds was measured using a △ T area meter (△ T Area Measurement System, Delta-T Devices Ltd., Burwell, Cambridge, England).
The increase and decrease of macrophytes throughout the vegetation period could thus be observed.

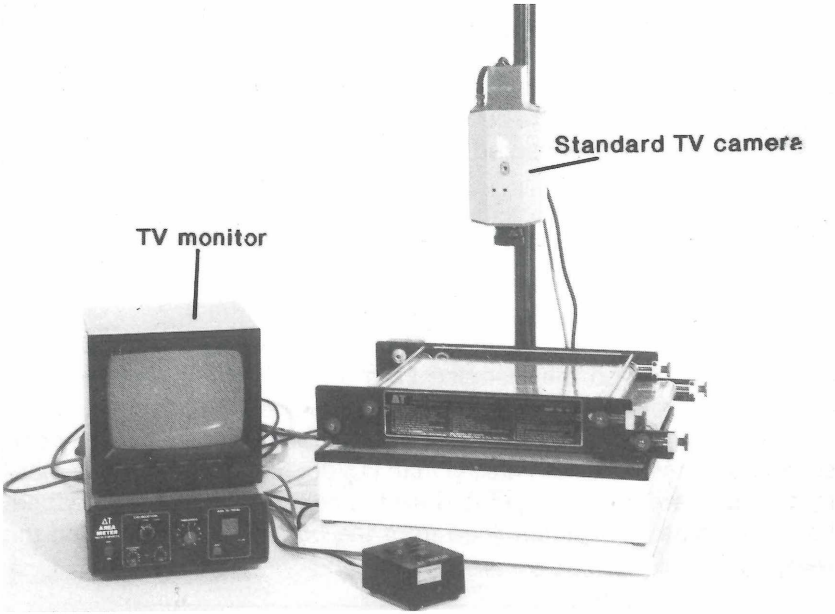

Plate 5.7.1. △ T Area measurement system, a device for estimating the area of the leaves of macrophytes.

5.7.3 Analysis of the mapping – the △T Area Meter

The △ T area meter measurement system measures the area of any object or silhouette that can be seen in high contrast by a standard TV camera. The camera scans the object, line by line, measures the area of each scan and builds up a picture on a TV monitor. Therefore the original TV picture of the object, the image of the measured area and the total area of the scanned object can be seen on the monitor. This sum is a measure of the object's area and can be adjusted for calibration using an object of known area. The threshold control is adjusted to make the two pictures coincide (Plate 5.7.1).

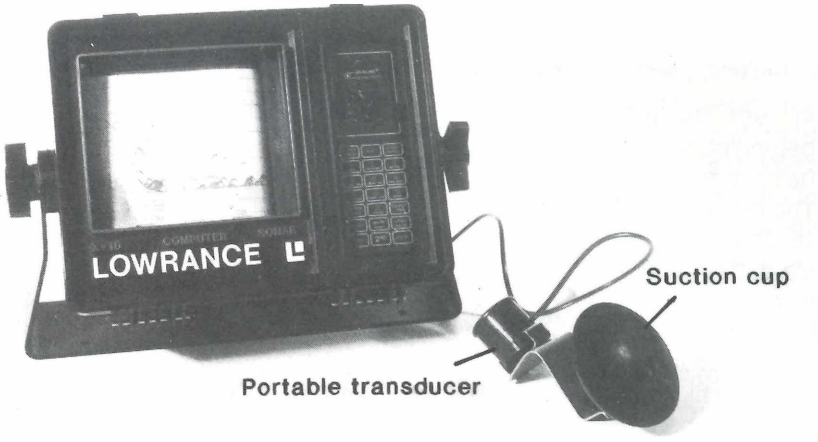

Plate 5.7.2. X-16 Echosounder with the portable transducer and suction cup for a device for estimating standing crop biomass.

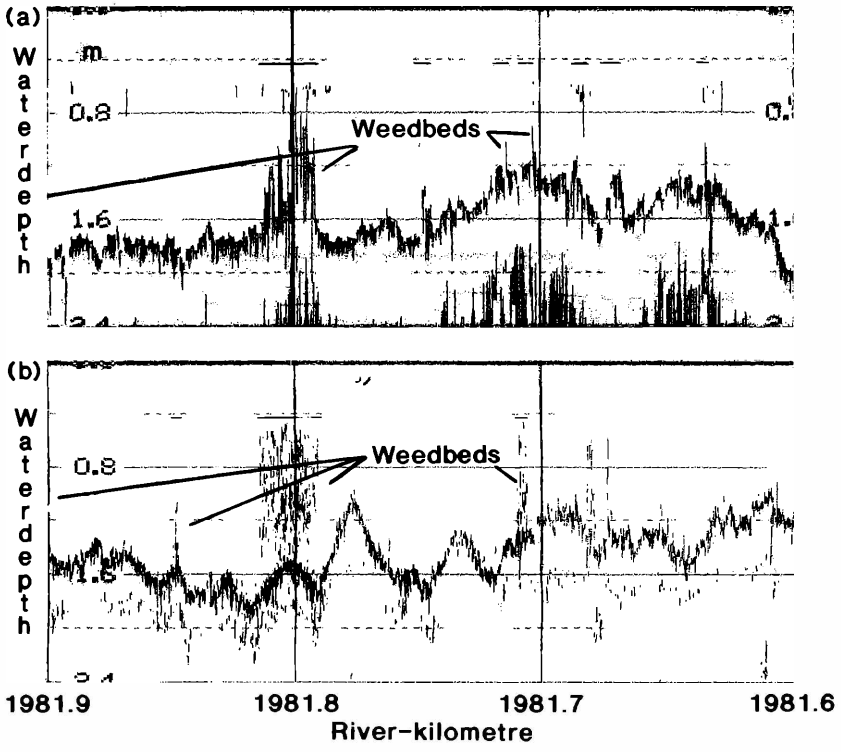

Fig. 5.7.2. Measurement of macrophyte development by an echosounder. (a) June 1987. (b) October 1987.

5.7.4 Measurements by echosounder

In 1987, the macrophytes were examined earlier in the year (at the beginning of June). At this time they were still so small that they could not be seen because of the high turbidity of the River Danube.
The echosounder (Lowrance Electronics, Inc. Tulsa, Oklahoma, USA, X-16; Plate 5.7.2) was fixed at the back of a motorboat which was driven along the shore over distances, 2 – 3 m and 5 m, respectively. At places where macrophytes already grew, the echoes of the bottom could easily be differentiated from those of the plants [Fig. 5.7.2(a)].
The echosounder was also used at the end of October 1987. The Danube was very high and turbid at this time and although the macrophytes were only a few centimetres below the surface, they could not be seen by éye [(Fig. 5.7.2(b)].
By comparing the shape of the weedbeds on the echogramm, three different types (more or less developed) could be distinguished. From each type, samples were taken later so that the biomass could also be estimated for those parts where they could not be mapped directly (Fig. 5.7.2).

5.7.5 The X-16 echosounder (Plate 5.7.2)

The portable transducer is attached to the transom of the boat by means of a suction cup. The transducer should be mounted on a selected area of the transom that is free from bubbles while the boat is running. This is important because air bubbles cause cavitation noise which shows up on the sonar as indiscriminate lines. The transducer has to be fixed horizontally to the boat.
The very high sensitivity of the echosounder allows small details to be visible.
The „greyline“ shows the substratum as a thin, black line with a grey area below it. Waterplants can be seen above the greyline (Fig. 5.7.2).

5.7.6 Estimating standing crop biomass

Two investigations were executed within each of the growing seasons, 1986 and 1987 respectively.
Firstly total biomass of *Potamogeton pectinatus* in the part of the Danube dammed up by the powerstation Altenwörth was estimated. Secondly the seasonal changes in the vertical stratification of biomass were also studied at special sites.

Each month from June until October, in 1986 and 1987 respectively, biomass samples of *Potamogeton pectinatus* were harvested. Direct harvests of macrophytes from squares provide the most accurate estimates of standing crop biomass (Grace & Twilley, 1976; Rich et al., 1971; Westlake, 1969). The small size of the square (30 x 30 cm) was chosen for these studies, so that the sampling did not destroy the site too much and therefore observations later in the year were possible. Downing & Anderson (1985) state that no significant difference could be demonstrated among frequency distributions of estimated macrophyte biomass by using different square sizes.
For estimating the vertical distribution of the biomass of *Potamogeton pectinatus* within the stand, usually four squares (30 x 30 cm) were randomly placed on the water surface at the centre of well-developed sites. Wooden frames were used in this case and all plant material within the frame was removed by hand in 10 cm thick layers until the substratum was reached.
In the laboratory, some samples for 1987 were divided into stems and leaves (there were no inflorescences that year) to estimate the portion of stems and leaves within the whole biomass of each layer and their development over the period when growth occurred.
All the samples were carefully washed and dried at 105 °C to constant weight after they had been weighed (fresh weight). The dry weight was measured and the standing crop biomass was expressed as g dry weight per square metre.
In addition to the harvests mentioned above, the whole biomass of *Potamogeton pectinatus* within larger square frames (50 x 50 cm) was harvested to get more samples for estimating the whole standing crop biomass in the study area. These samples were also dried at 105 °C and the dry weight per square metre was estimated.

5.7.7 Seasonal changes in growth

Individual plants of *Potamogeton pectinatus* were sampled throughout the growing season (June – October) to observe seasonal changes in growth characteristics.
The plants were cautiously pulled out by hand. They were taken from a stand with a dense growth each week, no matter whether they were small or had already reached the water surface.
On each sampling date, 9 plants on average were collected. The plants were quickly brought to the laboratory, where they were carefully washed and put on a background with a grid. The plant had to be placed so that

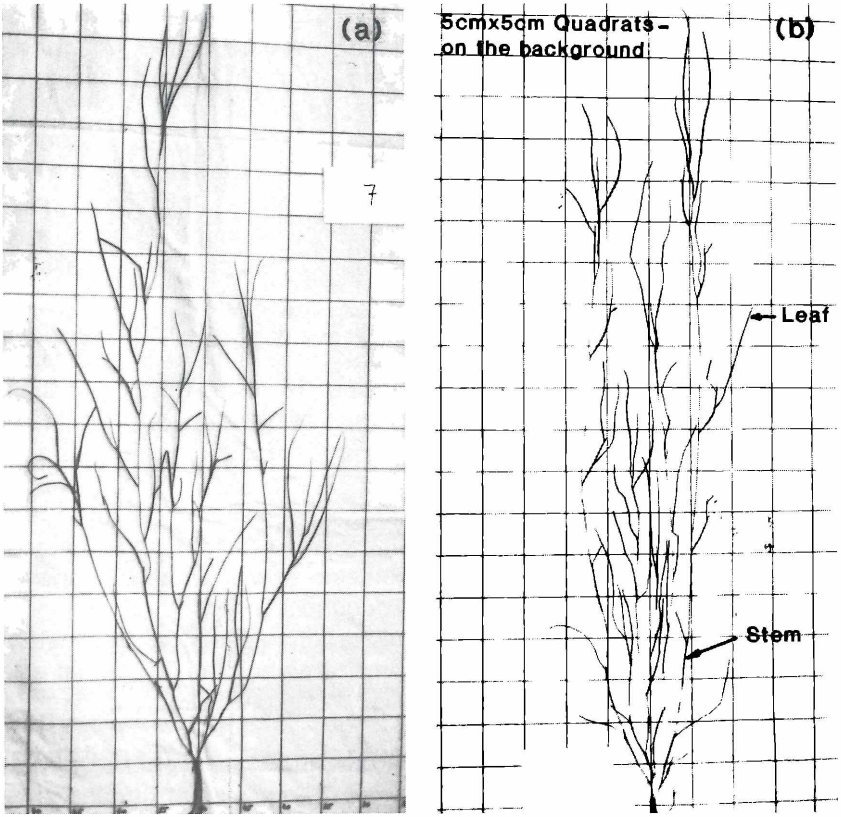

Plate 5.7.3. Seasonal changes in growth of *Potamogeton pectinatus* (a) 4. July 1987. (b) 12. July 1987.

all leaves and stems were visible. As the leaves of *Potamogeton pectinatus* are quite thin and the plant grows with short internodes later in the year when it has reached the water surface, it was not easy to arrange the plant on the background to display all leaves and stems. Another problem was the quick drying of waterplants. Thus they had to be kept wet until they were correctly spread out (Plate 5.7.3).
A photograph was then taken of each plant for each sampling date. The amount of stems and leaves within every 5 cm layer from top to bottom was counted on the slides later in the year.
After the mean number of stems and leaves had been estimated for each sampling date, a plant model was set up for each date.

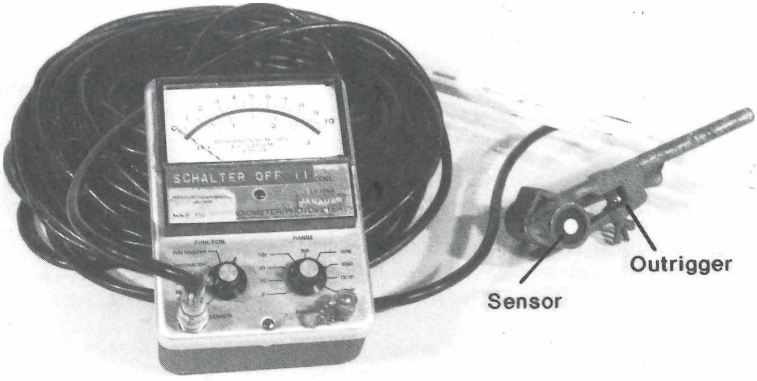

Plate 5.7.4. Li-cor Radiometer for measuring light within reedstands of macrophytes.

5.7.8 Light measurement

Measurements of PAR (Photosynthetic Active Radiation: 400 – 700 nm) were accomplished within reedstands of *Potamogeton pectinatus* and immediately beside them. A quantum sensor (Li-Cor, Delta Scientific, USA, LI-185A; Plate 5.7.4) was used to measure global radiation and irradiance penetrating the water. The sensor (LI-192SB) was put on a pole with an outrigger. It was then held into the water, taking care that there was no shadow above it. A water level was fixed on the pole to make sure that the sensor was held horizontally.
The first measurement, after the global radiation had been noted, was obtained just below the watersurface. The following measurements were taken in 5 cm steps until the substratum was reached. Care was taken not to destroy the stand by placing the sensor in it. Otherwise the natural light conditions within the weedbed could have been altered. Four readings were taken within each of the weedbeds at the point where biomass was later removed. At each site, a reading was also taken beside the stands to measure the attenuation of the water and dissolved inorganic and organic contents.
By comparing those measurements, the amount of radiation which was consumed by the plant itself could be estimated. By substracting the latter from the readings in the plantbed, the corrected attenuation of light in the plant column was determined.

References

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Grace, J.B., Twilley, L.J. (1976): Distribution and abundance of submerged macrophytes, including *Myriophyllum spicatum* L. (Angiospermae), in a reactor cooling reservoir. – Arch. Hydrobiol. 77, 475-478.

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