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Maria Dinka

Research Institute for Botany of the Hung.Acad. of Sciences
H-2163 Vácrátót

OBSERVATIONS CONCERNING THE SIZE AND WEIGHT OF ABOVEGROUND ORGANS OF BALATON REED-BEDS

INTRODUCTION

The increasing eutrophization of Lake Balaton involves the loosening, thinning and retreat of reed stands. To find its causes, reed stands exposed to load (with nutrients or sewage) of various degrees have been examined. The results have contributed to the knowledge on the role of reed in water purification and the productivity of reed in a contaminated environment.

The productivity of a natural community is basically determined by

1. genetically - the ecotype of population,
2. geographically - the geographical location (degree of latitude, degree of longitude, macroclimate) and
3. the habit of the stand which is controlled by nutrient supply.

Investigation on the relation of the chemical properties of water and the damage to reed-beds have not been finished yet; here only the results of the examinations of the habit of stands are concerned. Accordingly we have examined;

- if there is a significant difference in reed height and weight of shoots (altogether and by organs) in various zones of reed-beds exposed to various degress of nutrient load during the growing season,

- what impacts the various loads (growing nutrient supply of water and sediments) have upon reed growth,
- if the above biometric parameters of reed stands vary with investigated areas.

MATERIAL AND METHODS

On the northern shore of Lake Balaton four investigation places were designated along an about 50 km long section (Fig.1). Two of them are at sewage inflows (I and IV), place II is at the mouth of a natural watercourse, place III is unaffected by inflow of water.
Two sampling sites were selected in each investigation place.
One was in the shore zone of the reed-bed (by this the area between the shore and the deep water is meant), 5 m away from the shore at a water depth of 20 to 50 cm, the other was on the deep water side with water depths of 120 to 150 cm. Plants taken from the site near the shore are referred to as the reed-bed of the shore zone and the other as the reed-bed on the deep water side.
Sampling dates were the following: April 29, June 1, July 1-2, August 1, September 11) at place IV September 25) and October 22, 1980.
Two samples were collected from each place (one sample by zones) on every occasion; they contained 15 to 20 shoots. After sampling, above-ground organs were separated from underground ones. Along with reed samples, water and sediment samples were also taken for purposes of chemical analysis.
The samples were carried to the laboratory and washed, dried and then the shoots were cut into their organs (leaf-blade, leaf-sheath and culm). Their weight was measured, height of culm, number and diameter of internodes determined.
In early July, shoot density was counted by m^2, at investigation areas I., II and III in both zones, in twenty areal units of 1 m^2 for each investigation area. Data include the shoot density of developing or existing "reed-clumps" and the neighbouring thinner stand and consequently

their interpretation should be very careful.
The significant nature of differences between various parameters were shown by variance analysis of mean values (SVAB 1973, method. 2.7).

DESCRIPTION OF SAMPLING SITES

Areas at the mouth:

1. Investigation place I particularly loaded by sewage in the summer months. The brook reaches the bay through the sewage farm of the town of Keszthely. The total N and P content of Balaton water is highest here. The Mn-content is relatively high. Near the mouth the sediment contains 0,62 to 0,15 % N and 1,69 to 3,3 mg/100 g easily available P (Table 1,2).
The reed stand has considerably thinned out here. It has also retreated recently. Larger patches of reed clumps can be observed; they are thick. Next to the reed clumps the stand is thinner, at some place they are bordered by deep water.
Close to the shore shoot density was 46 to 213/m^2, while its range was from 50 to 300/m^2 on the deep water side. Besides reed, Typha latifolia and T.angustifolia also from stands.

2. Investigation place II was at a natural watercourse of the Szigliget Bay. The brook carries about 120.000 m^3 water containing 2,78 mg/l total N and 0,41 mg/l total P on the average into the bay as a daily average. Reed water contains 1,22 to 1,46 mg/l and 3,54 to 4,89 mg/l K and 3,54 to 4,89 mg/l Na which is less in magnitude than those measured at the other sites. Near the inflow the sediment contains 0,6 to 0,4 % N and 0,91 to 1,4 mg/100 g easily available P, while its K and Na content is relatively low (Table 1,2).
The thinning of reed-beds, clump development can also be observed here but the processes are less intensive compared to investigation place I.

In the reed-bed near the shore 80 to 320 shoots/m^2, while on the deep water side 100 to 280 shoots/m^2 were counted;Cladophora glomerata occured in masses.

3. At investigation place IV the reed-stands at the inflow are loaded with about 4.000 m^3/day sewage from the sewage plant. In the summer months the sewage leaving the plant contains as much as 31.44 mg/l total N and 9,7 mg/l total P. The outflowing sewage has a high Cl content (due to clearing with "hypo").
The sediment in the proximity of the inflow contains 6 % N and 3,4 mg/100 g easily available P. The Na, K and Zn content of the sediment and water is relatively higher (Table 1,2).
In the vicinity of the sewage outflow Typha latifolia and T.angustifolia form stands. The Typha-Phragmites boundary is 100 to 120 m away from the outflow; water is 30 to 40 cm deep here. Reed is largely degraded. Thinning out of reed is characteristic here, too; clump formation is higher than at sampling site I.

The area without inflow:

4. Investigation place III was on the western side of the Tihany peninsula. Water contains relatively less P (Table 2). In the reed-bed Hydrocharis morsus-ranae, Potamogeton pectinatus and Fontinalis antipyretica occured sporadically.
Traces of clump formation cannot be observed in the reed-bed. In the shore zone, the density of reed shoots is 46 to 135/m^2 while on the deep water side 86 to 111/m^2.

RESULTS AND DISCUSSION

Shoot development

The height of culm, number of internodes and leaves in function of time are demonstrated at various investigation places in Fig. 2.
There are differences in the mean height of culm at various sampling sites. Highest culms are measured in places I and II, on the deep water side of reed-beds. In place III, reed culms are higher closer to the shore,

in contrast to the other two investigation places. Development and growth started later here, in the deep water zone than at other sites. In late April only buds, conical shoots had developed. In the most seriously contaminated place number IV, reed culms were lower even at the beginning of the growing season in comparison to other samples, and this difference persisted to the end of the growing season. Maximum height was attained in September for the places I,III, IV but it was a month later for place II (Fig. 2). The same pattern of changes was observed for reed plants in other areas (HASLAM 1969, HO 1979, SZCZEPANSKA-SZCSEPANSKI 1976).

As far as the temporal change of culm heights is concerned, the following can be stated on the basis of variance analysis: In April heights of culm significantly (P= 5 %) differ in regard to reed-beds close to the shore and on the deep water in all the four investigation places. In June difference is significant only in places II and III. From July, however, average values of culm heights for the deep water and shore zone are not significant any longer, except place II at the end of the growing season.

Comparing the zones of similar nature in the investigation places, it can be stated that the April culm heights in the nearshore zones of sampling sites did not differ remarkably; at the same time, there were significant differences between heights of culm in the deep water zones. From July the culm height differences between the reed-beds of the investigation places IV and III were not substantial, while the culm height of reed stands in places I and II differed significantly from the other two places.

At the beginning of the growing season there could not be found any substantial difference between the number of internodes of the investigation places; reed culm consists of 7 to 10 internodes on the average, irrespectively to the sampling site. By middle summer when growth slows down or stops, the number of internodes is 30 to 32 on the average in places I, II and III, in the most heavily contaminated place, number IV, only 19 to 21.

There were no considerable differences in number of leaf-blades on a single culm at the beginning of the growing season, their number was 4 to 6 everywhere; however leaf number differs at the various; by middle summer it was only 13 to 14 in place IV and, in contrast,it was 15to18at all the three other sampling sites.
Differences in culm basal diameter resemble to those in culm height. In June culm diameter in the shore zones of places I and II was 5 mm, in the deep water zones 9 mm. In places III and IV the diameter of reed culms was 6 to 8 mm in both zones.
Culm basal diameter had increased of about 1 to 2 mm by August at the last mentioned places while it had grown 2 to 3 mm in places I and II.
A close correlation was found between the number of internodes and culm height on the one hand and between leaf number and culm height on the other (Fig. 3,4).

Growth study

In the Figure 5 it can be seen that the intensity and duration of growth differs by zones. In the deep water zone of place I, maximum daily growth of culm reaches 3,28 cm in June-July; increase of weight is also highest in these months: 0,83 g/day of which the increase of leaf-blade weight is 0,22 g. In the near shore zone maximum daily height increase was measurable between July and August 2,48 cm with a weight increase of 0,49 g/day; the maximum of increase of weight was observed between August und September with a value of 0,79 g/day.
In the deep water zone of place II average daily growth was highest between April and June: 3,77 cm with the increase of weight of 0,54 g; by the end of the growing season increase of weight had reached 0,68 g/day.
In the shore zone the growth of culm was maximal between June and July: 4,61 cm/day; the increase of weight in this period was 0,62 g. Increase of weight intensified from June to August.

The reed-bed in the deep water zone of place III has "made up" for the initial disadvantage in growth by the end of the growing season (Fig. 2,5,6). Average daily growth and increase of weight prolonged with the same intensity (2,55 cm and 0,46 g).
In the shore zone growth between April and June was intensive, 3,24 cm/day on the average with an increase of weight of 0,48 g.
In the deep water zone of place IV shoots were lighter and lower originally; their maximum growth rate was between June and July; shoots grew 3,15 cm/day and their weight increased 0,6 g/day. In the shore zone the period of maximum shoot growth and increase of weight is not the same; maximum culm growth (2,47 cm) is between April and July, while the maximum of increase of weight (0,46 g/day) is between July and August.
Average weights of overground shoots and organs at various sampling sites are respresented in Fig. 6.
There are striking differences between shoot weights at different places. In the most heavily contaminated place, number IV, the average weight of samples (shoot weight, weight of organs) in the least during the growing season, compared to other samples. Largest weight are measured in zones of the less polluted place, number I and in the deep water zone of place II. Shoot weight for place III fell between these extremes.
On the basis of variance analysis there can be observed a significant difference in the mean values for shoot weights in the zones of the various investigation places in April. In June all sampling sites, except samples from place IV, showed significant difference between shore zone and deep water reed; in July there was a significant difference only in Place I, in the further period of the growing season the difference was not significant, except place II at the end of the growing season.
In April, investigation places in the shore zone did not differ by shoot weight; reed-beds of the deep water zones showed significant difference. (Then 8 to 14 % of total weight consisted of leaf-blades,

40 to 50 % of leaf-sheaths and 40 to 50 % of the culm.
A weight unit of culm compares to 0,7 to 1,2 units of leaf-sheath and 0,11 to 0,33 leaf-blade).
From July shoot weights in areas I and II are significantly higher than at the other two sampling sites. Weight differences of samples from places III and IV are not significant. (In the period 20 to 25 % of total weight was constituted of leaf-blades, 15 to 20 % of leaf-sheath and 53 to 60 % of the culm. A weight unit of culm compares to 0,24 to 0,35 unit of leaf-sheath and 0,30 to 0,50 unit of leaf-blades. Weight proportion of leaf-blade falls with leaf fall by autumn to 0,11 to 0,17 unit while the proportion of leaf-sheath is gradually decreasing to this value),
Yield is much more dependent on the increase of culm weight than on growth in the number and weight of leaves.
A close correlation was found between the basal diameter of culm and culm weight on one hand and between shoot weight and culm height. (Fig. 7,8). A linear relationship between the shoot height and shoot weight was found by HO (1979),MOCHNACKA-LAWACZ (1974) and SZCZEPANSKA-SZCZEPANSKI (1976).

SUMMARY

1. Differences in shoot weight and height between reed-beds in the shore zone and in the deep water zone are significant in the first half of the growing season but not so at its end.

2. Intensity of reed growth varies with time in the zones.
While the maximum increase of height and weight per day of reed in the deep water zone is between June and July, highest growth rates for near-shore reed-beds are observed a month later between July and August.

3. Heavy load of pollutants, sometimes even toxic ones, disadvantageously affect reed production, lessen load as compared to common communal sewage exerts a positive influence upon reed growth and yield through

the increase of size and weight. Unloaded stand-characteristics reflect conditions occurring at the nearby natural lakes which lack the continuous replenishment of plant nutrients carried by inflowing water.

Data from the first evaluation of our above-outlined investigations are convincing for us in proving that the monitoring of reed development and growth conditions, in relation to environmental factors can promote further attempts at the disclosure of the function reed stands have in material budget.

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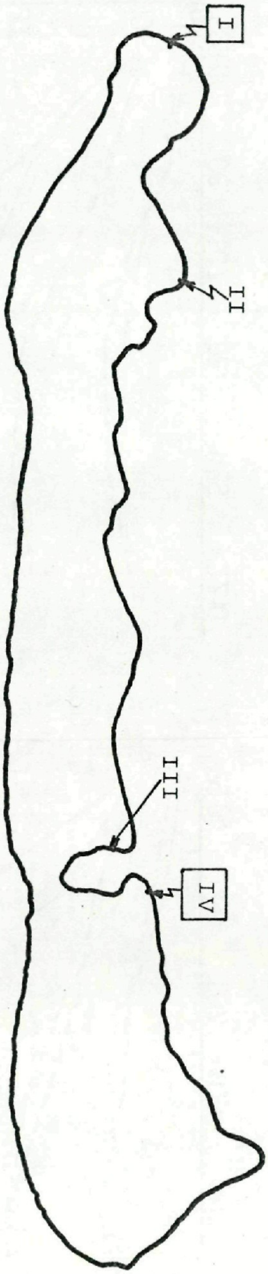

Fig.1. Map of the lake Balaton

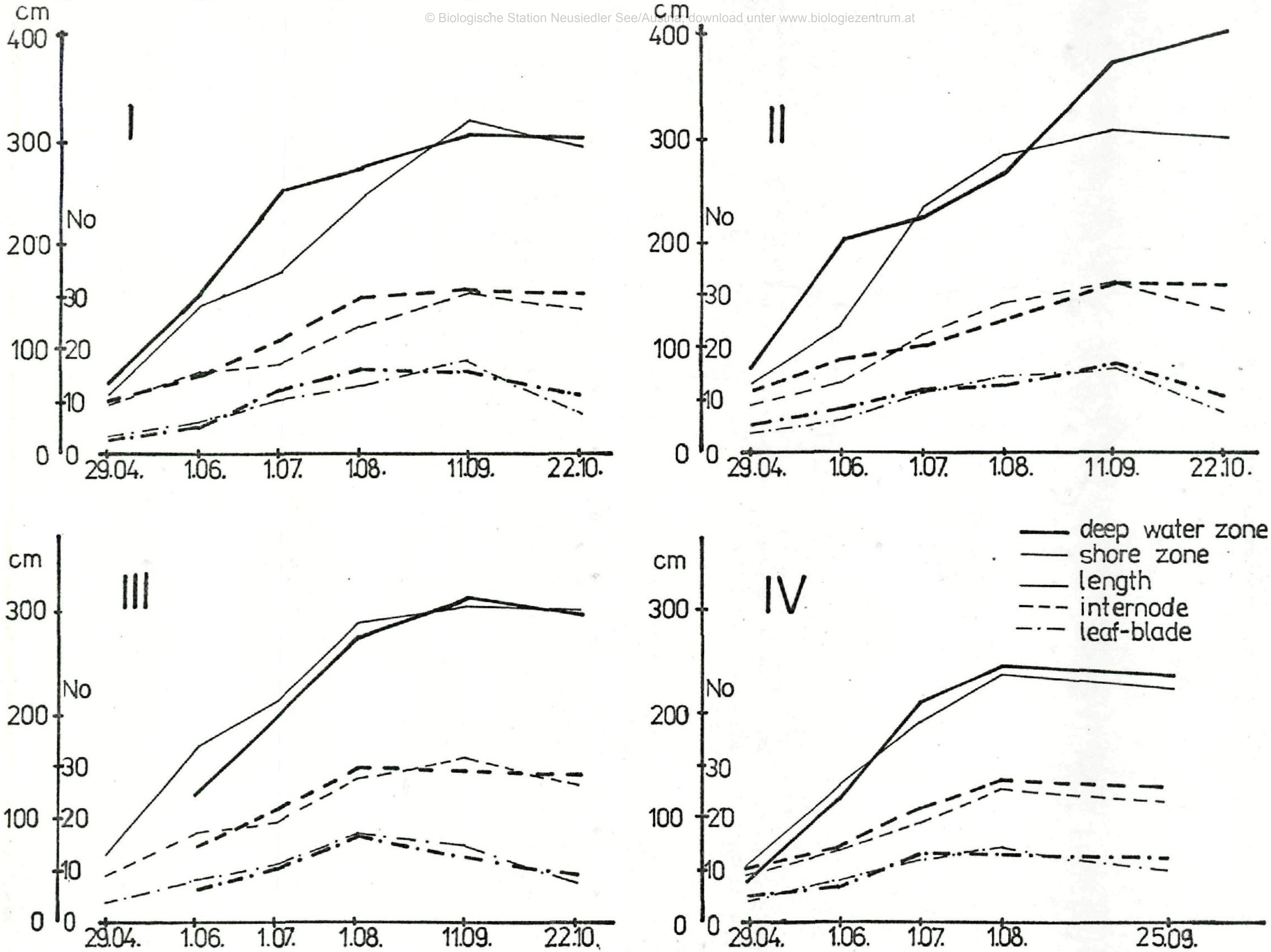

Fig.2. Length of culm, number of internodes and leaf-blades in the growing season

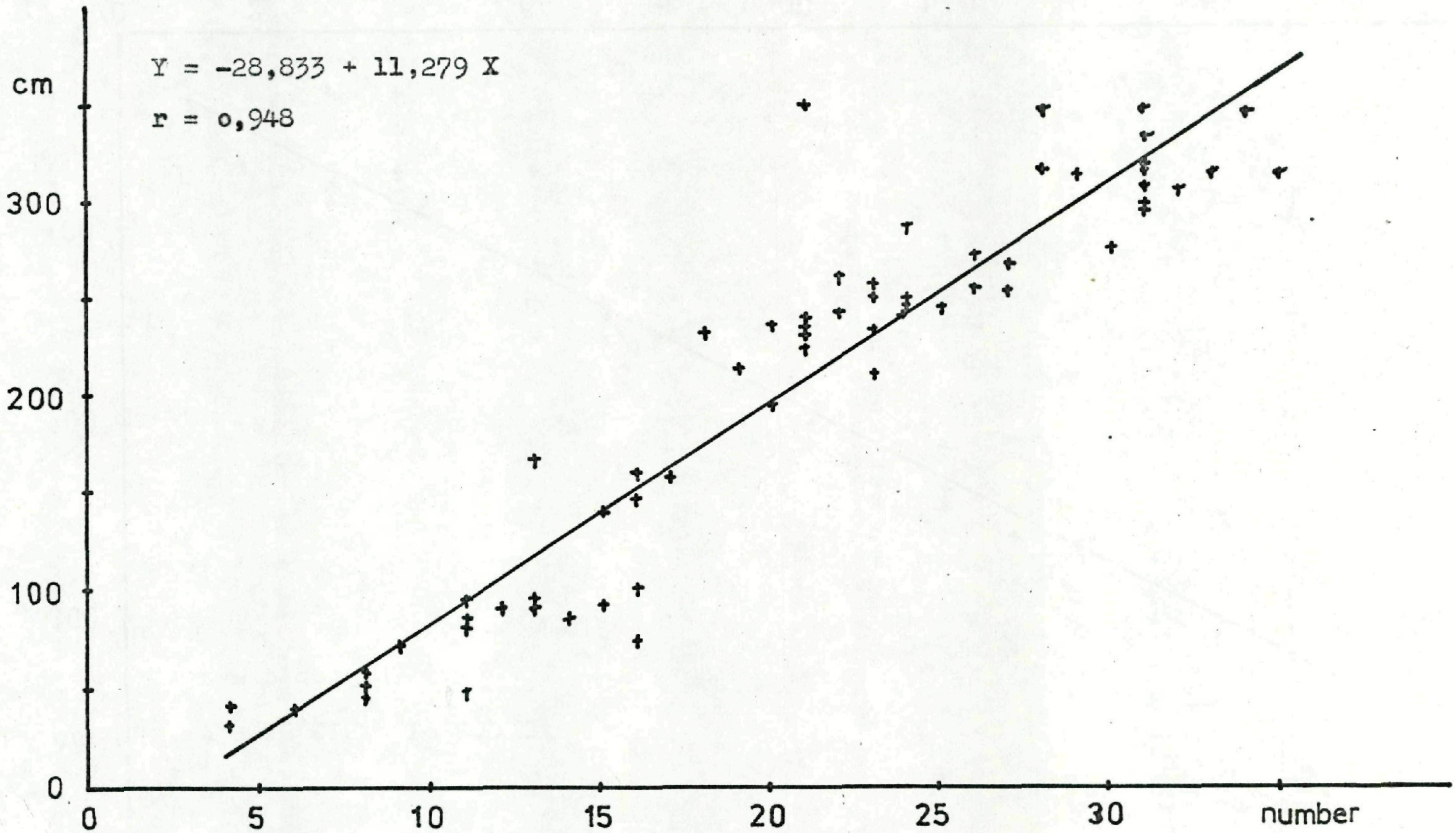

Fig.3. Relationship between number of internodes and culm height

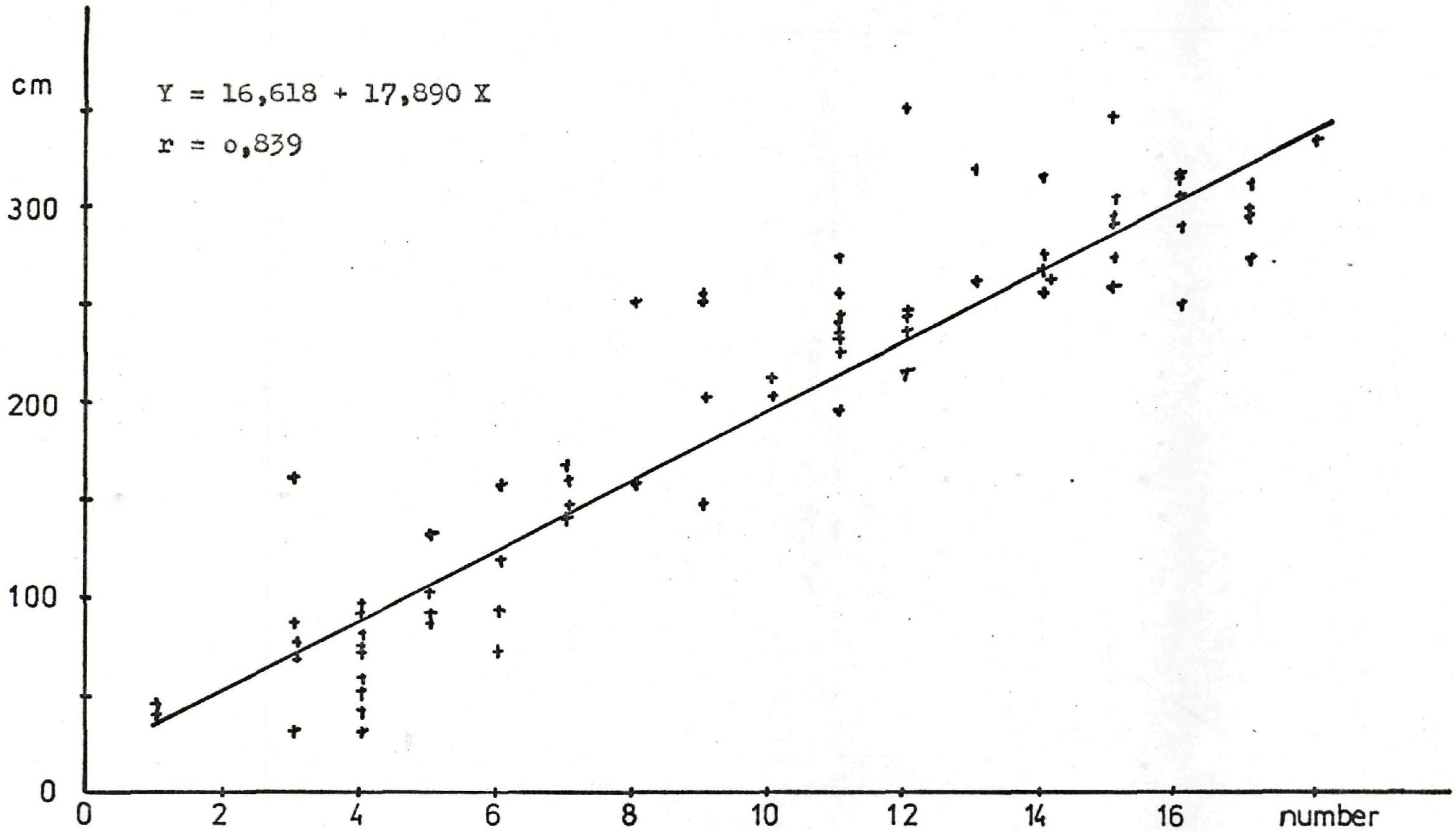

Fig.4. Relationship between the number of leaf-blades and culm height

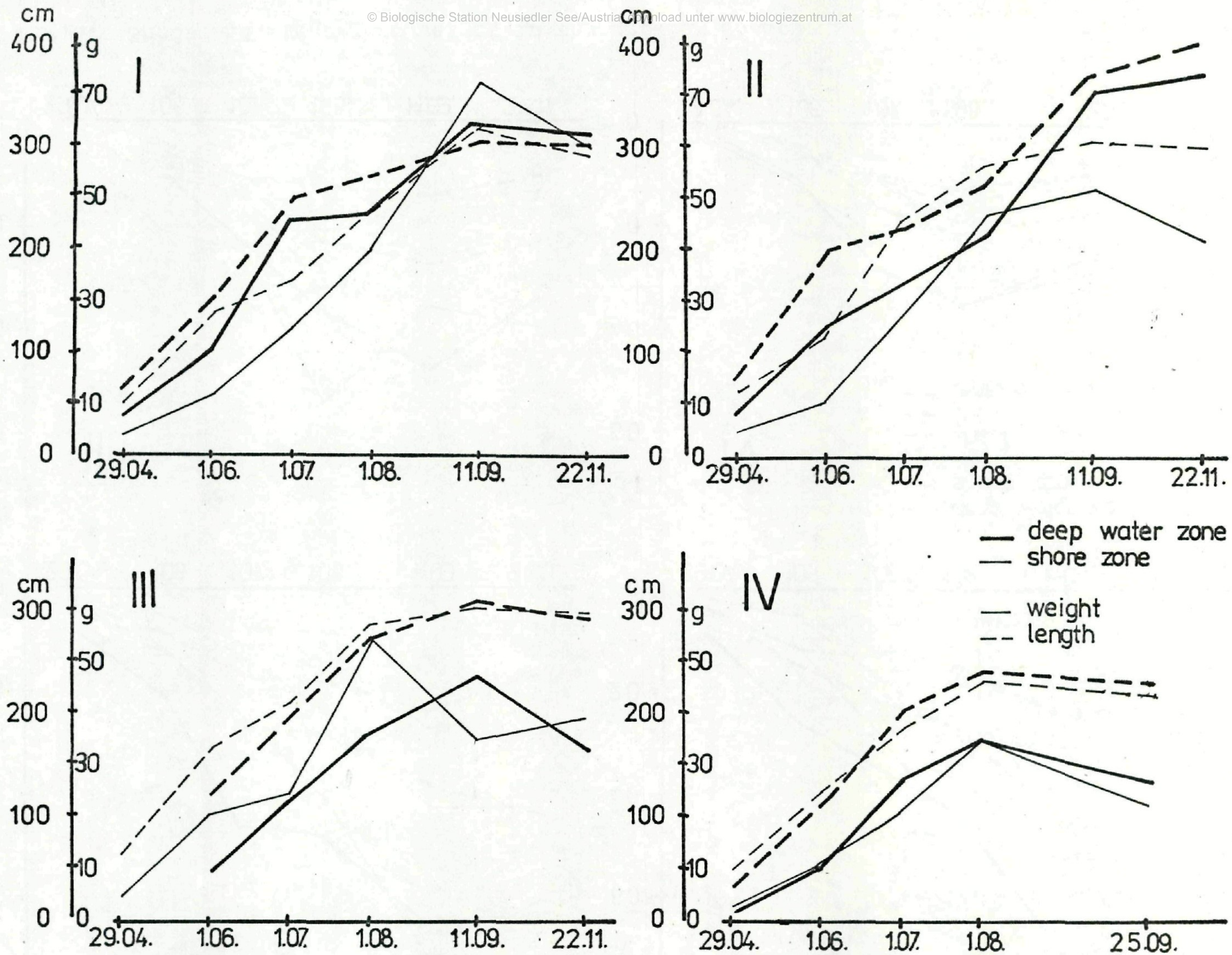

Fig.5. Length and weight of shoot in the growing season

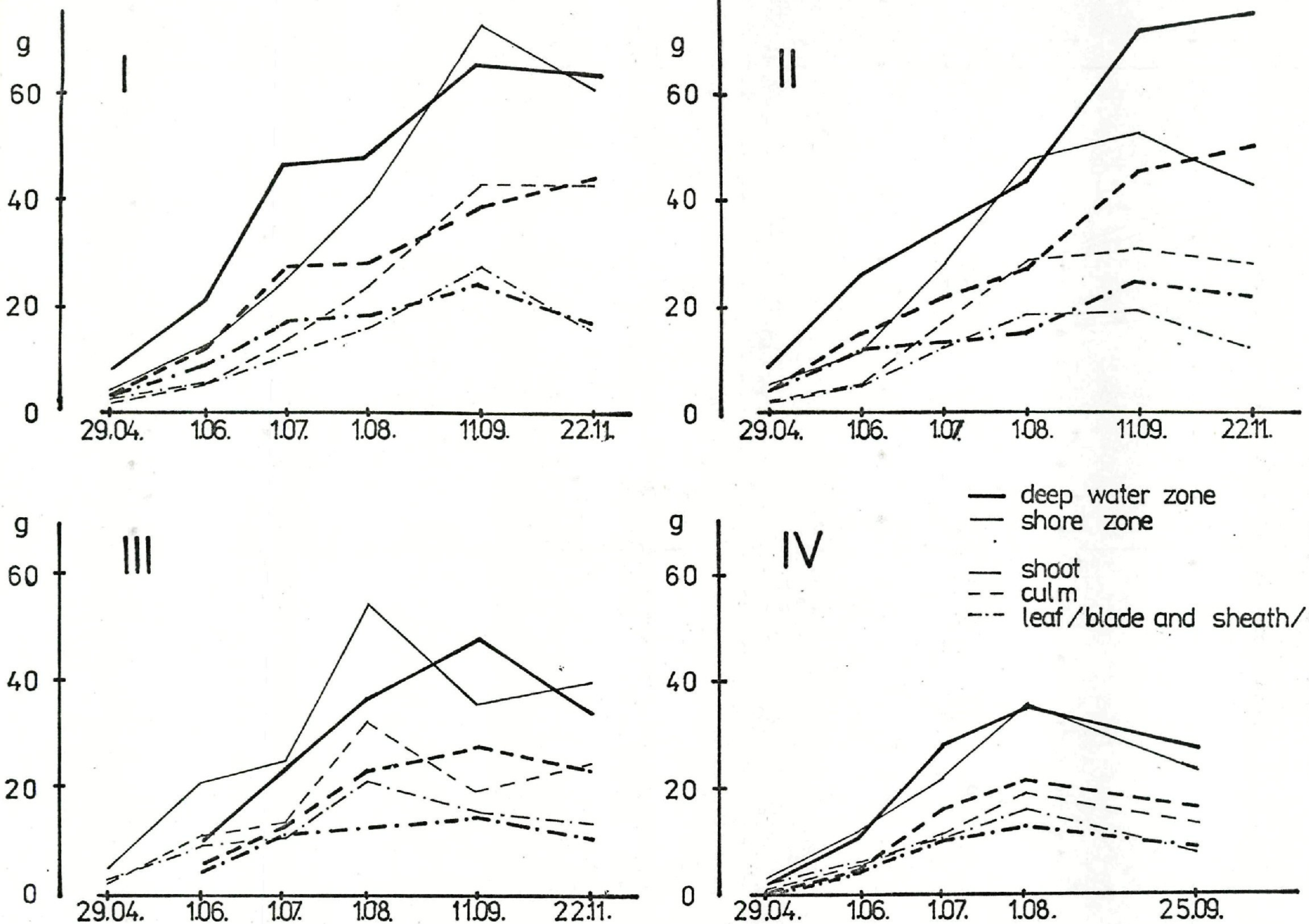

Fig.6. Shoot and its organs weight in the growing season

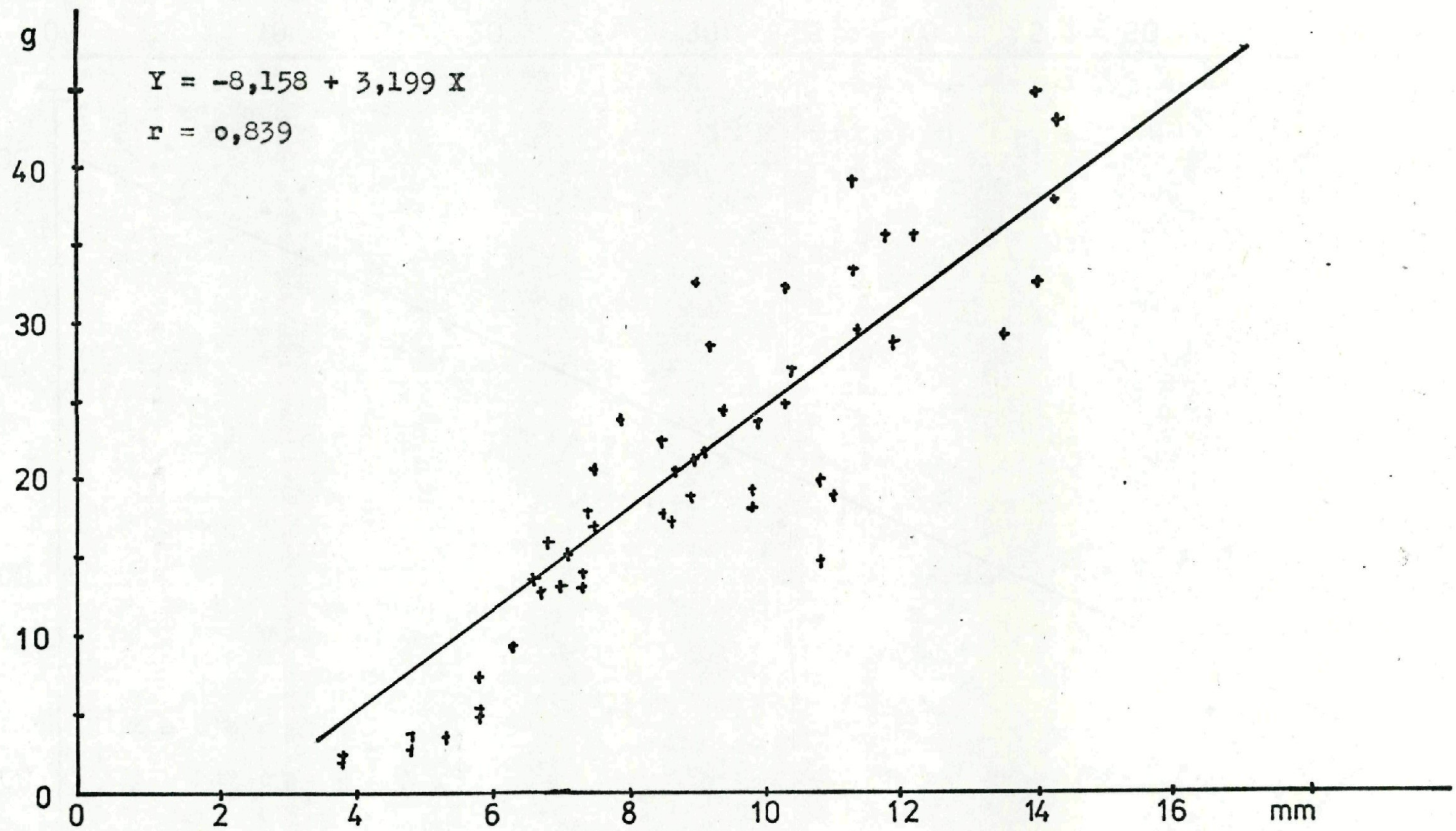

Fig.7. Relationship between the basal diameter of culm and culm weight

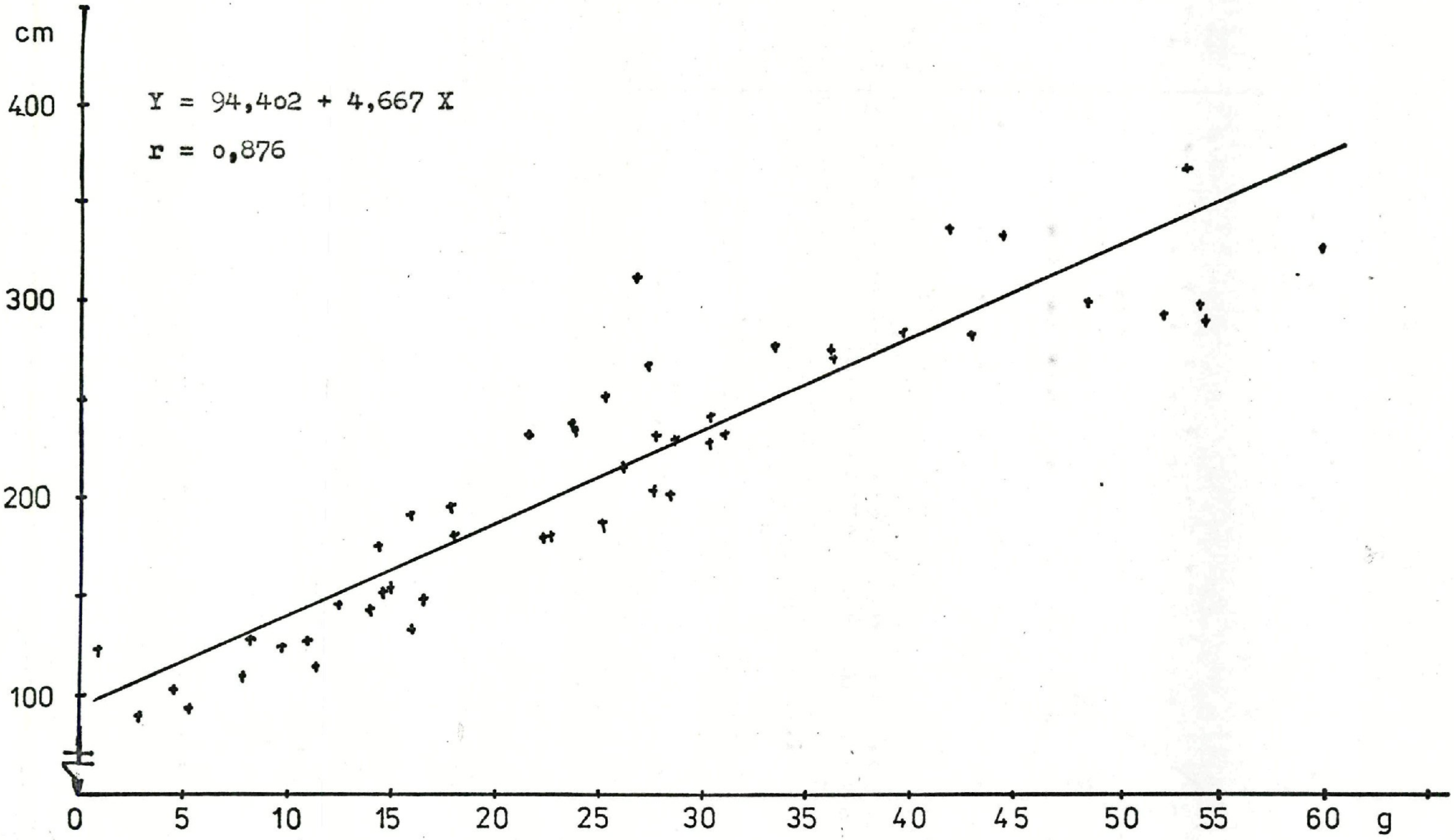

Fig.8. Relationship between shoot weight and culm height