THE APPLICATION OF UNDERWATER STEREOPHOTOGRAMMETRY TO ECOLOGICAL STUDIES OF MACROPHYTES

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Abstract

The paper describes technical and methodical solution for close range underwater photogrammetry, applicable to hydrophytoecology. Selected stereogram and maps are presented to show the ecological processes that were studied photogrammetrically.

Macrophytes growing on the floor of lakes, rivers and seas are less accessible to the ecologist than are terrestrial plants. This is due to the specific features of the aquatic environment, where man, despite the achievements in technology, feels uncertain. Efforts aimed at improving methods for in situ studying should therefore also search for possibilities of reducing the time of staying under water. This is possible when close range underwater photogrammetry is applied.

The subject of hydrophytoecological studies is to determine relations among living plant organisms, as well as between the latter and the aquatic environment where they are living. These relationship are considered in biocoenoses and populations, that is, at two hierarchical levels of the organization of ecological systems. The higher, i.e., the biocoenotic level has already been fairly commonly studied by means of photointerpretation techniques. They are used in cartometrical studies of vegetation /Lang 1969, Johnson, Harris 1980, Raitala et al.1985/ and in the assessment of its role in ecosystems /Wolff, Lindner 1974, Jacques 1983/. Here aerial /Lang 1969, Almkvist 1975, Jacques 1983/ and satellite /Raitala 1986, Raitala, Lampinen 1986/ photographs are used. The aim of this paper is to present the possibility of applying stereophotogrammetry to ecological studies of underwater plants. The intention is to improve traditional, very labour-consuming phytopopulation study methods by using underwater photogrammetric photographs of constant observation sites, taken at a short distance. Two stereograms made at times t_1 and t_2, will be used to illustrate the structure and organization of the population of a selected underwater plant species, and indicate ecological phenomena an processes that can be studied by photogrammetric techniques.

The stereograms were prepared by the method suggested by Lundälv /1971/, Rørslett et al. /1978/ and Beker, Kaczyński /1985/. As the reference points a stereometrical test, 0,5 x 0,5 x 0,1 m, was used with colour markers, 0.05 m long, on it /cf. Rørslett et al. 1978, Szmeja 1987/. The pictures were

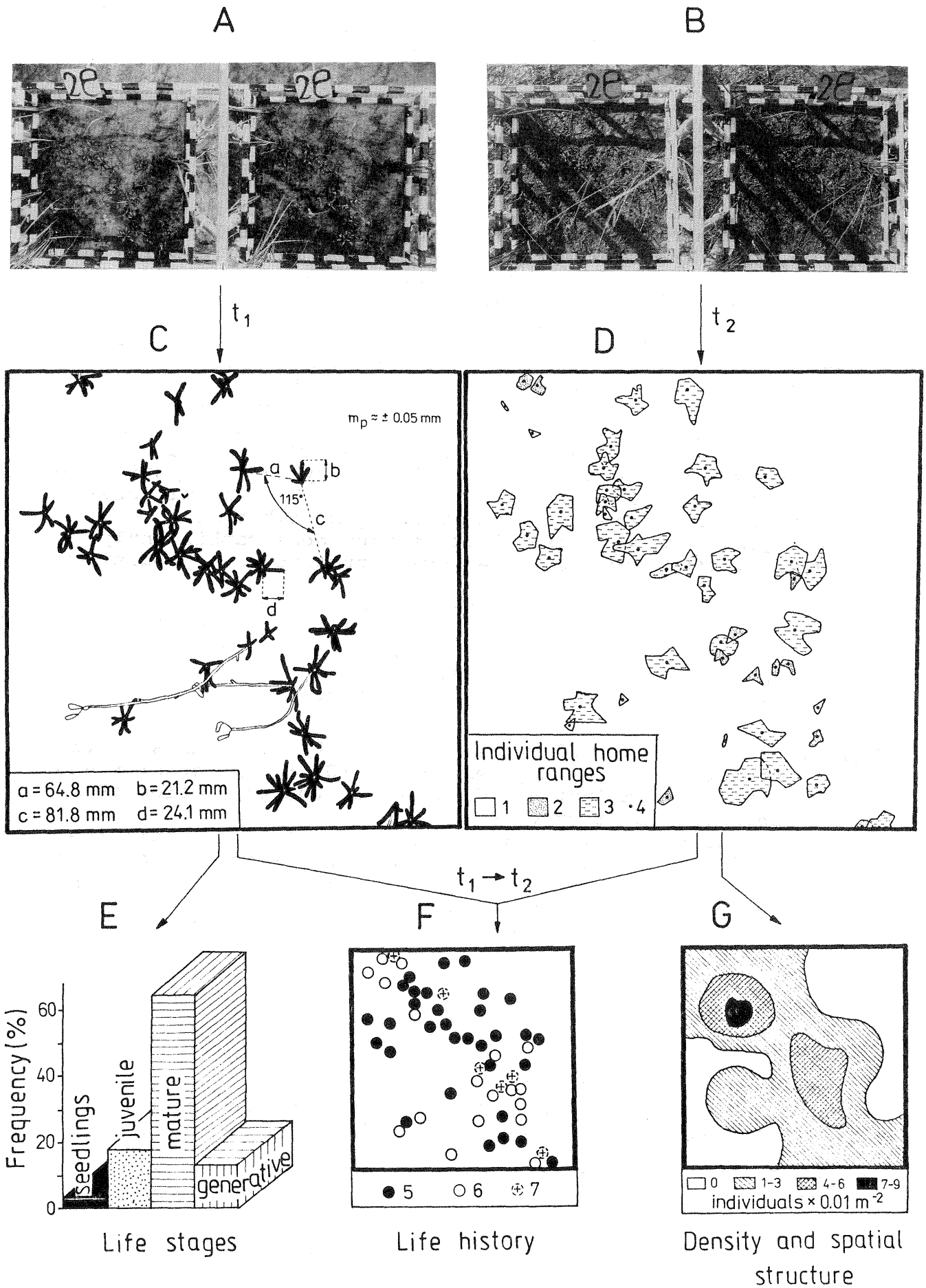
A
B
2e
2e
2e
2e
t1
t2
C
D
mp ≈ ± 0.05 mm
a
b
115°
c
d
a = 64.8 mm b = 21.2 mm
c = 81.8 mm d = 24.1 mm
Individual home ranges
1 2 3 4
t1 → t2
E
F
G
Frequency (%)
60
40
20
0
seedlings
juvenile
mature
generative
5 6 7
0 1-3 4-6 7-9
individuals × 0.01 m-2
Life stages
Life history
Density and spatial structure

Fig. 1

taken with the aid of a Pentacon Six-TL camera fitted with a Flektagon 4/50 mm objective and an underwater SZP-2 stereophotogrammetrical set-up in a water-tight casing /cf. Beker, Kaczyński 1985/. The set-up consisted of two Hasselblad 500 C/M cameras and a Distagon 4/50 mm objectives. A black and white panchromatic ORWO NP 22 /22 DIN, 125 ASA/ film, 60 x 60 mm in frame size, was used.

Parameters of stereogram taken by SP2-2: $\varphi_1 = \varphi_2 = 90^\circ$, base lenght 0.255 m, true photographic distance 0.90 m, apparent distance 0.63 m, adopted index of refraction in water $n_w = 1.33$, base ratio V= 1 : 3.5, objective focal lenght in water 66.5 mm. The stereograms were plotted in a 1:2 scale on a Zeiss Jena Topocart. Measurement error RMS = ± 0.5 mm.

Evaluation of the usefulness of stereograms /Fig. 1/:

1. In the pictures /A, B/ taken in two different time /t_1, t_2/ in a scale about 1:17, all the individuals of the plant species under study can be identified and counted: Nt_1 = 38 /C/, Nt_2 = 49 /D/; t_1 /1986.06.12, t_2 /1986.09.30/.
2. Biometric characteristics of living individuals /C/, as well as their seasonal variation, e.g., biomass increase per unit time, can be determined with sufficient accuracy.
3. This provides valuable material for studying the spatial relation between plants, e.g., the size of individual areas and their arrangement /D/ and variation with time.
4. Stereograms are very useful in various demographis analyses, e.g. studying the life-stage structure of a population /E/.
5. It is possible to use stereopair taken underwater in studies of population dynamics, especially of: fecundity, mortality, survival, and rate of individual /F/ or generation rotation, as well as in the assessment of the spatial structure type /G/ and its changes with time.

Fig. 1. An example use of stereograms /A, B/ in studies of the structure /C, D, E/, demography /D, E, F/, density and spatial organization /C, D, G/ of the population of a selected plant species
1 - seedling, 2 - juvenile individual, 3 - mature individual, 4 - shoot growing point, 5 - individuals which survived from time t_1 to t_2; 6 - a cohort of seedlings and juvenile shoots which survived from time t_1 to t_2; 7 - individuals which died between time t_1 and t_2.

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