

FUNCTION OF PHYTOPSAMMON IN CAPTURING BIOGENES AT  
THE LAND/WATER ECOTONE IN MESOTROPHIC LAKE PIASECZNO

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**Abstract.** In 1996–1998, the photosynthetic activity of psammic and plankton algae communities of the eulittoral was studied in the near-shore zone of Lake Piaseczno (Łęczna-Włodawa Lakeland, Eastern Poland). Based on the C:N:P weight ratio in the process of photosynthesis, the quantities of carbon, nitrogen and phosphorus consumed by phytosammon and phytoplankton communities during 1 day were calculated. The eupsammon had the highest count of assimilated carbon (from 791.5 in the spring to 1411.7 mg C m<sup>-2</sup> day<sup>-1</sup> in the summer), nitrogen (130.1 in the spring and 232.5 mg N·m<sup>-2</sup>·day<sup>-1</sup> in the summer) and phosphorus (17.9 in the spring and 31.9 mg P m<sup>-2</sup> day<sup>-1</sup> in the summer). The lowest quantities of assimilated elements were recorded in the psammolittoral phytoplankton.

**Key words:** lake, algae, psammon, psammolittoral, photosynthetic activity, nutrients

INTRODUCTION

Changes in land development and land use in the catchment area, besides such factors as earth grain composition, water depth, high daily temperature fluctuations and nutrient content, have the decisive effect on the chemical composition of underground water, lake water and the distribution of macrophytes and algae communities in the near-shore zone lake. If plant communities – e.g. certain macrophyte species – subside in the catchment area or eulittoral, their place and physiological function is taken over by other macrophytes, and in special cases by algae communities [4]. In numerous oligo- and mesotrophic lakes, macrophytes are completely absent from the sandy littoral and sandy bottom of the lake, while the communities found there have unique algae species.

In the psammolittoral of Lake Piaseczno, 31 such species have been found [3].

A community of such algae living on the sand surface or in its deeper layers, up to several meters inland from the coastline is referred to as phytoeupsammon, while that living in the area permanently covered with water as phytohydropsammon [2]. The study of the physiological activity of these communities demonstrated that these algae, as the first link in the food chain, play a major role not only by producing through photosynthesis organic compounds and oxygen, but also by drawing and capturing in the same process nutrients flowing from the catchment area to the lake. Therefore one is justified to ask if there are natural mechanisms in the psammolittoral in the absence of macrophytes, that results in capturing nutrients flowing from the catchment area to the lake or perhaps this function is taken over by psammic algae?

#### MATERIAL AND METHODS

The research was conducted in the psammolittoral of Lake Piaseczno (23° 02' E, 51° 23' N). It is a mesotrophic no run-off lake [1, 6] located in the Łęczna-Włodawa Lakeland, in Eastern Poland. The research was conducted in 1996-1998, always in the spring, summer and autumn, in the total of 12 sessions.

The phytosammon photosynthetic activity was measured directly using the author's own method of light and dark bottles, 175 ml each, based on the titrated Winkler method for measurement of the concentration of oxygen in water, produced during photosynthesis, without disturbing the structure of the sandy soil sampled [2].

The photosynthetic activity of phytoplankton in the psammolittoral was measured using the traditional method. The *in situ* expositions lasted from sunrise to sunset. The results obtained helped to determine the quantity of assimilated carbon, nitrogen and phosphorus during one day of exposition. The quantity of nutrients assimilated during photosynthesis by psammic and plankton algae communities was calculated based on the C:N:P weight ratio = 41.4:7.3:1, following from the chemical photosynthesis formula, and the quantities of assimilated carbon was calculated assuming that 1 g of oxygen produced = 0.312 g of carbon bound [5]. Standard deviations (SD) and variation coefficients ( $V = SD/\text{mean} \cdot 100$ ) were calculated, being the measure of dispersion of results from the mean.

#### RESULTS AND DISCUSSION

In all research sessions, eupsammon algae – in contrast to hydropsammon and phytosammon algae – demonstrated highest photosynthetic activity. They as-

simulated highest quantities of carbon, nitrogen and phosphorus.

The quantities of carbon assimilated in the eupsammon community ranged from 495.72 in the spring of 1998 to 1687.92 mg C m<sup>-2</sup> day<sup>-1</sup> in the summer of 1996; and in hydrosammon from 407.89 in the spring of 1996 to 1484.48 mg C m<sup>-2</sup> day<sup>-1</sup> in the summer of 1997. The psammolittoral phytoplankton generated least carbon: from 119.54 to 389 mg C m<sup>-2</sup> day<sup>-1</sup>. The mean annual figures for different communities varied, in eupsammon and plankton they were highest in 1996, and in hydrosammon in 1997 (Tab. 1).

**Table 1.** Quantities of carbon assimilated (in mg C m<sup>-2</sup> day<sup>-1</sup>) by phytopsammon and phytoplankton in the individual research seasons in Lake Piaseczno

EUPSAMMON	Spring	Summer	Autumn	Mean of years
1996	1068.14	1687.92	875.56	1210.54
1997	495.72	1624.88	929.14	1016.58
1998	810.56	922.28	731.94	821.59
N	3	6	3	
Mean of season	791.47	1411.69	845.55	
SD	234.08	347.02	83.26	
V	29.58	24.58	9.85	
HYDROPSAMMON				
1996	407.86	1245.68	786.19	813.25
1997	573.38	1484.48	896.02	984.62
1998	614.86	522.24	1006.24	714.44
N	3	6	3	
Mean of season	532.03	1084.13	896.15	
SD	89.42	409.10	89.83	
V	16.81	37.74	10.02	
PHYTOPLANKTON PSAMMOLITTORAL				
1996	300.83	364.32	389.00	351.39
1997	210.12	281.92	227.30	239.78
1998	119.54	329.20	383.06	277.27
N	3	6	3	
Mean of season	210.17	325.15	333.12	
SD	74.01	33.76	74.87	
V	35.22	10.38	22.47	

The largest quantities of nitrogen and phosphorus, as in the case of carbon, were assimilated by eupsammon algae in summer time. The average value for season was 232.45 mg N m<sup>-2</sup> day<sup>-1</sup> and 31.89 mg P m<sup>-2</sup> day<sup>-1</sup>. The minimum figures were reported in the spring of 1997 – 81.49 and 11.18 and maximum in the summer of 1996 – 277.48 mg N m<sup>-2</sup> day<sup>-1</sup> and 38.07 mg P m<sup>-2</sup> day<sup>-1</sup>. In the eupsammon, the

mean figure was highest in 1996 and in hydropsammon in 1997: respectively 199 and 161.9 mg N m<sup>-2</sup>day<sup>-1</sup> and 31.89 and 33.48 mg P m<sup>-2</sup> day<sup>-1</sup>. In the phytoplankton, these two elements were assimilated by algae in lower amounts, ranging from 19.65 to 63.95 mg N m<sup>-2</sup> day<sup>-1</sup> and from 2.7 to 8.77 mg P m<sup>-2</sup> day<sup>-1</sup> (Tab. 2).

**Table 2.** Quantities of nitrogen assimilated (in mg N m<sup>-2</sup> day<sup>-1</sup>) by phytopsammon and phytoplankton in the individual research seasons in Lake Piaseczno

EUPSAMMON	Spring	Summer	Autumn	Mean of years
1996	175.594	277.480	143.934	199.00
1997	81.492	267.117	151.616	166.74
1998	133.249	152.744	120.325	135.44
N	3	6	3	
mean of season	130.11	232.45	138.62	
SD	38.48	56.52	13.31	
V	29.58	24.31	9.60	
HYDROPSAMMON				
1996	67.049	204.779	129.243	133.69
1997	94.258	244.036	147.298	161.86
1998	101.077	85.852	165.417	117.45
N	3	6	3	
mean of season	87.46	178.22	147.32	
SD	14.70	67.25	14.77	
V	16.81	37.74	10.02	
PHYTOPLANKTON PSAMMOLITTORAL				
1996	49.454	59.891	63.949	57.76
1997	34.542	46.345	37.367	39.42
1998	19.652	54.118	62.973	45.58
N	3	6	3	
mean of season	34.55	53.45	54.76	
SD	12.17	5.55	12.31	
V	35.22	10.38	22.47	

The highest mean value was reported in the autumn – 54.76 mg N m<sup>-2</sup> day<sup>-1</sup> and 7.51 P m<sup>-2</sup> day<sup>-1</sup> (Tab. 3).

The comparison of the quantity of carbon, nitrogen and phosphorus assimilated by eupsammon (E), hydropsammon (H) and plankton (P) algae, and the calculated E : H : P ratio of 3.5 : 2.8 : 1, demonstrates a significant role for phytopsammon communities in drawing and capturing nutrients being washed out from the catchment area into the lake. Their highest photosynthetic activity in summer time (Fig. 1) demonstrates that during that period the quantities of nutrients the lake are the highest.

**Table 3.** Quantities of phosphorus assimilated (in mg P m<sup>-2</sup> day<sup>-1</sup>) by phytopsammon and phytoplankton in the individual research seasons in Lake Piaseczno

EUPSAMMON	Spring	Summer	Autumn	Mean of years
1996	24.09	38.07	19.75	27.30
1997	11.18	36.64	20.80	22.87
1998	18.28	20.95	16.51	18.58
n	3	6	3	
mean of season	17.85	31.89	19.02	
SD	5.28	7.75	1.83	
V	29.58	24.31	9.60	
HYDROPSAMMON				
1996	9.20	28.09	17.73	18.34
1997	12.93	33.48	20.21	22.21
1998	13.87	11.78	22.69	16.11
n	3	6	3	
mean of season	12.00	24.45	20.21	
SD	2.02	9.23	2.03	
V	16.81	37.74	10.02	
PHYTOPLANKTON PSAMMOLITTORAL				
1996	6.78	8.22	8.77	7.92
1997	4.74	6.36	5.13	5.41
1998	2.70	7.42	8.64	6.25
n	3	6	3	
mean of season	4.74	7.33	7.51	
SD	1.67	0.76	1.69	
V	35.22	10.38	22.47	

### CONCLUSIONS

1. The phytopsammon community demonstrated the highest photosynthetic activity, followed by the phytohydropsammon community, both of which assimilated far more nutrients than the phytoplankton of the lake's coastal area.
2. All communities assimilated drew largest quantities of nutrients in the summer and smallest in the spring.
3. As the sandy littoral has no macrophytes, at the land/water boundary they are replaced in the capturing of nutrients by mainly phytopsammon algae communities.

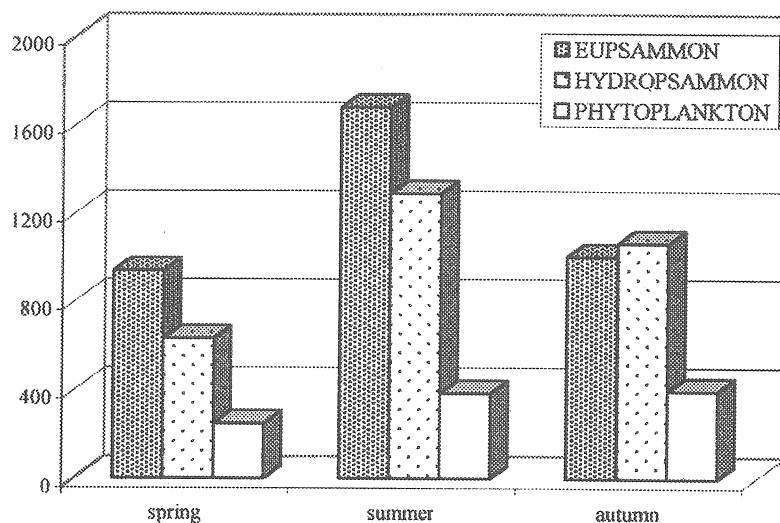


Fig. 1. Total quantities of carbon, nitrogen and phosphorus in mg (C+N+P) m<sup>-2</sup> day<sup>-1</sup> assimilated by psammic and plankton algae communities in individual seasons in lake/water ecotone of Lake Piaseczno

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## FUNKCJA FITOPSAMMONU W PRZEPLYWIE BIOGENÓW NA STYKU LĄD/WODA W MEZOTROFICZNYM JEZIORZE PIASECZNO

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**Streszczenie.** W latach 1996-1998 badano aktywność fotosyntetyczną zbiorowisk glonów psammonowych i planktonowych psammolitoralu w przybrzeżnej strefie jeziora Piaseczno (Pojezierze Łęczyńsko-Włodawskie, Wschodnia Polska). W oparciu o wagowy stosunek C : N : P w procesie fotosyntezy, wyliczono ilości węgla, azotu i fosforu pobierane przez zbiorowiska fitopsammonowe i fitoplanktonowe w ciągu 1 dnia. Fitoeupsammon charakteryzował się najwyższą wartością zasymilowanego węgla (od 791,5 wiosną do 1411,7 mg C·m<sup>-2</sup>·day<sup>-1</sup> w lecie), azotu (130,1 wiosną i 232,5 mg N·m<sup>-2</sup>·day<sup>-1</sup> w lecie) i fosforu (17,9 wiosną i 31,9 mg P·m<sup>-2</sup>·day<sup>-1</sup> w lecie). Najniższe wartości zasymilowanych pierwiastków odnotowano w fitoplanktonie psammolitoralu. Brak makrofitów i duża aktywność fizjologiczna glonów zbiorowiska eupsammonowego na lądzie oraz hydropsammonowego w wodzie strefy przybrzeżnej jeziora, świadczy o podstawowej roli tych zbiorowisk jako bariery ochronnej, w zatrzymywaniu spływających ze zlewni do jeziora substancji biogennych.

**Słowa kluczowe:** jeziora, glony, psammon, psammolitoral, aktywność fotosyntetyczna, nutrieny

