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THE CONCHOLOGICAL VARIABILITY OF *SPHAERIUM CORNEUM* (LINNAEUS, 1758) IN THE POLISH WATERS

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ABSTRACT: The conchological variability of *Sphaerium corneum* (Linnaeus, 1758) from Polish waters is manifested by the presence of two types of populations. All the features mentioned in the diagnosis show great variability. For instance the shell outline oscillates from oval to triangular or trapeziform. In some populations all the margins of the shells are much curved, in others the ventral margin is straight, joining the anterior and posterior ones at sharp angles. The variability of the shell colour is considerable, much like in other bivalve freshwater molluscs. The asymmetry of the shells, mentioned in the description of *S. corneum* "2nd type" is already distinctly marked in the appearance of the young.
The regression lines w/l (l) (width : length depending on length), w/h (l) (width : height depending on length), and w(l) (width depending on length) show that the first mentioned relation reflects more pronouncedly the differences between the manners of growth of the populations discussed. The regressive slope b (y = a + bx) is the best index of these differences. The values of that index change in the material studied from 1.5 (Ina river) to 7.28 (forest bogs – Makruty). The changes of the non-metric features presented in the diagnosis are parallel to the changes in the shell proportions.

KEY WORDS: *S. corneum*, bivalve, conchological variability

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The changes of the non-metric features presented in the diagnosis (Tab. 1) are parallel to the changes in the shell proportions.
Key words: S. corneum, bivalve, conchological variability.

Sphaerium corneum (Linnaeus, 1758) shows the greatest conchological variability among three Sphaerium species found in Poland. On account of the variability numerous forms, or even subspecies and species were described (Žadin 1952, Ehrmann 1956, Ellis 1962, Herrington 1962, Zeissler 1971). The paper is an attempt at a biometrical analysis of some populations of S. corneum from various types of water bodies. Some

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non-metric characters, for example: the shell outline, the position of the umbones, their shape, and the shell colour, have also been considered.

MATERIAL AND METHODS

The material was collected in 1975-1982; it was fixed in 4% formol or 75% ethanol. The shell dimensions: length (l), height (h), and width (w) were measured with 0.1 mm accuracy, according to the schems (Fig. 4A) by means of a scaled eyepice.

SAMPLING LOCALITIES

1. Makruty, 1977; a meadow bog near Olsztyn.
2. Sarąg lake, 1977; a slightly eutrophic lake near Olsztyn.
3. Jeziorak lake, 1975; an eutrophic lake near Iława.
4. Wigry lake, 1980; an oligo-, α-mesotrophic lake (Czeczuga 1979).
5. The River Rega, 1980; a drainage ditch flowing into the river.
6. Gardno lake, 1975; an eutrophic lake close to the Baltic Sea, the water very mobile.
7. The River Nida, 1977; southern Poland.
8. The River Radunia, 1980; a locality situated between two eutrophic lakes: Kłodno and Brodno Małe.
9. The River Bug, 1980; near Siemiatycze.
10. The Wieprz-Krzna Canal, 1980.
11. The River Ina, 1980; a small river near Przemocze (Szczecin province).
12. The River Narewka, 1980; a small river in the Białowieża National Park.
13. The River Warta, 1980; a river locality near Obrzycko.
14. Sławskie lake, 1975, near Sława (Zielona Góra province).
15. The River Młynówka, 1975; a small river near Cieszyn.
16. Pieskowa Skała, 1976; a pond in Pieskowa Skała, near Kraków.
17. Niepołomice Forest, 1975; forest bogs in the forest, southern Poland.

RESULTS

In the collected material the conchological variability is manifested in the presence of two types of populations. The diagnoses of the exemplary extreme ones are presented in Tab. 1, Fig. 2. All the

Table 1

Some conchological features of Sphaerium corneum (Linnaeus, 1758) in extreme populations

	"1st" type" populations: meadow bog Makruty near Olsztyn	"2nd type" populations: a Ina river (Szczecin province)
shell outline	oval-triangular, almost symmetric, strongly convex	oval-trapezoid, asymmetric, flat or slightly convex
colour	horny brown, growth lines darker	horny light brown, growth lines darker from time to time only, along the margin horny-yellow band sometimes
shell surface	concentrically striated	slightly concentrically striated
shell margin		ventral margin flattened, sometimes forming a keel
umbo	wide, prominent, somewhat bent anterad	narrow, somewhat bent anterad, slightly prominent and protruded
ligament	quite sheltered	quite sheltered
embryonic shell	flat, rather large, under magnification 20-30x almost smooth, sometimes a little protruded	relatively small, delicately concentrically striated under magnification 20-30x
hinge plate	feebly developed, narrow, delicate	under the umbones very narrow, lateral parts wider and more massive
cardinal tooth C2	short, high, curved	rarher long, high, curved
cardinal tooth C4	longer, thinner and lower than C2	as long as C3, thinner and lower than C2
cardinal tooth C3	thin, long, in the form of a biarmed plate with divided and delicately thickened ends	in the form of a weakly S-shaped curved plate, thickened and bifurcated at the posterior end
anterior and posterior teeth	thin and delicate	rather big and solid (massive)
habitat	small, densely overgrown, slowly flowing and stagnant waters, rarely greater water bodies	larger water reservoirs and running waters well oxygendted

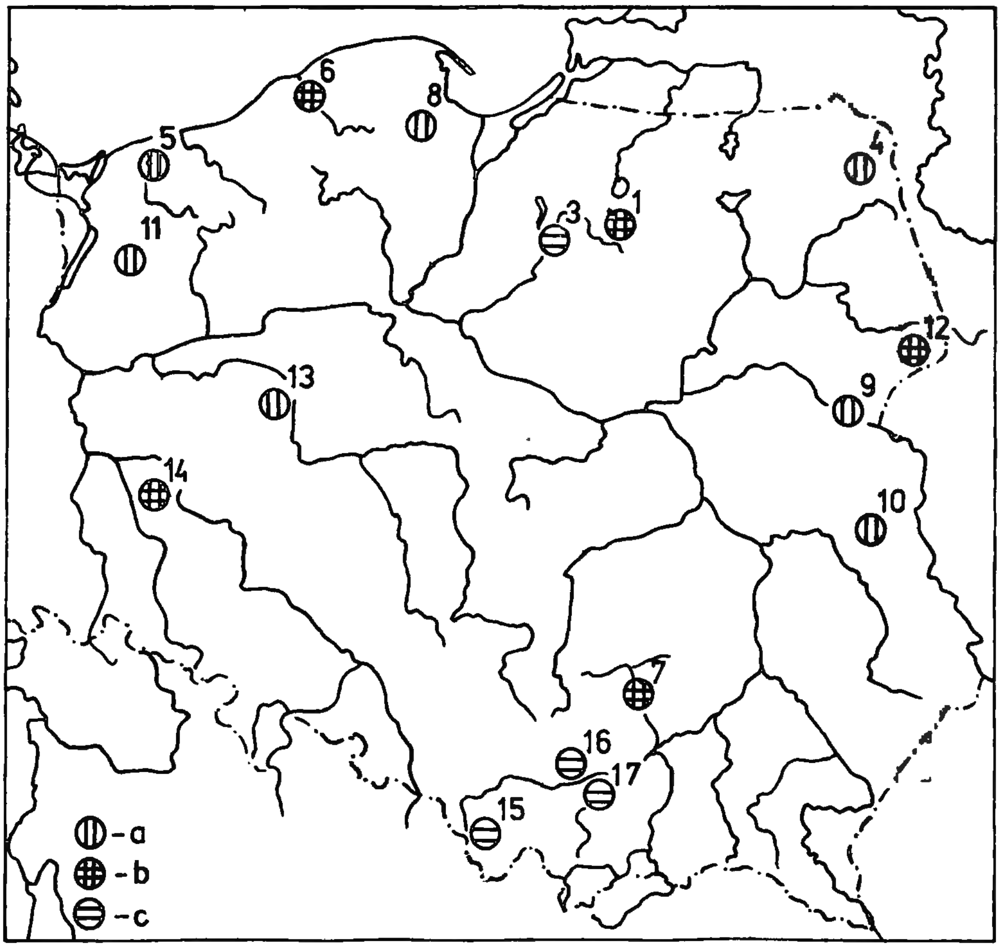

Fig. 1. Distribution of the localities: 1-17 number of the locality, a - - Sphaerium corneum "2nd type", b - S. corneum "1st" and "2nd type" sympathricaly, c - S. corneum "1st type"

features mentioned in the diagnoses show a great variability. The shell outline oscillates from oval to triangular or trapeziform. In some populations all the shell margins are much curved, in others the ventral margin is straight and joins the anterior and posterior ones at sharp angles. The anterior and posterior shell margins are also nearly straight. The flatness of the ventral margin, which forms a keel, occurs with a various frequency in the material of each "2nd type" population. The variability of the shell colour is considerable, much like in other molluscs. In some „2nd type" shells besides concentric bands colouring the growth lines, radial brown stripes occur with various intensity; they are often absent.

It is very difficult to describe the variability range of the hinge plate. However, concerning the previous data (e.g. Favre 1927) it is impossible to regard the hinge plate pattern as a crucial taxonomical feature in the systematics of Sphaeriidae, especially of the genus Sphaerium (Fig. 3).

The shell asymmetry mentioned in the description of the S. corneum "2nd type" is already distinctly marked in the appearance of the young. It was observed, for instance, in the population from the River Nida, where three age classes of young (in respect of their dimensions at least) were found in one adult. The smallest ones showed a well marked asymmetry.

BIOMETRICAL ANALYSIS

In the populations of both types changes in width : length (w/l) and width : height (w/h), depending on length, were analysed to compare with each other the modes of the individual width growth. The length was accepted as most directly connected with the age of an individual. The regression lines w/l (l) and w/h (l) in both cases are almost parallel to each other (Fig. 4B). Hence, in the biometrical analysis of the other populations height was omitted. It is confirmed by approximate values of the correlation coefficients of these parameters in the studied populations. For instace, they amount to 0.706 (w/h) and 0.745 (w/l) in the "2nd type" population, while in the "1st type" population they reach 0.9171 and 0.9467 respectively. In both cases the correlation coefficient of w/l (l) reaches higher values.

The correlation of the shell width (w) and its length (l) is closer. It amounts to 0.9960 in the "1st type" shells and 0.9792 in the "2nd type" ones. The dependence w(l) is generally rather a quadratic function, however, within the range of the experimental values it approximates to a linear dependence and is examined as such. Comparing the above with the w/l (l) dependence one can see that the latter reflects more pronouncedly the differences between the studied populations in respect of their growth mode (Fig. 5). The regressive slope (b) of the w(l) function is 1.5 times greater in the "1st type" populations than in the "2nd type" ones and several times greater respectively for the w/l (l) function (Fig. 4B).

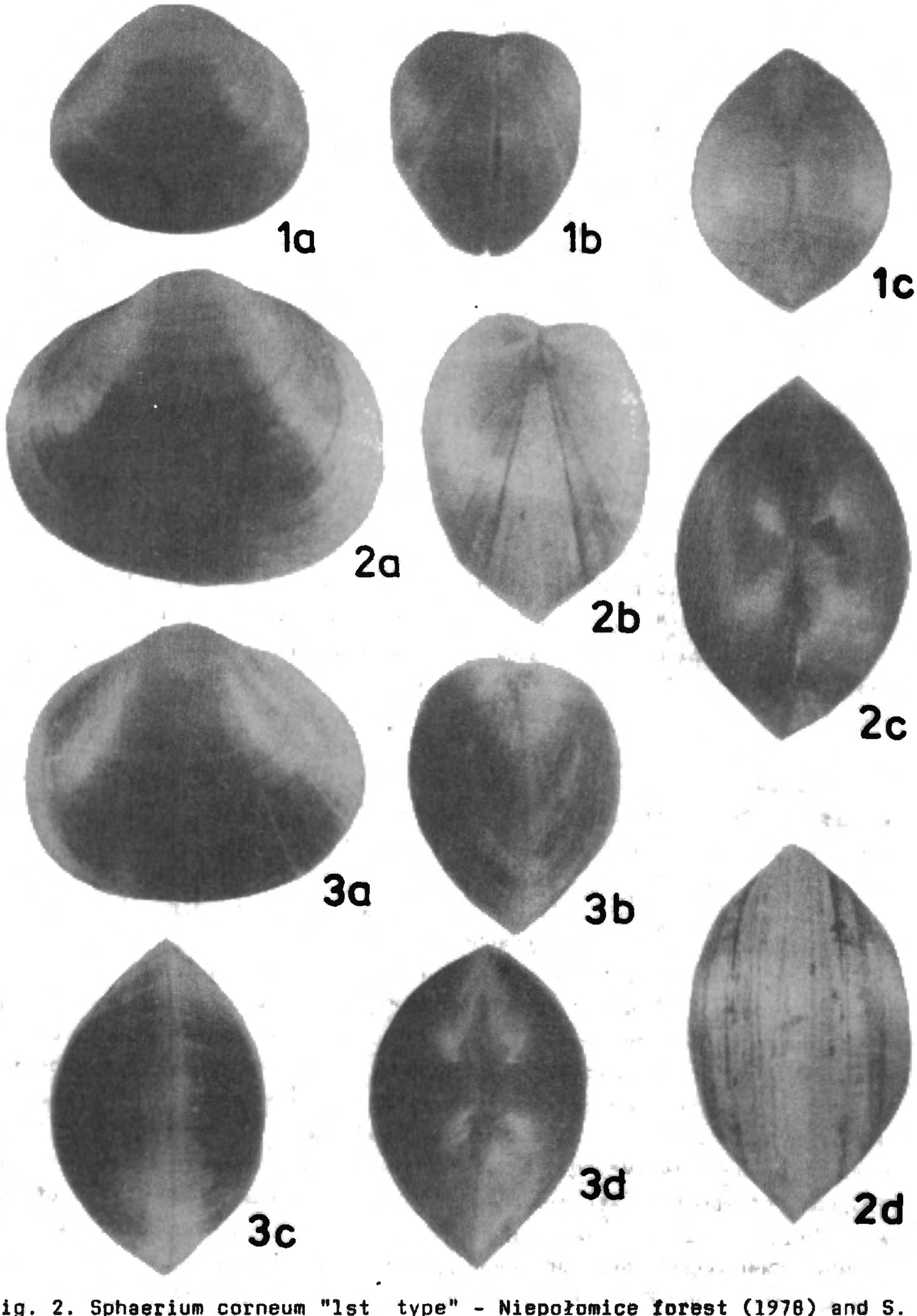

Fig. 2. Sphaerium corneum "1st type" - Niepołomice forest (1978) and S. corneum "2nd type" - Ina river (1980): 1 - S. corneum "1st type": a - side view, b - frontal view, c - dorsal view; 2 - S. corneum "2nd type": a - side view, b - frontal view, c - dorsal view, d - ventral view; 3 - S. corneum "2nd type" juv.: a - side view, b - frontal view, c - ventral view, d - dorsal view

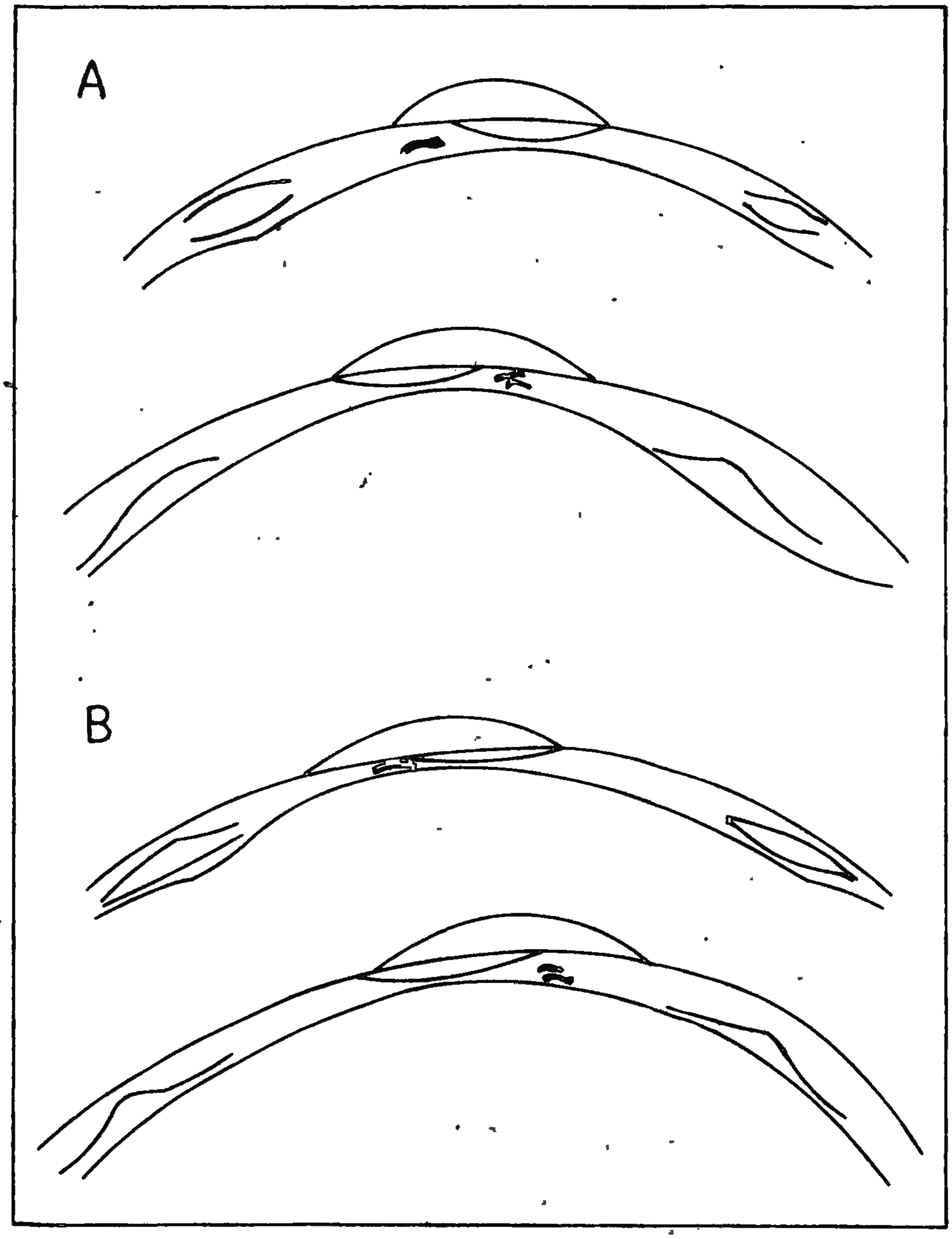

Fig. 3. The hinge plate of (A) S. corneum "1st type" from Sarąg Lake (1977) and (B) of S. corneum "2nd type" from Bug river (1980)

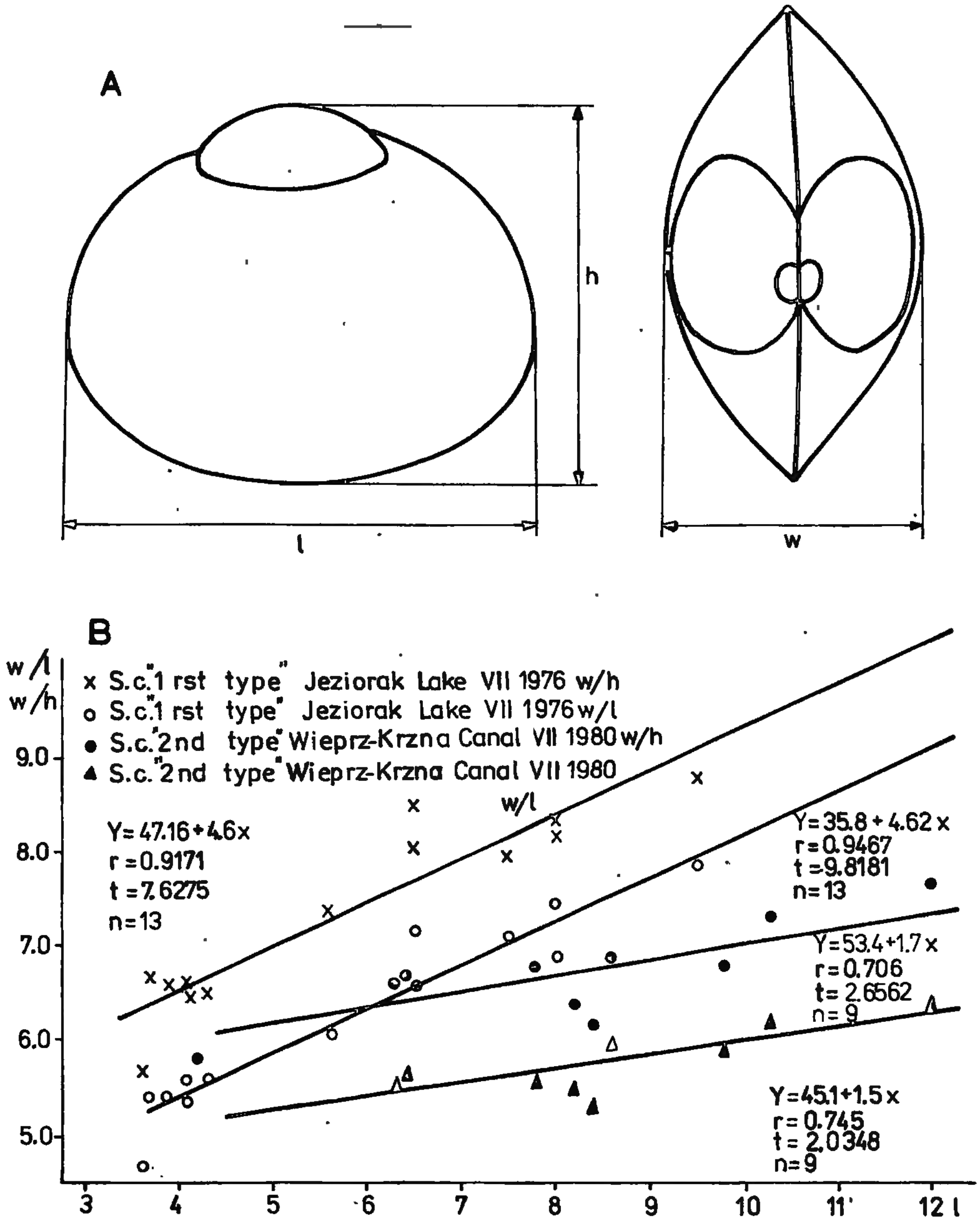

Fig. 4. A - scheme of measuring of the shells, B - regressions of w/l (1) and w/h (1) in the *Sphaerium corneum* populations from Jeziorak Lake and Wieprz-Krzna Canal

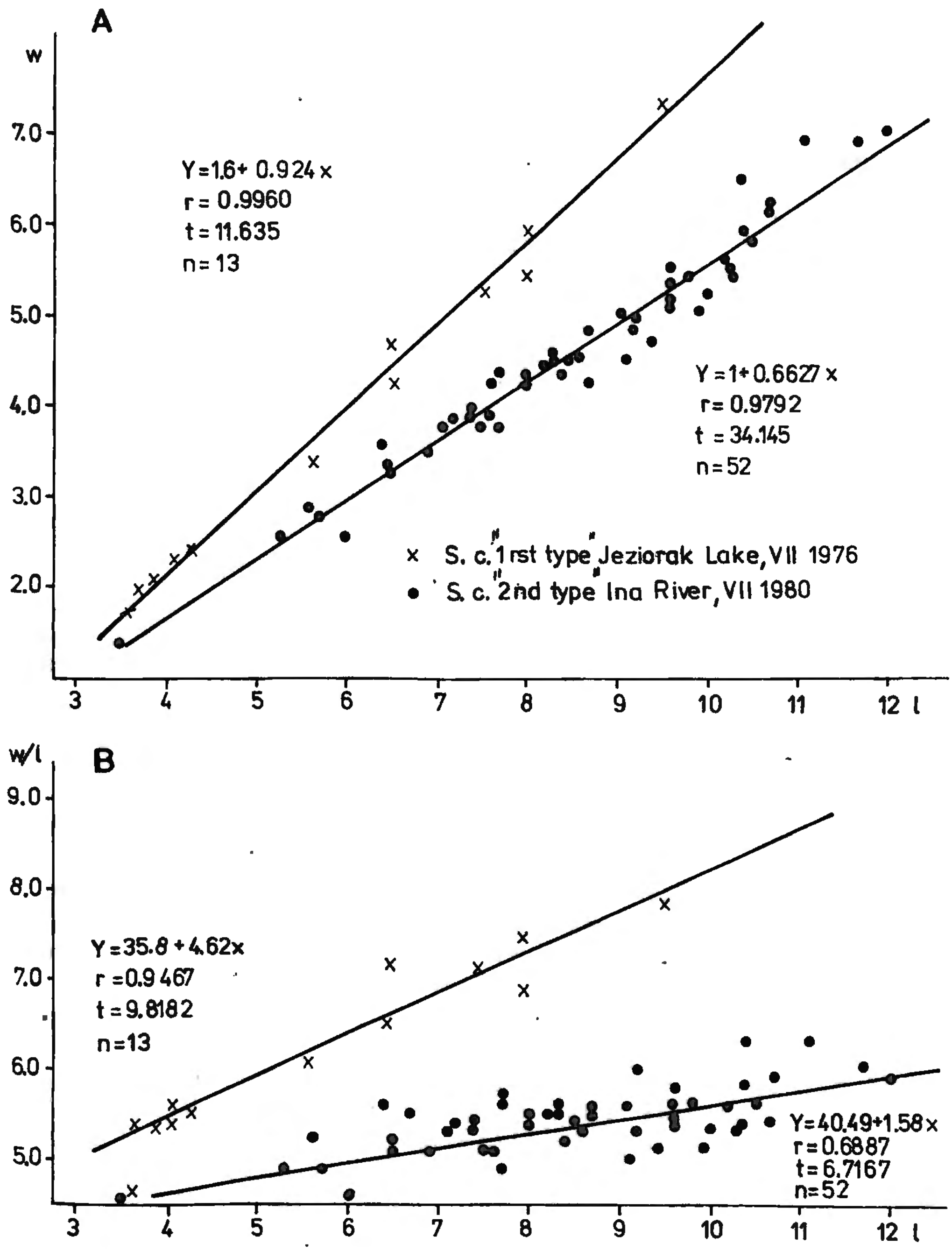

Fig. 5. Regressions of w(l) - A, and w/l (l) - B, in the populations of <u>Sphaerium corneum</u> "1st type" from Jeziorak lake and of <u>S. corneum</u> "2nd type" from Ina river

Table 2

Correlation coefficients (r), regressive intercepts (a), regressive slopes (b) of the dependences w/l(l) and standard deviations (SX, SY) in the S. corneum populations from localities

Localities	r	a	b	SX	SY
1. Makruty, 1977, meadow bog near Olsztyn	0.95	23.41	7.29	1.45	11.39
2. Jeziorak lake, 1976	0.96	34.95	4.78	2.00	9.95
3. Wigry lake, 1980 near Stary Folwark	0.79	33.32	3.44	1.88	8.14
4. Drainage ditch flowing into the Rega river, 1980	0.97	31.79	3.19	3.23	10.60
5. Gardno lake, 1975	0.71	41.14	3.02	1.99	8.51
6. Nida river, 1977	0.65	37.31	2.49	1.54	5.87
7. Sarąg lake, 1977	0.89	42.99	2.27	2.77	7.08
8. Radunia river, 1980	0.73	46.85	2.07	2.28	6.46
9. Bug river, 1980 near Siemiatycze	0.74	38.88	1.65	1.82	4.05
10. Wieprz-Krzna Canal, 1980	0.81	43.74	1.62	1.83	3.67
11. Ina river, 1980	0.65	40.59	1.57	1.77	4.07

The significance of the regression of the discussed dependence was verified using t^*test (Parker 1978). The t values obtained here correspond, except three cases, to the probabilities 0.001; thus, the parameters discussed are highly significantly correlated. In the populations from the Wieprz-Krzna Canal and the River Radunia the t values correspond to greater probabilities (0.02 p 0.05 for w/h (l) and 0.05 p 0.1 for w/l (l) - Wieprz-Krzna Canal, 0.002 p 0.01 for w/l (l) - the River Radunia) but they lay within the limits of error.

The values of the regressive slope (b; $y = a + bx$) are listed in Table 2. They reflect the slope angle of the regression lines w/l (l) and illustrate the width growth rate. In the studied material they vary from 1.5 (the River Ina) to 7.28 (forest bogs in Makruty). The poles of the variability are the populations from the ecologically antagonistic localities. In the closed, overgrown bog pits in a pine forest the sphaeriids grow in width rather fast; their shells are very convex. On the contrary, on a well oxygenated locality (the bottom overgrown with sponges) the shells of the species studied are flat: the slope angles of the regression lines are far more acute. The variability of the non-metric features listed in the diagnosis (Tab. 1) is parallel to the variability of the shell proportions.

DISCUSSION AND CONCLUSIONS

The interpretation of the above observations is very difficult for several reasons. For many years the results of conchological and biometrical studies have been applied in the mollusc systematics (Nilsson 1956, Waldén 1966). The main principles of the application as well as the criteria and methods used are differentiated and often criticized, considering at least the great conchological variability which in many cases makes the use of the shell features in the determination impossible (e.g. Lymnaeidae: Roszkowski 1915, Falniowski 1980; Zonitidae: Riedel 1957). However, examples of the usefulness of the morphometric and conchological characters in the Bivalvia taxonomy are more numerous. Holopainen and Kuiper (1982) tried the application of morphometric indices in the identification of Sphaeriidae. They used the shell height: : shell length ratio and the shell width : double shell height ratio as indices. The indices have not been applied in the present paper. They are more weakly correlated with the specimen length than the w/l ratio, moreover, relatively low values of the regression coefficient b indicate only a slight linear tendency and the regression illustrates poorly the variability of the mentioned parameters (Parker 1978). Similar values of these indices were found for S. corneum specimens from Poland. It was acknowledged that the regression w/l (l) presents a more differentiated picture: it indicates better the differences between populations, additionally, the coefficients of this regression are pronouncedly different from zero; in the studied examples the regression is highly significant.

The discussed S. corneum populations show a great conchological variability and differ between each other mainly in respect of their width growth rate. The differences are best illustrated by the dependences w/l. The habitats of the studied populations are extremely differentiated in many respects. The water fecundity (i.e. food resources) does not seem the most important factor of the width growth. The size of gills which act as brood pouches determines the convexity of a specimen. The close correlation between the length and width of the shells in the "1st type" populations (Fig. 5A) which live in eutrophic habitats under rather bad oxygen conditions, as well as parallelly the higher regressive slope (b) of the w/l (l) dependence in this group

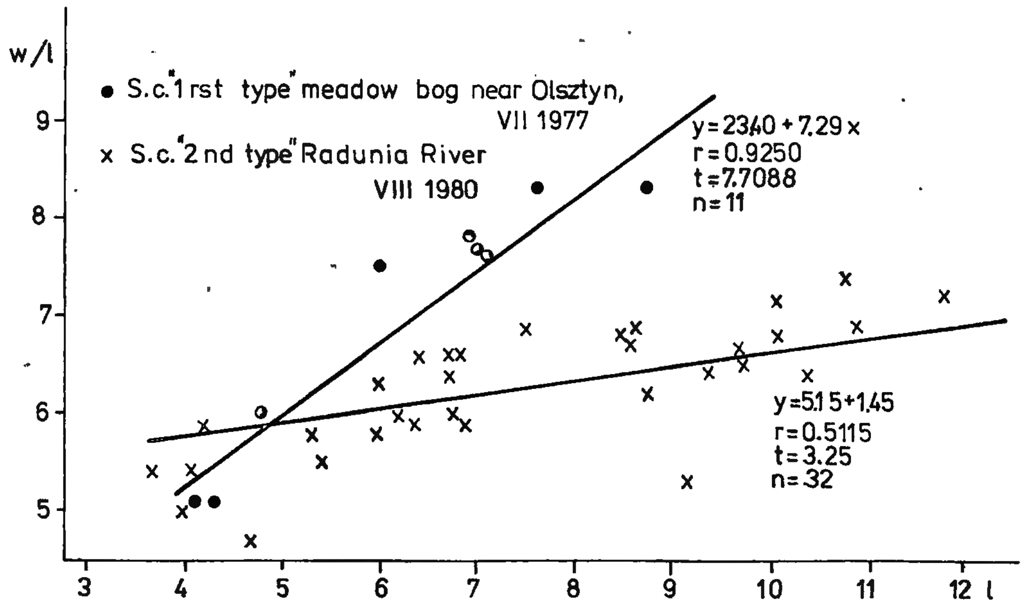

Fig. 6. Regressions of w/l (l) in the populations of S. corneum "1st type" from a meadow bog near Olsztyn and S. corneum "2nd type" from Radunia river

(Fig. 5B, Tab. 2) indicate the following: S. corneum grows in width as fast as possible in the habitats with a low oxygen content. In extreme cases the diameter (width) almost equals the length of the shell (ca. 90%). It may prove the tendency of the maximum increase of the gill surface. As a result, in small water bodies and various kinds of the stagnant parts of lakes, especially of those strongly eutrophic, S. corneum specimens are very convex. They are less convex or even flat under good exygen conditions, in very mobile vaters, slightly eutrophic and pure (the River Ina). The values of the regressive slope (b) of the w/l (l) dependence are lower (Fig. 6, Tab. 2).

The variability of the other conchological features mentioned above (Tab. 1) accompanies the presented biometrical differentiations of S. corneum. The ecological interpretation of this variability is very problematic: the more or less circular or trapezoid outline, asymmetry etc. may be connected with the water mobility. Hence, for instance asymmetry is manifested very early in the development of Sphaerium. The colour variability has been commonly attributed to the habitat chemical properties. The question of the systematical interpretation of the above phenomena remains open. It is commonly known that the studied variability was the basis of numerous descriptions of forms (f. firma Clessin, f. nucleus Studer, f. lacustris Draparnaud). Perhaps even S. corneum scaldianum (Normand,1844) is one of the examples. The sympatric occurrence of both the extreme conchological types of S. corneum (Fig. 1) that might be identified with S. corneum corneum ("1st type") and S. corneum scaldianum ("2nd type") points out the necessity of a revision of their systematic position. However, such a revision would need thorough taxonomic studies based on modern cytological and biochemical methods. The diagnosis of S. scaldianum (see Žadin 1952) does not fully correspond with the description of the specimens from the "2nd type" populations. However, it seems that since the distinct character of the two types of populations has been recognized, the diagnosis of S. scaldianum should constitute a basis for the discussion on their systematic position .

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ZMIENNOŚĆ KONCHOLOGICZNA SPHAERIUM CORNEUM (LINNAEUS, 1758) W POLSKICH WODACH

S t r e s z c z e n i e : Zmienność konchologiczna Sphaerium corneum (Linnaeus,1758) przejawia się obecnością dwóch typów populacji. Osobniki owalne, pękate zamieszkują małe, silnie zeutrofizowane zbiorniki wodne, osobniki trójkątne i trapezoidalno-owalne, mniej pękate żyją w akwenach o lepszych warunkach tlenowych i ruchliwszej wodzie. Dobrym wskaźnikiem tej zmienności wydaje się być wartość współczynnika regresji b(y= = a + bx). Zmienności cech mierzalnych towarzyszy równoległa zmienność cech niemierzalnych.

Zaobserwowane formy identyfikować można z S. c. corneum i S. c. scaldianum Normand, 1844. Ustalenie ich właściwej pozycji systematycznej jest jednak obecnie niemożliwe, tym bardziej że stwierdzono ich występowanie sympatryczne (Fig. 1), co nie pozwala uznać warunków siedliskowych za czynnik decydujący o skali zmienności.