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CHARACTERISTICS OF YOUNG SEA TROUT *(SALMO TRUTTA* M. *TRUTTA* L., 1758*)* GROWING IN POMERANIAN RIVERS TO THE SMOLT STAGE

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ABSTRACT

The study on the young (from 1-month-old larvae to smolts) sea trout (*Salmo trutta* m. *trutta)* in Pomeranian rivers involved 21 morphometric characters and 10 meristic characters, opercular bone pattern, anal fin shape, pyloric caeca count, and coloration.

The body and fin coloration were among the earliest species-specific characteristics appearing in the sea trout; the young fish acquired coloration in autumn, when aged 0+ and when measuring 6-10 cm in the fork length. The dynamics of some characters such as the caudal peduncle, caudal fin indentation, and upper jaw length began as early as in 4-5-month-old individuals. Other characters, e.g., opercular bone pattern, could be observed in the fish aged 1+. Some other characters, e.g., anal fin shape in the young trout, did not resemble those in adults. The study demonstrated differences in the dynamics and a high variability of morphometric and meristic characters in sea trout individuals that had been growing in various streams.

Key words: morphometric characters, meristic characters, coloration, *Salmo trutta m. Trutta.*

INTRODUCTION

The sea trout (*Salmo trutta* m. *trutta* L., 1758), a salmonid, occurs in some Pomeranian rivers [7, 8] and, as a result of stocking, is at present more and more common [1, 2]. The literature have most frequently dealt with adults [1, 2, 3, 6, 8, 9], the young trout receiving much less attention [4, 23]. More attention given to the young sea trout would be helpful in differentiating between the sea trout and other species, particularly the salmon. In addition to dealing with morphometric characteristics, numerous publications on the sea trout provided data on the number of chromosomes [25, 32], protein polymorphism [37], mitochondrial DNA structure [36], and osteological analysis [14, 15, 18]. On the other hand, there is a lack of a more in-depth analysis of the young sea trout morphometry. Such an analysis would be helpful in identifying live individuals without any sophisticated equipment. This study was intended to fill the gap. In addition, the data presented complement the characteristics of the young sea trout grown in streams of Western and Central Pomerania in Poland. Knowledge on ranges of typical characters of the sea trout at various ages, coupled with habitat chara-cteristics, allows to develop a template of a kind, helpful in species identification. Linking variability of individual characters with age and habitat of origin provides an additional factor with which to broaden characterisation of the juvenile sea trout.

The data make it possible to compare the Pomeranian sea trout with populations from other areas and will form a basis for further monitoring of the sea trout in the area of study.

The paper describes gradual emergence of species-specific characters in young sea trout ranging in age from early larvae to smolts.

MATERIALS AND METHODS

The study involved fish obtained from the Polish Anglers'Association hatchery at Goleniów, intended – as 1-month-old larvae - for stocking; individuals already stocked in selected streams were used as well. The fish were acquired within 1988-2000 from streams of Western and Central Pomerania (Fig. 1). The Pilchowianka yielded 3 samples obtained from July through September, while the remaining streams produced 1-2 samples each. A total of 298 individuals were examined (Table 1). Following capture, the fish were weighed and measured and examined; after their morphology was described, the fish were fixed. The fixed individuals were examined for a conventional morphometric analysis of the left side of the body [5, 10, 17, 28, 30, 38]. The analysis involved 21 metric and 10 meristic characters (Table 2); in addition, the opercular bone pattern [5] and the anal fin shape [24, 22] were analysed. The first ray of the anal fin as well as the distance between the beginning of the first ray and the tip of the terminal one (the p-k distance) was measured. The measurements were made with a callipers to 0.1 mm. Mean values and corresponding standard deviations as well as the condition coefficients of the fish are reported. The condition coefficient was calculated from the formula $K=W \cdot 100 \cdot L^{-3}$, where W is the body weight (g) and L is the body length (cm) [16]. The relative lengths of various parts of the head are reported as % *longitudo capitis*; the relative lengths of various parts of the body are given as % *longitudo caudalis* [3, 5], for which reason it was possible to follow the dynamics of various parameters of fish grown under natural conditions in streams differing in trophic status and other environmental conditions [35]. Analysis of various relative lengths allowed also to detect between-streams differences in the dynamics of certain parameters. Smaller individiduals were examined and measured under a stereomicroscope.

Fig. 1. Area of fish capture : 1 - Pilchowianka, 2 - Mołstowa, 3 - Gowienica, 4 - Wieprza

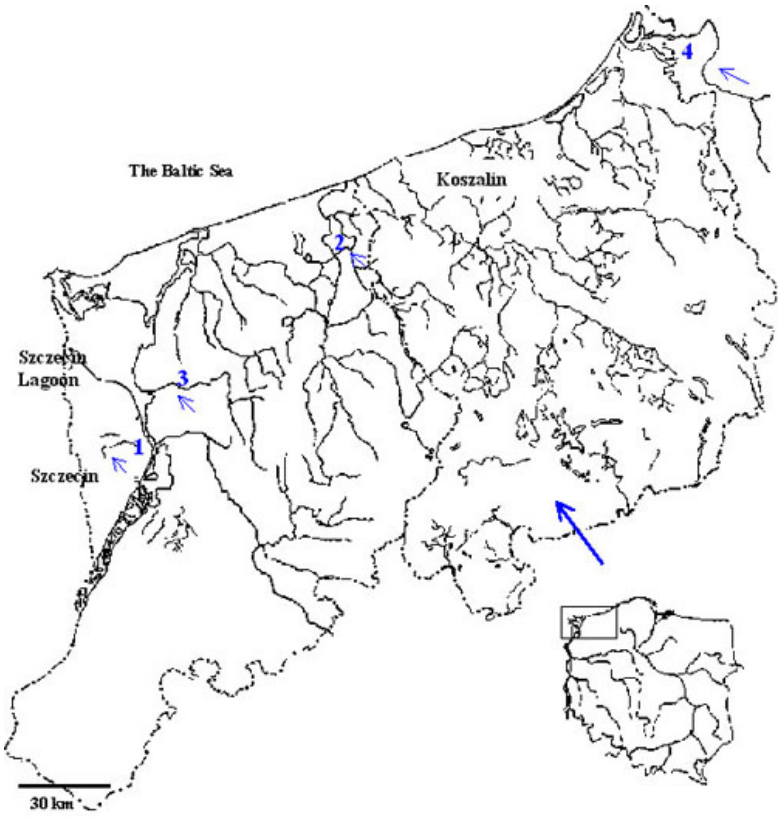


Table 1. Summary of materials used in the study

Location	Date of catch	Age	Number (n)	Caudal length (cm)		Body weight (g)		Condition factors	
				mean	S.D.	mean	S.D.	mean	S.D.
Goleniów	06.1995	brood	30	2.45	0.18	0.95	0.28	-	-
Pilchowianka	07.1992	0+ (3 monthly)	20	6.27	1.27	3.49	1.23	1.28	0.1
Pilchowianka	08.1992	0+ (4 monthly)	20	8.15	1.02	7.58	3.98	1.26	0.11
Pilchowianka	09.1992	0+ (5 monthly)	20	9.48	1.1	12.29	2.91	1.3	0.09
Mołstowa	10.1999	0+ (6 monthly)	9	12.1	1.6	26.86	13.02	1.4	0.1
Mołstowa tributary	11.1995	0+ (7 monthly)	42	11.35	0.73	20.05	3.95	1.4	0.1
Mołstowa	01.1999	0+ (9 monthly)	9	12.74	2.92	19.21	11.74	0.87	0.18
Mołstowa tributary	01.1999	0+ (9 monthly)	10	9.95	2.11	12.03	9.12	1.05	0.13
Mołstowa tributary	01.1999	1+	10	16.76	1.08	49.51	9.49	1.04	0.07
Pilchowianka tributary	11.1988	1+	36	9.8	1.12	13.93	11.1	1.24	0.11
Gowienica	04.2000	1+ (smolt)	13	18.05	1.64	57.28	14.32	1.0	0.1
Gowienica	05.1996	2+ (smolt)	11	17.12	0.94	56.29	10.58	1.11	0.01
Wieprza	05.1998	1+ 2+ (smolts)	68	18.07	1.66	65.39	20.04	1.08	0.10
Total	298								

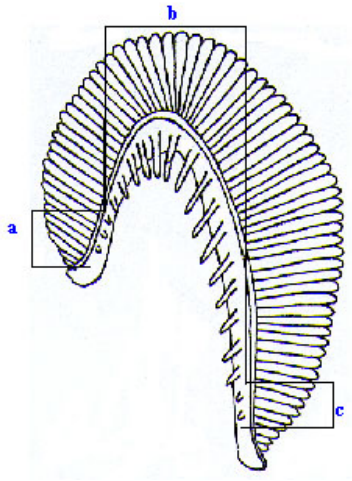
Table 2. Morphometric and meristic characters

Character	Character Code	Character	Character Code
Longitudo caudalis	Tl	*Numerus radiorum pinnae ventralis*	V
Longitudo totalis	Fl	*Longitudo basis D*	LD
Longitudo corporis	Sl	*Altitudo D*	AD
Longitudo capitis	lc	*Longitudo basis P*	LP
Altitudo corporis maxima	H	*Distantia P-V*	P-V
Altitudo corporis minima	h	*Numerus squamarum ordinum*	
Latitudo corporis maxima	laco	*longitudinalium*	ll
Longitudo pedunculi caudalis	lpc	*Numerus squamarum supra lineam*	
Altitudo capitis	hc	*lateralem*	s
Latitudo capitis	lac	*Numerus squamarum infra lineam*	
Longitudo ossis maxillare	lmx	*lateralem*	i
Longitudo ossis dentale	lmd	*Numerus squamarum supra lineam*	
Spatium praeorbitale	pro	*laterales, infra pinnae adiposa*	squ
Spatium postorbitale	poO	*Numerus spinarum ad arcum branchii*	Sp.branch.
Diameter oculi	O	*Numerus radiorum branchialis*	RB
Longitud praedorsale	PD	*Longitudo maximum radiorum pinnae A*	
Numerus radiorum pinnae dorsalis	D	*Distantia p-k**	lxA
Numerus radiorum pinnae analis	A	*Numerus appendicum pyloricorum*	p-k
Numerus radiorum pinnae pectoralis	P		Ap.pyl.

* Explanation in the text.

The gill raker count on the first gill arch (disregarding the first rudimentary arch) is a genetically determined, species-specific character very useful in taxonomic identification of, i.a., salmonids [3, 5, 17, 19]. For a more precise determination of the number, type, distribution, and dynamics of gill rakers on the first gill arch, the latter was divided into three sections: two of them, a and c, were located on both ends of the arch and carried nodular rakers (section a on the shorter terminal stretch of the arch and section b on the longer one), while section b supported long, well-developed rakers (Fig. 2). Distinguishing between the three sections with nodular and well-developed rakers allowed to follow the dynamics of raker growth on the first gill arch.

Fig. 2. The first gill arch with sections measured:
a, c: with nodular processes; b: with well-developed rakers



In view of the small size of the fish examined, the number of fin rays is reported collectively, without dfferentiation for soft and hard rays.

The vomer from the fixed individuals was examined as well; the shape of the vomer as well as the distribution of teeth on it is a very important salmonid diagnostic character [5, 11, 12, 13, 14, 15, 18, 20, 21, 33].
Additional data were collected from 1679 sea trout aged 0+, 144 individuals aged 1+, and 75 individuals aged 2+, in which the pyloric caeca count was determined.

Statistical tests (ANOVA; Mann-Whitney U test; Statistica 5.5) were used to test for significance of differences in body proportions and meristic characters between trout aged 0+, 1+ and 2+ .

RESULTS

When analysing the young sea trout coloration, a particular attention was paid to the number, arrangement, and colour of larger and smaller spots on the sides of the body and on the fins.

The sea trout caught when aged 3 months (*l.caudalis* of 5.6-7.4 cm) had a dark-grey dorsal side and a light-grey abdomen; there were 8-11 dark-grey oval larval spots on the sides of the body. The anterior edge of the dorsal fin was dark grey, the fin itself showing dark-grey smudges. No spots were visible on the operculum and behind the eye.

The fish aged 0+ (*l. caudalis* of 7.8-11.6 cm) had silver to olive-silver, dark grey dorsal side, lighter sides, and light-grey to white abdomen. There were 9-12 dark grey, rounded larval spots on the sides of the body and 8-12 orange spots on the lateral line. In some individuals, the anterior lateral line spots behind the head were grey-orange. Below the lateral line, there were 9-17 anterior spots arranged alternately in two rows. Above the lateral line, there were 13-49 dark grey spots; in some individuals, those spots close to the lateral line were orange. The spots in question were frequently arranged, alternately, in two rows: 2 spots in the upper and 1 spot in the lower row. Behind the eye on the head there were 1-2 dark, round or oval spots. The opercular surfaces showed 1-5 round or oval black spots, dark brown in smaller individuals. The dorsal fin showed a grey-orange margin and the presence of 3-10 dark-grey or orange spots which, in some individuals, were arranged in two rows. The adipose fin edge was dark orange.

The larger sea trout (*l. caudalis* of 15.1-18.2 cm) showed a higher number of spots, particularly on the dorsal fin (7-19) and on the opercular surfaces (3-11). The smolts, silver in colour, showed fewer spots on the dorsal fin, above the lateral line (those were mostly black), and below it (those were red). There were somewhat more red spots on the lateral line, while the larval spots were absent. The remaining data on the number and distribution of the larger and smaller spots are summarised in Table 3.

The opercular bone pattern could not be analysed in the fish aged 0+, the bones being well-visible in the sea trout aged 1+ and 2+.

Table 3. Sea trout coloration

River / Characters			Pilchowianka Mołstowa 0+ (n = 26)		Mołstowa tributary (n = 10)		Gowienica (n = 13) smolts	
			mean	S.D.	mean	S.D.	mean	S.D.
Caudal length			9.63 7.8-11.6	1.50	16.00 15.1-18.2	1.20	18.00 16.1-20.4	1.60
Spots	on dorsal fin		6.71 3-10	3.10	12.4 7-19	3.70	9.8 3-16	3.90
	above the lateral line	L	18 13-49	11.40	34.00 18-53	13.80	20.6 7-34	7.10
		R	24.86 13-34	7.70	34.30 18-56	14.50	-	-
	on the lateral line	L	9.43 8-12	1.60	8.70 7-11	2.90	9.20 7.12	1.90
		R	10.57 9-11	1.30	9.40 6-11	1.80	-	-
	below the lateral line	L	8.29 4-13	3.10	10.10 5-17	3.80	8.8 4-15	3.80
		R	9.43 6-13	2.50	10.90 4-18	4.50	-	-
	on the of the opercular bones	L	2.57 1-5	1.50	9.90 9-11	0.70	0.00	0.00
		R	2 1-3	1.00	10.10 9-12	0.90	0.0	0.00
Larval spots		L	10.14 9-12	1.10	5.30 3-11	2.60	1.6 1-3	0.90
		R	10.14 9-11	0.70	5.10 4-12	3.00	-	-

L- left side of the body; R - right side of the body.

The metric characters typical of the sea trout include: the length of the head (19.39-27.12% of *l. caudalis*); the minimum body depth (7.32-11.25% of *l. caudalis*; Tables 4 and 5); the upper jaw length (38.89-52.,94% of *l. capitis*; Tables 6 and 7); and the preorbital distance (as a percentage of the eye diameter; Table 8). Most of the characters examined in the young sea trout, the species-specific ones in particular, were dynamic. Among the metric characters, a tendency to increase was shown by the upper jaw length and the preorbital distance (in % *l. caudalis*), the dynamics being evident as early as in individuals aged 3-5 months. The decreasing trend was typical of the maximum body depth, the caudal peduncle length, and the lower jaw length (as % *l. caudalis*) (Table 5), although it was increasing in those individuals aged 3-5 months (Table 4), and the minimum body depth as related to the distance between the pectoral and anal fins (Table 8). Some of the characters lacked any dynamics, the mean values being similar in various age groups. Compared with other age groups, the smolts showed a narrower and less tall head, a shorter caudal peduncle, a lower upper jaw and postorbital distance, a shorter lower jaw and predorsal distance, and a lower maximum depth; i.e., their body was more "slender".

Table 4. Relative lengths (% *longitudo caudalis*) of various parts of the sea trout body

Character	3 monthly (n = 20)		4 monthly (n = 20)		5 monthly (n = 20)	
	mean	S.D.	mean	S.D.	mean	S.D.
Longitudo totalis	104.70 103.57-105.36	0.34	104.3 103.53-105.48	0.61	105.00 103.90-106.32	0.70
Longitudo capitis	24.40 22.95-27.12	0.48	23.39 20.89-24.72	1.19	23.88 22.22-26.25	1.29
Altitudo corporis maxima	21.49 20.00-23.61	0.14	21.42 17.50-24.66	1.89	20.91 15.65-23.64	1.66
Altitudo corporis minima	8.76 7.58-10.00	0.38	9.22 7.32-10.96	0.95	9.10 7.37-11.25	0.85
Latitudo corporis maxima	12.78 10.61-14.29	0.96	11.96 10.59-13.58	0.71	12.04 10.91-13.40	0.69
Longitudo pedunculi caudae	29.47 26.76-31.15	0.82	29.24 26.67-30.89	1.17	30.29 28.28-31.96	1.04
Longitudo ossis maxillare	10.63 9.45-13.56	1.12	10.68 9.76-11.63	0.5	11.04 10.48-11.69	0.38
Longitudo ossis dentale	13.60 12.07-16.95	1.38	13.45 11.09-14.93	0.84	13.27 11.82-15.58	0.92

Table 5. Relative lengths (% *longitudo caudalis*) of various parts of the sea trout body

Character	0+ (n = 60)		1+ (n = 36)		Smolts (n = 68)	
	mean	S.D.	mean	S.D.	mean	S.D.
Longitudo totalis	104.63 103.53-106.32	0.68	105.55 102.27-114.10	1.41	104.17 100.57-110.53	1.81
Longitudo capitis	23.82 20.89-27.12	1.23	25.10 21.57-26.92	1.26	21.62 19.39-24.03	0.80
Altitudo corporis maxima	21.08 17.50-24.66	1.44	20.22 15.19-22.28	1.42	18.41 15.46-21.67	1.25
Altitudo corporis minima	9.04 7.32-11.25	0.78	8.69 7.92-9.33	0.38	8.02 6.80-10.61	0.56
Latitudo corporis maxima	12.08 10.59-14.29	0.91	11.07 8.70-13.4	1.19	11.18 9.33-13.74	0.82
Longitudo pedunculi caudae	29.67 26.67-31.96	1.23	26.79 23.44-33.63	1.92	25.73 21.51-30.25	1.48
Longitudo ossis maxillare	9.70 9.46-13.56	1.38	11.70 10.13-13.48	0.62	10.36 9.09-11.94	0.68
Longitudo ossis dentale	13.44 11.09-16.95	1.06	13.21 10.92-14.34	0.74	12.41 10.76-14.37	0.83
Longitido praedorsale	44.96 41.18-49.32	1.52	43.13 36.22-46.41	1.75	39.80 36.99-42.29	1.15

Table 6. Relative lengths (% *longitudo capitis*) of various parts of the sea trout head

Character	3 monthly (n = 20)		4 monthly (n = 20)		5 monthly (n = 20)	
	mean	S.D.	mean	S.D.	mean	S.D.
Altitudo capitis	68.56 52.94-78.57	3.37	66.81 61.80-72.22	3.13	63.96 57.14-69.57	4.18
Latitudo capitis	52.40 41.18-57.14	4.19	51.24 45.00-64.71	3.78	50.55 42.86-56.52	3.92
Longitudo ossis maxillare	43.44 38.89-50.00	2.93	45.75 40.81-52.94	2.6	46.31 42.86-50.00	2.39
Longitudo ossis dentale	55.62 47.06-62.50	5.05	57.66 46.36-64.71	4.53	55.56 50.00-60.00	2.82
Spatium praeorbitale	22.40 18.75-29.41	4.49	26.05 22.73-25.41	2.17	25.44 22.73-30.43	2.14
Spatium postorbitale	51.23 47.06-56.25	2.32	50.78 47.06-54.55	2.03	52.07 47.83-56.52	2.27
Diameter oculi	26.36 22.22-28.57	4.49	23.17 20.00-25.00	1.37	21.36 19.23-25.00	5.26

Table 7. Relative lengths (% *longitudo capitis*) of various parts of the sea trout head

Character	0+ (n = 60)		1+ (n = 36)		smolts (n = 68)	
	mean	S.D.	mean	S.D.	mean	S.D.
Altitudo capitis	66.45 52.94-78.57	5.1	66.44 51.74-67.22	3.40	60.61 51.35-72.50	3.26
Latitudo capitis	51.40 41.18-64.71	3.97	46.45 37.22-59.09	4.56	45.32 41.03-53.33	2.51
Longitudo ossis maxillare	45.17 38.89-52.94	2.89	46.00 43.33-50.79	8.0	47.90 42.11-56.25	2.83
Longitudo ossis dentale	56.28 46.36-64.71	3.95	52.65 45.58-56.72	2.57	57.40 50.00-68.57	3.32
Spatium praeorbitale	24.63 18.05-30.43	2.79	25.68 21.40-34.43	2.58	25.91 21.21-30.56	1.78

Table 8. Mean values of characters describing sea trout body proportions

Character	0+ (n = 60)		1+ (n = 36)		Smolts (n = 68)	
	mean	S.D.	mean	S.D.	mean	S.D.
Altitudo corporis minima /P-V (x 100)	32.13 25.00-40.91	3.36	-	-	28.43 22.92-36.21	2.21
P-V/ l. caudalis (x 100)	28.21 22.52-36.36	1.89	-	-	28.26 24.58-30.77	1.20
Longitudo capitis / longitudo totalis (x 100)	22.83 2.24-25.81	1.24	23.56 20.75-25.44	1.75	20.77 18.71-23.24	0.86
Spatium praeorbitale / diameter oculi	1.00 0.71-1.33	2.00	1.05 0.84-1.53	0.18	1.26 0.87-1.57	1.5

The difference between the length of the first ray in the anal fin and the p-k distance (i.e., the distance between the beginning of the first ray and the end of the last ray in the anal fin) ranged from 0.04 to 0.07 cm in the young sea trout caught within July-September when aged 0+ and amounted to 0.09 cm at the age of 1+; in only two individuals measuring (*l.caudalis*) 16.1 and 17.5 cm the first ray was shorter than the p-k distance by 0.17 and 0.16 cm, respectively. Those individuals measuring 18.7 cm in the fork length showed the mean difference between the first ray and the p-k distance to be 0.14 cm; in one individual only was the distance between the first and the last ray longer by 0.2 cm. As shown by the data (Table 9), in the folded anal fin the first ray slightly overlapped with the last one. The anal fin of the young sea trout showed a characteristic indentation in the central part and on the posterior edge, the lower edge being “sharpened”.

Table 9. Sea trout anal fin measurements

River	Date of catch	Age	Caudal lenght (cm)		Anal fin					
					Anal fin first ray (cm)		p-k section * (cm)		Difference ** (cm)	
			mean	S.D.	mean	S.D.	mean	S.D.	mean	S.D.
Pilchowianka	07.1992	0+	6.27	1.27	0.89	0.06	0.93	0.05	0.04	0.03
Pilchowianka	08.1992	0+	8.15	1.02	1.17	0.1	1.22	0.1	0.05	0.04
Pilchowianka	09.1992	0+	9.48	1.01	1.31	0.14	1.37	0.14	0.07	0.05
Pilchowianka	07-09.1992	0+	7.99	1.68	1.11	0.2	1.17	0.21	0.06	0.04
Mołstowa	15.10.1999	0+	12.10	1.6	1.64	0.24	1.73	0.24	0.09	0.07
Gowienica	17.04.1999	1+	18.05	1.64	2.28	0.18	2.34	0.13	0.07	0.09
Gowienica	05.1996	2+	17.12	0.94	2.29	0.16	2.38	0.22	0.09	0.15
Wieprza	05.1998	smolts	18.07	1.66	2.35	0.27	2.21	0.27	0.14	0.11

*p-k: the section between the beginning of the anal fin first ray and the end of the terminal ray (cm),
** Difference between the length of the anal fin first ray and the p-k section (cm).

The number of nodular processes on the first gill arch was observed to decrease with age, the number of well-developed rakers increasing (Table 10). The dynamics of this kind was visible as early as in the fish aged 3-5 months. They had an average of 5 nodular gill arch processes, the corresponding count in the individuals aged 1+ collected from different sites ranging from 2.9 to 3.9 (Table 11). The first gill arch raker count ranged from 15 to 20, from 13 to 20; and from 13 to 19 in the individuals aged 0+, 1+, and in smolts, respectively. The well-formed rakers had rounded tips.

Table 10. Gill raker count on the first gill arch in the sea trout aged 0+

First gill arch sections	3 monthly (n = 20)		4 monthly (n = 20)		5 monthly (n = 20)	
	mean	S.D.	mean	S.D.	mean	S.D.
a	2.50 2-4	0.71	3.00 2-6	1.15	2.60 1-4	0.84
b	11.60 10-13	0.84	12.50 10-15	1.35	13.50 12-13	0.71
c	2.50 1-4	0.85	2.60 2-3	0.52	2.10 1-3	0.74
a+c	5.00 3-6	0.94	5.60 4-6	1.35	4.70 3-6	0.95
a+b+c	16.60 15-18	1.07	18.10 16-20	1.37	17.6 13-19	1.78

Table 11. Gill raker count on the first gill arch

First gill arch sections	0+ from Pilchowianka (n = 60)		1+ from Chojnówka (n =10)		1+ from Łożnica (n = 13)		1+ from Mołstowa tributary (n =10)		Smolts from Wieprza (n = 68)	
	mean	S.D.	mean	S.D.	mean	S.D.	mean	S.D.	mean	S.D.
a	2.66 1-6	0.9	2.40 1-4	1.17	1.30 1-3	0.67	1.60 1-2	0.52	3.34 1-4	0.64
b	12.55 10-15	1.27	13.10 12-14	1.66	15.15 13-17	1.34	16.00 15-17	0.71	12.81 9-14	1.05
c	2.41 1-4	0.73	1.50 1-3	0.71	1.92 1-2	0.51	1.30 1-2	0.48	1.78 1-3	0.71
a+c	5.07 3-6	1.13	3.90 3-6	1.52	3.00 1-3	1.04	2.90 2-3	0.32	4.09 2-7	0.96
a+b+c	17.41 15-20	1.55	17.00 13-19	1.83	17.92 16-20	1.5	18.00 17-20	0.82	16.90 13-19	1.32

The individuals examined showed a slight, but constant, age-dependent increase in the fin ray count (Tables 12 and 13) and lateral line scale count (Tables 14 and 15), starting from the 3-5-mo-old fish and observable in those aged 1+ and 2+ . The range of variation of the two characters widened with age, particularly due to the increasing upper limit of the range. The most extensive changes were observed in the scale count in a section extending from the dorsal fin to the lateral line; the mean count increased from 18.91 in the fish aged 0+ to 20.42 in those aged 1+ to 21.6 in the fish aged 2+ to 22.96 in smolts. The scale count along a transverse section extending from the lateral line to the adipose fin was 10-13 (11.37 mean count); 11-14 (12.28); 12-13 (12.57); and 11-19 (14.62) in the sea trout aged 0+, 1+, 2+, and smolts, respectively (Table 15). The mean branchiostegal ray counts were similar in different age groups, but the group-specific ranges widened from 10-12 (0+) to 9-12 (1+ and smolts) (Tables 14 and 15).

Table 12. Mean values of characters describing the sea trout fin size and topography

Character	3 monthly (n = 20)		4 monthly (n = 20)		5 monthly (n = 20)	
	mean	S.D.	mean	S.D.	mean	S.D.
Numerus radiorum pinnae D	10.4 9-12	0.71	10.2 10-11	0.41	10.5 10-12	0.61
Numerus radiorum pinnae A	8.45 8-9	0.51	9.2 8-10	0.52	8.95 8-10	0.51
Numerus radiorum pinnae P	11.55 10-13	0.89	11.85 11-12	0.37	11.65 10-12	0.59
Numerus radiorum pinnae V	9.05 9-10	0.22	8.9 8-9	0.31	8.9 8-9	0.31
Longitudo basis D / l.caudalis.	12.75 11.59-13.79	0.72	12.51 11.70-14.64	1.10	12.43 10.91-14.10	0.8
Altitudo D / l.caudalis	17.67 15.71-19.64	1.47	16.67 14.81-18.60	0.90	16.07 14.55-17.95	0.79
Longitudo basis P / l.caudalis	18.22 16.67-20.00	0.51	18.84 15.11-21.15	1.76	18.15 16.36-20.51	1.08

Table 13. Mean values of characters describing the sea trout fin size and topography

Character	0+ (n = 60)		1+ (n = 36)		smolts (n = 68)	
	mean	S.D.	mean	S.D.	mean	S.D.
Numerus radiorum pinnae D	11.05 9-12	0.75	10.5 10-11	0.51	11.93 9-13	1.01
Numerus radiorum pinnae A	9.26 7-10	0.56	9.00 8-11	0.83	10.72 10-13	0.62
Numerus radiorum pinnae P	11.82 10-13	0.69	12.47 11-13	0.61	12.38 10-13	0.60
Numerus radiorum pinnae V	8.89 8-10	0.29	8.86 8-9	0.35	8.96 8-9	0.21
Longitudo basis D / l.caudalis	12.56 10.45-14.29	0.88	12.98 11.70-14.67	0.73	11.28 9.70-14.21	0.87
Altitudo D / l.caudalis	16.81 14.55-19.64	1.16	18.44 15.98-21.67	1.46	13.62 10.12-15.93	0.21
Longitudo basis P / l.caudalis	18.39 15.85-21.92	1.38	18.03 15.11-21.15	1.45	14.14 9.60-16.59	1.27

Table 14. Meristic characters: scale count, gill raker count on the first gill arch, branchiostegal ray count

Character	3 monthly (n =20)		4 monthly (n =20)		5 monthly (n = 20)	
	mean	S.D.	mean	S.D.	mean	S.D.
Numerus squamarum in linea lateralis	116.30 114-118	2.12	117.50 116-120	1.19	117.65 116-120	1.23
Numerus squamarum supra lineam laterales	18.20 17-19	0.52	19.15 18-20	0.67	18.90 18-21	0.79
Numerus squamarum infra lineam laterales	17.40 17-18	0.50	18.20 17-19	0.70	17.80 17-19	0.623
Numerus squamarum supra lineam laterales, infra pinnae adiposa	10.50 10-12	0.61	11.60 11-12	0.50	12.00 11-13	0.73
Numerus radiorum branchialis	10.9 10-11	0.30	10.85 10-11	0.37	10.35 10-11	0.49

Table 15. Meristic characters: scale count, branchiostegal ray count

Character	0+ (n = 60)		1+ (n = 36)		smolts (n = 68)	
	mean	S.D.	mean	S.D.	mean	S.D.
Numerus squamarum in linea lateralis	117.15 114-120	1.34	120.78 113-130	3.41	120.56 115-127	2.69
Numerus squamarum supra lineam laterales	18.75 17-21	0.83	20.39 18-23	1.08	22.96 17-28	2.36
Numerus squamarum infra lineam laterales	17.80 17-19	0.68	23.94 20-27	1.69	26.17 19-30	2.55
Numerus squamarum supra lineam laterales, infra pinnae adiposa	11.37 10-13	0.88	12.28 11-14	0.88	14.62 11-19	1.62
Numerus radiorum branchialis	10.70 10-11	0.46	11.25 9-12	0.94	10.76 9-12	0.67

Without dissectiing the vomer out, its details could not be examined because the vomer lamella was not visible and the teeth were very fine.

The cultured trout were distinct in having a smaller caudal fin indentation, a shorter caudal peduncle, and a wider head, compared with those characters in the young sea trout grown in the wild. The dorsal and pectoral fins were not as advanced in their development as their equivalents in the wild fish, which is evident in the data (Tables 12 and 13).

Table 16. The sea trout pyloric caeca count

0+ (n = 1679)		1+ (n =144)		2+ (n = 75)	
mean	S.D.	mean	S.D.	mean	S.D.
48.12 34-64	5.12	42.28 29-69	6.48	43.21	2.57

The pyloric caeca count of the young sea trout ranged from 29 to 69 (Table 16).

Some characters (the branchiostegal ray count, spots on the opercular surfaces and on the sides) were analysed also by examining the right side of the body. The asymmetry was visible in the spot count (the differencein the number of spots above the lateral line between the left and right side of the body could even be as high as several) and in the branchiostegal ray count (a difference of 1-2 rays). In all the cases, the number of spots was higher on the right side of the body.

DISCUSSION

The relevant literature describes most often the adult sea trout with well-developed, species-specific traits [5, 8], while papers dealing with the young sea trout are few [34, 23]. Based on the analysis of morphological characters, this study strove to characterise the young sea trout and to follow the emergence of certain species-specific traits and their dynamics. Owing to the lack of literature on young salmonid morphometry, it was not possible to compare the results with data collected from other streams. For this reason, some of the parameters are compared with those of the adult sea trout.

The young sea trout from the Pomeranian rivers were somewhat larger, compared to individuals caught in other streams. The *l.caudalis* of the individuals aged 0+, caught in August was 8.15; those aged 0+ caught in October and the ones aged 1+ caught in April measured 12.1 and 17.27 cm, respectively, while the sea trout of corresponding age, caught in the Norwegian river Arungsleva in May measured 7.4; 7.7; and 9.2 cm [4]. On the other hand, the sea trout contemporaries from other Polish rivers [8] showed lengths similar to those recorded in this study.

Coloration of the young sea trout from the Pomeranian rivers did not differ from descriptions presented by other authors with respect to selected aspects of coloration, e.g., the adipose fin colour, the presence of red and black spots on the body sides and on fins [31], and distribution of spots on the opercular surfaces [26]. The young Pomeranian sea trout showed 9-12 larval spots, the counts reported by other authors being 9-10 [35] and 9-14 [5]. As mentioned by Kuzyshchyn et al. [23], who analysed coloration of the brook trout from various streams, the coloration may be affected by the geological characteristics of a stream. Those authors distinguished between as many as 6 patterns of coloration. The Pomeranian sea trout grew in forest streams and were fairly similar in their coloration; the individuals differed in the number of larger and smaller spots only. The fish examined in this study were similar in the colour, number, shape and distribution of the spots to the Norwegian trout having the so-called normal genotype (SS) underlying this type of coloration [29].

The characteristic arrangement of opercular bones, corresponding to the published descriptions [5, 22] was well-visible as from age 1+.

Certain typical sea trout characteristics, such as the wide caudal peduncle, small indentation in the caudal fin, and the long upper jaw extending beyond the eye, began to emerge as early as in individuals aged 4-5 months and measuring about 10 cm in *l.caudalis*. The subsequent dynamics of the characters in the ensuing months and years confirms the early appearance of those morphometric species-specific traits. The total length (*longitudo totalis*) of the young sea trout was longer than the head by the factor of 4.38 in the fish aged 0+ , the respective factors for the fish aged 1+, 2+, smolts, and adults being 4.24; 4.62; 4.8, and 4-5 [5]. The upper jaw length to the eye diameter ratio at age 0+ and 1+ was 1.9, and 2.3 in smolts; these ratios were higher than those reported by Mills [after 5] (1.20 and 1.27 in length classes of 5.0-9.9 and 10.0-14.9 cm, respectively). The upper jaw was in the young sea trout relatively longer than in the adults as it was 9.70-11.70% of *l. caudalis*, compared to 7.7-10.2% in the adults [3]. The lower jaw was 12.41-13.44% of *l. caudalis* in the young sea trout against 12.1-16.9% in the adults.

Meristic characters are a very frequent and, in the opinion of some authors [5, 17], the best diagnostic criterion in species identification. The fin ray count and the lateral line scale count formulae of the adult sea trout are as follows:

D II-V 8-12, *A* II-V 8-12, *P* I 12-14, *V* I 7-8, *l. l.* 111 $\frac{18-29}{19-43}$ 156 [3]; Wałecki 1864 [after 5]; Schechtel 1925; Staff 1950 [after 5] ; Gąsowska 1962 [after 5] ; Chełkowski 1970; [after 5]. No differentiation was made between hard and soft fin rays in the young sea trout, but, considering the total ray count, it was lower than that in the adults in the dorsal and anal fins, the total counts in the pectoral and abdominal fins being similar to those in the adults. The scale count ranges found on, above, and below the lateral line were narrower in the young sea trout than in the adults, the upper limit in the latter being usually higher. The scale count in the transverse section from the lateral line to the adipose fin ranged within 10-13, 11-19, and 14-19 in the sea trout aged 0+, smolts, and adults [8], respectively.

The branchiostegal ray count is a species-specific character; it is used for identification of intraspecific variety 5, 27]. The count was 9-12 in the sea trout examined, the range being identical to that reported by Chełkowski [8] for the adults, but wider than the range of 9-10 reported from the young sea trout by Šustov [34].

Holčik [17], Rosenfeld [27], and Brylińska [5] consider the gill raker count on the first gill arch as an important diagnostic character for species identification. The range of the count in the young sea trout was almost identical to that of the adults (13-18 in [3]; 13-19 in [5]). The pyloric caeca count is another meristic character of use in species identification [5, 17]. According to Chełkowski [8], the adult trout count is 30-65, while Brylińska [5] reported 40-60; the present authors found the count in the adults to range within 31-65 [Domagała and Kirczuk, unpubl.], the young sea trout featuring 29-69 pyloric caeca.

The first anal fin ray was in the sea trout examined slightly longer than the distance between the beginning of the first ray and the tip of the terminal ones. It would be difficult to regard this character as typical of the young sea trout because, in the adults, the first ray clearly reaches beyond the terminal one [22].

Because the vomer was not dissected out, it was not possible to evaluate the characteristic features of the vomer (triangular lamella; arrangement of the teeth on the lamella base and on the main part of the vomer [5, 21].

The coefficient K of the same population increases with fish length and decreases as the parr are transformed into smolts. Because of that, due to variations in fish length, the coefficient is treated in the present work as an auxiliary measure only.

Table 17. Statistical significance of differences between the analysed characters of trout aged 0+, 1+ 2+ (ANOVA; Mann-Whitney U test; Statistica 5.5)

Charakter	0+[1]/1+	0+[1]/2+[2]	1+/2+[2]	Charakter	0+[1]/1+	0+[1]/2+[2]	1+/2+[2]
D	I	I	I	lpc/ Fl	I	I	I
A	*au	I	I	lmx/ Fl	I	I	I
P	I	I	*u	lmd/ Fl	I	I	I
V	*au	*au	*au	hc/ lc	I	I	I
s	I	I	I	lac/ lc	*au	*au	*au
i	I	I	I	lmx/ lc	*a	I	I
squ.	I	I	I	lmd/lc	I	I	I
ll	I	I	*u	pro/ lc	I	I	*u
RB	*a	I	I	poO/ lc	I	I	*u
Sp. branch.	I	I	I	h/ P-V	I	I	I
Tl/ Fl	*au	I	I	P-V/ Fl	I	I	I
lc/ Fl	I	I	I	lc/ Tl	I	I	I
H/ Fl	*au	I	I	pro/ O	I	I	I
h/ Fl	I	I	I	LD/ Fl	I	I	I
laco/ Fl	I	I	*u	AD/ Fl	*a	I	I
pD/ Fl	*au	I	I	LP/ Fl	*au	I	I

[1] Trout 0+ from Mołstowa, [2] Trout from Wieprza.
* No significant difference ($p > 0.05$), I – difference significant($p < 0.05$), a – ANOVA, u – Mann-Whitney U test.

Most characters analysed were significantly different ($p<0.05$) between trout aged 0+, 1+, 2+; Tab. 17. This points to a wide variability of trout during the freshwater stage of life.

CONCLUSIONS

The analysis of young sea trout, growing from early larvae to smolt, demonstrated that the pattern of species-specific characters was not equally clear-cut in all the populations examined because they are very variable and, particularly in the smallest individuals, some of the species characteristics were not formed yet. For this reason, a comprehensive characterisation of a species ought to be based on a suite of characters; this is the only approach warranting a correct interpretation and diagnosis. Metric and meristic characters as well as coloration, analysed in combination, ensure a good chance of a correct species identification of a young trout. The analysis presented in this work allows to pinpoint the following characteristic features of the young sea trout:

1. Coloration was one of the earliest species-specific characters. Numerous spots above and below the lateral line throughout the length of the body; adipose fin orange; paired fins with orange-coloured edges; 13-49 red and black spots above the lateral line; 7-12 red spots on the lateral line; 4-17 spots below the lateral line; 3-19 red and black spots on the dorsal fin; 9-12 larval spots; smolts silver, without larval spots.
2. Caudal fin with a small indentation; caudal peduncle wide (7.32-11.25% of *longitudo caudalis*).
3. Upper jaw extending to the distal end of eye diameter or beyond it.
4. The following fin ray count and lateral line scale count formulae applied to different age groups:

0+ - *D* 9-12, *A* 7-10, *P* 10-13, *V* 8-10, *l. l.* 114 $\frac{17-19}{17-18}$ 120,

1+ - *D* 10-11, *A* 8-11, *P* 11-13, *V* 8-9, *l. l.* 113 $\frac{18-23}{20-27}$ 130,

smolts - *D* 9-13, *A* 10-13, *P* 10-13, *V* 8-9, *l. l.* 115 $\frac{17-28}{19-20}$ 127

5. Mean scale counts (range in parentheses) in the transverse section from the lateral line to the adipose fin in different age groups were as follows: 0+ 11.37 (10-13),
   1+ 12.28 (11-14),
   smolts 14.62 (11-19).
6. 13-20 gill rakers on the first gill arch.
7. 9-12 branchiostegal rays.
8. 29-69 pyloric caeca.
9. The ranges of ray counts in the dorsal and anal fins were similar to those in the adults. The ranges of ray counts in the pectoral and abdominal fins as well as the ranges of scale counts above and below the lateral line were narrower than those in the adults. The characteristic pattern of the opercular bones was possible to observe in the fish aged 1+. It was not possible to evaluate the characteristic features of the vomer without dissecting it out from the young sea trout body.

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