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Fish systematics

**MORPHOMETRY OF ATLANTIC ARGENTINE *ARGENTINA SILUS*  
(ASCANIUS, 1775) (FAM. ARGENTINIDAE, SALMONIFORMES)  
FROM THE NORTHEAST ATLANTIC**

**MORFOMETRIA ARGENTYNY WIELKIEJ *ARGENTINA SILUS*  
(ASCANIUS, 1775) (FAM. ARGENTINIDAE, SALMONIFORMES)  
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Analysis involving 31 metric and 8 meristic characters was performed on 76 individuals of Atlantic argentine. Moreover, the material investigated was characterised in view of length (l. t.) and weight distribution. Results were presented with regard to both sexes.

INTRODUCTION

Atlantic argentine inhabits eastern and western part of North Atlantic.

In the Northwest Atlantic fishes of this species reach Cape Cod (Cohen, by Borodulina, 1964). In the western part of the ocean argentine occurs in the region from 54°40' N to 40°00' N, being found in Davis' Strait, off Labrador coast as well as George and Grand Banks (Whitehead et al. 1984).

In the eastern part of Atlantic (Fig. 1) argentine enters the warm waters off the south Spitzbergen, surrounding the Bear's Isle, reaching Demidov' Bank and Motovskii Gulf, as well as inhabits the whole coast of Norway. The species occurs in the deeper parts of the North Sea (in the south off western coasts of Scotland and Ireland). It is distributed also close to the southern coasts of Island, where from it migrates to the southeast coasts of Greenland (Whitehead et al. 1984).

First recorded catch of argentine came from the beginning of sixties of the present century. According to Żukowski (1971) in 70-ties the best fishing grounds were waters of

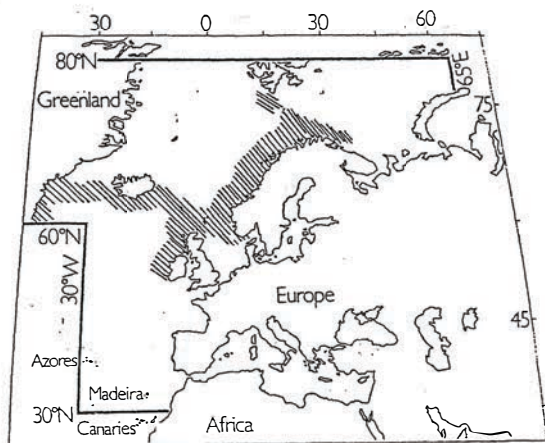


Fig. 1 Distribution of *Argentina silus* (according to Whitehead et al. 1984).

New Scotia, as well as fishing grounds situated in the central and northern part of the Norwegian Sea and southwest regions off Island.

According to the statistical data (Anonymus 1992) in 80-ties the highest catches of fish belonging to Argentinidae were found for Norway (22.5 thousand t in 1989), next for Holland, Sheep Isles, Ireland and Scotland; it is of interest to indicate for argentine as the most abundantly caught among the fish of family Argentinidae.

Although argentine plays to-day an important commercial role in catches, papers dealing with this species were not relatively numerous. Some of the hitherto published works are of special interests, e.g. papers of Borodulina (1964) or Żukowski (1971).

In Poland the description of genus *Argentina* L., 1758 appeared for the first time in 1779 in the Kluk's work (by Żukowski 1971), then in Koleśnik (1968) and Żukowski (1971).

The present work was aimed at providing a detailed characteristics of biometric features of Atlantic argentine from the northeast Atlantic.

## MATERIALS AND METHODS

Material to be examined was bought in the Office of Fish Distribution in Szczecin, in October 1991. Fishes were captured by Dutch shipowner in March/April 1991 in the northeast Atlantic. A total of 76 argentines (including 59 females and 17 males) were investigated, involving 31 metric and 8 meristic characters, with regard to both sexes.

Measurements of the total length (l.t.), body length (l.c.) and caudal length (l.caud.) were taken with the ruler to 0.1 cm, while remaining measurements were performed with the aid of the callipers with the same accuracy. Weight was established to 5 g.

The linear measurements of fish body were made according to the scheme (being slightly modified) for salmonids, given by Pravdin (1966). The scheme is demonstrated in Figs 2 and 3. Symbols used for characters under study are presented in Table 1.

Metric characters were treated as per cent indices (i.e. in relation to the body length). Percentage ratios of the metric characters in questions were related to the body length ( $x_1$ ) or to lateral head length ( $x_4$ ).

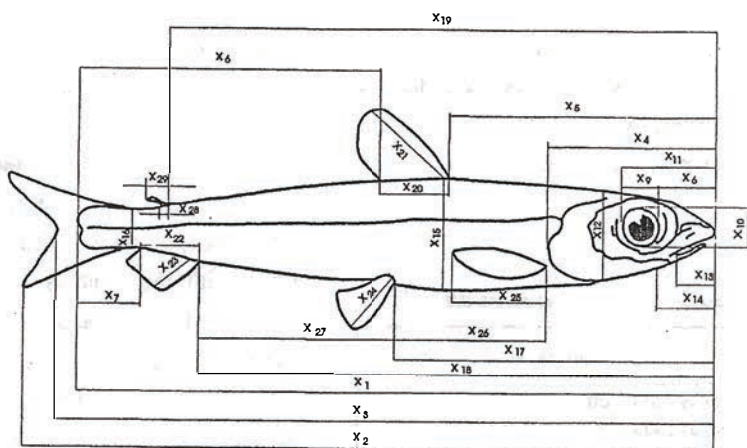


Fig. 2. Design of measurements of metric characters.

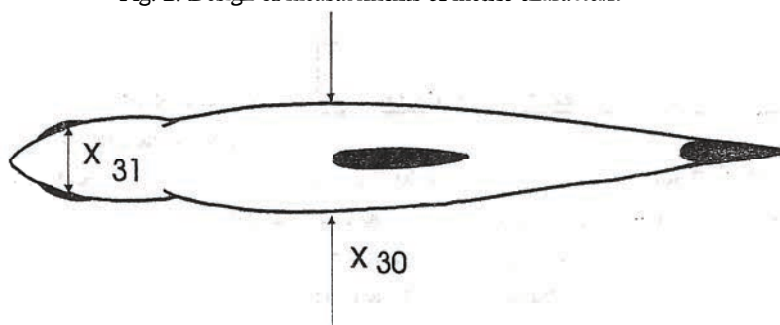


Fig. 3. Scheme of body width and interocular distance.

Table 1

Symbols used for metric characters studied

Symbol of character	Latin name	Symbol of character	Latin name
X <sub>1</sub>	longitudo corporis	X <sub>17</sub>	longitudo praeventrale
X <sub>2</sub>	longitudo totalis	X <sub>18</sub>	longitudo praeanae
X <sub>3</sub>	longitudo caudalis	X <sub>19</sub>	longitudo ad pinnae adiposa
X <sub>4</sub>	longitudo capitis	X <sub>20</sub>	longitudo basis pinnae D
X <sub>5</sub>	distancia praedorsale	X <sub>21</sub>	altitudo pinnae D
X <sub>6</sub>	longitudo postdorsale	X <sub>22</sub>	longitudo basis pinnae A
X <sub>7</sub>	longitudo pedunculi caudae	X <sub>23</sub>	altitudo pinnae A
X <sub>8</sub>	spatium praeorbitale	X <sub>24</sub>	longitudo pinnae V
X <sub>9</sub>	diameter oculi horizontalis	X <sub>25</sub>	longitudo pinnae P
X <sub>10</sub>	diameter oculi verticalis	X <sub>26</sub>	distancia P - V
X <sub>11</sub>	spatium postorbitale	X <sub>27</sub>	distancia V - A
X <sub>12</sub>	latitudo capitis	X <sub>28</sub>	longitudo basis pinnae adiposa
X <sub>13</sub>	longitudo ossis maxillare	X <sub>29</sub>	altitudo pinnae adiposa
X <sub>14</sub>	longitudo ossis dentale	X <sub>30</sub>	latitudo corporis
X <sub>15</sub>	altitudo corporis maxima	X <sub>31</sub>	distancia interorbitalis
X <sub>16</sub>	altitudo corporis minima		

Concerning the fact, that argentine's soft rays in fins being fragile and easy to destroy, some measurements for broken rays were disregarded. Therefore the total length ( $x_2$ ) was examined in 61 fishes, height of dorsal fin ( $x_{21}$ ) and anal one ( $x_{23}$ ) was measured in 52 and 45 fishes, respectively, the length of pectoral fin ( $x_{25}$ ) was investigated in 44 individuals.

Table 2

Symbols used for meristic characters studied

Symbol of character	Latin name
D	numerus radiorum pinnae dorsalis
A	numerus radiorum pinnae analis
C	numerus radiorum pinnae caudalis
P	numerus radiorum pinnae pectoralis
V	numerus radiorum pinnae ventralis
sp.br.	numerus spinarum ad arcum branchiorum
vt.	numerus vertebrarum
l.l.	numerus squamarum linnae lateralis

Eight meristic characters were established, being summarized along with the symbols applied in Table 2. The number of soft rays in dorsal (D), anal (A), caudal (C), pectoral (P) and ventral (V) fins were counted. Number of vertebrae (vt.) was estimated after fishes have been filleted. Gill rakers were counted on the first gill arch on the left side of the head. The number of scales in the lateral line were exam-

ined on the left side of fish body. Owing to the scales in argentine skin being placed in shallow pockets, often only the pockets have to be counted instead.

All metric and meristic characters were treated statistically, the arithmetic mean ( $\bar{x}$ ), standard deviation (S), standard errors of mean (m) and coefficient of variation (v) being calculated.

When the biometric characters are taken into account, coefficient of variation (v) seems to be of significant importance. According to Ruszczyc (1981) coefficient of variation is significant statistically when reaching values ranging from 8 to 10%. Considering that statement, characters with the value of coefficient up to 10% were regarded as low plastic. In order to verify the  $H_0$  hypothesis assuming the lack of differences between mean values in males and females, test C by Cochran and Cox (Oktaba 1974) was employed.

## RESULTS

### Length distribution of fish studied

The total length was measured in 48 females and 13 males (a total of 61 fishes) in order to establish the length distribution.

Characteristics of the sample investigated, with respect to the total length (in cm), individual weight (in g), number of individuals (n) for the entire material, as well as for both sexes is demonstrated in Tables 3, 4 and 5.

The total length of Atlantic argentines studied covered the range from 32.9 to 49.7 cm with the average length of 42.8 cm (Tab.3). The weight of body ranged within 252 - 940 g.

The mean individual weight amounted to 595 g. Specimens in 42.1 - 44.0 cm and 44.1 - 46.0 cm predominated. The length class 42.1 - 44.0 cm was the most numerous one, contributing 31.1% to the whole sample. In this interval the mean length and mean individual weight amounted to 43.0 cm and 603 g, respectively.

**Table 3**  
Characteristics of the sample investigated with respect to total length (cm), individuals weight (g) and number of specimens in particular classes of length

Class of length (cm)	Mean length (cm)	Mean weight (g)	Number of individuals	%
32.1 - 34.0	32.9	252	1	1.6
34.1 - 36.0	35.3	327	2	3.2
36.1 - 38.0	37.8	390	3	5.0
38.1 - 40.0	39.2	467	4	6.5
40.1 - 42.0	41.1	533	9	14.8
42.1 - 44.0	43.0	603	19	31.1
44.1 - 46.0	44.7	694	17	27.8
46.1 - 48.0	47.2	851	3	5.0
48.1 - 50.0	49.2	870	3	5.0
Total	42.8	595	61	100.0

**Table 4**  
Characteristics of the females investigated with respect to total length (cm), individuals weight (g) and number of specimens in particular classes of length

Class of length (cm)	Mean length (cm)	Mean weight (g)	Number of individuals	%
36.1 - 38.0	37.7	420	2	4.2
38.1 - 40.0	39.4	490	3	6.2
40.1 - 42.0	41.0	542	5	10.4
42.1 - 44.0	43.1	610	16	33.4
44.1 - 46.0	44.7	693	16	33.4
46.1 - 48.0	47.2	851	3	6.2
48.1 - 50.0	49.2	870	3	6.2
Total	43.6	647	48	100.0

**Table 5**  
Characteristics of the males investigated with respect to total length (cm), individuals weight (g) and number of specimens in particular classes of length

Class of length (cm)	Mean length (cm)	Mean weight (g)	Number of individuals	%
32.1 - 34.0	32.9	252	1	7.7
34.1 - 36.0	35.3	327	2	15.3
36.1 - 38.0	38.0	371	1	7.7
38.1 - 40.0	38.8	400	1	7.7
40.1 - 42.0	41.1	521	4	30.7
42.1 - 44.0	42.5	565	3	23.2
44.1 - 46.0	44.8	720	1	7.7
Total	39.8	475	13	100.0



Females constituted 78.6% of the sample investigated (Tab. 4). Classes 42.1 - 44.0 cm and 44.1 - 46.0 cm were prevailing, being of equally abundance, jointly contributing 66.8% to the females studied count. The mean length and mean individual weight in the 42.1 - 44.0 cm length class amounted to 43.1 cm and 610 g, respectively, while in 44.1 - 46.0 cm one - 44.7 cm and 693 g. The mean length, as well as mean weight were considerably higher than in males.

In the sample studied males constituted 21.4% (Tab. 5). Individuals in the length class of 40.1 - 42.0 cm slightly predominated. The mean length in this interval amounted to 41.1 cm, whereas the average individual weight - 521 g.

As it is demonstrated in Tabs 4 and 5, the mean length of males (39.8 cm) was nearly by 4 cm lower than in females (43.6 cm). The mean individual weight was also lower in males (475 g), when comparing to females (647 g), with the difference of 172 g.

#### Analysis of metric characters

Metric characters of the Atlantic argentine as well as their relation to the body length ( $x_1$ ) and lateral head length ( $x_4$ ) expressed as the per cent indices, for the entire material and both sexes separately are summarised in Tabs 6, 7 and 8, respectively.

As can be seen in Tab. 6, containing results for whole sample, coefficient of variation appeared to be significant (i.e. exceeding 10%) in 3 features only: maximum height of anal fin (A), length of pectoral fin (P) and height of adiposal fin (ad). Thus those characters should be regarded as plastic.

Value of coefficient of variation calculated for per cent indices of the lateral head length appeared to be non-significant statistically.

When analyzing values of coefficient of variation concerning both sexes separately (Tabs 7 and 8), it is evident that in case of females values reaching above 10% refer to the same metric characters as in the whole sample. In males only the height of anal fin (A) is significant statistically.

In the whole sample and both sexes as well, value of coefficient of variation is significant merely in particular features (expressed as per cent indices of body length), and non-significant for all characters under study related to lateral head length.

When comparing mean values of per cent coefficients calculated for metric characters in males and females showed in Tab. 9, it appeared that differences between female and male individuals are inconsiderable, not exceeding 2%.

Females are characterised by possessing slightly larger postdorsal ( $x_6$ ) and prefrontal ( $x_{17}$ ) distance, larger height of head ( $x_{12}$ ) and body ( $x_{15}$ ), as well as larger distance between pectoral and ventral fins ( $x_{26}$ ). Values of the remaining metric characters were higher in males.

Table 6

Metric characters of argentine expressed in relative values as percent indices  
(in % of longitudo corporis and longitudo capitis lateralis)

Symbol of character	% longitudo corporis					
	n	Range	$\bar{x}$	S	m	V
X <sub>2</sub>	61	112.1-118.2	114.71	1.13	0.14	0.99
X <sub>3</sub>	76	102.1-111.4	105.75	1.18	0.13	1.12
X <sub>4</sub>	75	24.4-28.7	26.58	0.94	0.10	3.54
X <sub>5</sub>	76	41.6-46.0	43.53	1.09	0.12	2.50
X <sub>6</sub>	76	40.3-49.6	44.98	1.63	0.18	3.62
X <sub>7</sub>	76	8.5-11.5	9.73	0.63	0.07	6.47
X <sub>8</sub>	76	7.1-9.0	8.02	0.40	0.04	4.99
X <sub>9</sub>	76	7.9-10.3	8.90	0.47	0.05	5.28
X <sub>10</sub>	76	6.1-10.3	8.55	0.59	0.06	6.90
X <sub>11</sub>	75	8.3-11.4	10.00	0.59	0.06	5.90
X <sub>12</sub>	76	12.2-16.0	13.56	0.67	0.07	4.94
X <sub>13</sub>	76	5.8-6.9	6.31	0.28	0.03	4.44
X <sub>14</sub>	76	7.8-10.2	8.81	0.42	0.04	4.77
X <sub>15</sub>	76	16.9-22.9	19.55	1.45	0.16	7.42
X <sub>16</sub>	76	5.0-6.8	5.70	0.36	0.04	6.32
X <sub>17</sub>	76	46.4-56.5	52.50	1.62	0.18	3.09
X <sub>18</sub>	76	74.3-84.8	80.76	1.90	0.21	2.35
X <sub>19</sub>	76	81.5-88.3	85.00	1.26	0.14	1.48
X <sub>20</sub>	76	7.1-9.2	8.19	0.45	0.05	5.49
X <sub>21</sub>	52	12.1-18.3	15.95	1.15	0.16	7.21
X <sub>22</sub>	76	7.4-9.8	8.52	0.48	0.05	5.63
X <sub>23</sub>	45	4.9-10.2	8.22	1.07	0.16	13.05*
X <sub>24</sub>	76	9.1-12.6	10.61	0.71	0.08	6.69
X <sub>25</sub>	44	9.6-15.9	13.20	1.35	0.20	10.23*
X <sub>26</sub>	76	21.5-28.7	25.25	1.54	0.17	6.10
X <sub>27</sub>	76	25.1-32.3	28.52	1.43	0.16	5.01
X <sub>28</sub>	76	1.8-2.5	2.18	0.17	0.02	7.80
X <sub>29</sub>	75	3.4-6.6	5.47	0.56	0.06	10.24*
X <sub>30</sub>	75	9.6-15.3	12.18	0.97	0.11	7.96
X <sub>31</sub>	74	5.1-7.4	6.30	0.43	0.05	6.83
% longitudo capitis lateralis						
X <sub>8</sub>	75	26.9-33.2	30.17	1.21	0.14	4.01
X <sub>9</sub>	75	29.4-36.2	33.57	1.35	0.15	4.02
X <sub>10</sub>	75	29.1-38.3	32.48	1.87	0.21	5.76
X <sub>11</sub>	75	33.7-41.9	37.63	1.93	0.22	5.13
X <sub>12</sub>	75	46.4-57.5	51.08	2.28	0.26	4.46
X <sub>13</sub>	75	22.1-26.8	23.79	0.93	0.10	3.91
X <sub>14</sub>	75	28.0-36.3	33.21	1.39	0.16	4.19
X <sub>31</sub>	73	20.2-27.3	23.95	1.38	0.16	5.76

\* Character significant statistically.

Legend of statistical symbol:

n - number of individuals;  $\bar{x}$  - arithmetic mean; S - standard deviation; m - standard error;

V - coefficient of variation.

Table 7

Metric characters of argentine females expressed in relative values as percent indices  
(in % of longitudo corporis and longitudo capitis lateralis)

Symbol of character	% longitudo corporis					
	n	Range	$\bar{x}$	S	m	V
X <sub>2</sub>	48	112.1-117.3	114.56	1.08	0.16	0.94
X <sub>3</sub>	59	102.1-108.1	105.57	0.96	0.12	0.91
X <sub>4</sub>	58	24.4-28.7	26.43	0.83	0.11	3.14
X <sub>5</sub>	59	41.6-46.0	43.52	1.14	0.15	2.62
X <sub>6</sub>	59	40.3-49.6	45.19	1.59	0.21	3.52
X <sub>7</sub>	59	8.5-10.0	9.68	0.61	0.08	6.30
X <sub>8</sub>	59	7.1-9.0	7.95	0.38	0.05	4.78
X <sub>9</sub>	59	7.9-10.0	8.82	0.40	0.05	4.54
X <sub>10</sub>	59	6.1-9.9	8.47	0.55	0.07	6.49
X <sub>11</sub>	58	8.5-11.6	9.99	0.54	0.07	5.41
X <sub>12</sub>	59	12.5-16.0	13.60	0.70	0.09	5.15
X <sub>13</sub>	59	5.8-6.9	6.30	0.28	0.04	4.44
X <sub>14</sub>	59	8.0-9.8	8.79	0.40	0.05	4.55
X <sub>15</sub>	59	17.1-22.7	19.71	0.44	0.06	2.23
X <sub>16</sub>	59	5.0-6.3	5.66	0.36	0.05	6.36
X <sub>17</sub>	59	46.4-56.5	52.52	1.65	0.21	3.14
X <sub>18</sub>	59	74.3-84.8	80.69	1.86	0.24	2.31
X <sub>19</sub>	59	81.5-88.3	84.81	1.27	0.17	1.50
X <sub>20</sub>	59	7.1-9.2	8.18	0.44	0.06	5.38
X <sub>21</sub>	41	12.1-17.8	15.95	1.09	0.17	6.83
X <sub>22</sub>	59	7.4-9.8	8.50	0.46	0.06	5.41
X <sub>23</sub>	34	4.9-9.8	8.15	1.06	0.18	13.01*
X <sub>24</sub>	59	9.1-12.6	10.47	0.71	0.09	6.78
X <sub>25</sub>	32	9.6-15.2	12.96	1.35	0.24	10.42*
X <sub>26</sub>	59	21.5-28.7	25.34	1.56	0.20	6.16
X <sub>27</sub>	59	25.1-31.7	28.51	1.37	0.18	4.81
X <sub>28</sub>	59	1.8-2.5	2.15	0.17	0.02	7.91
X <sub>29</sub>	58	3.4-6.6	5.41	0.63	0.08	11.65*
X <sub>30</sub>	58	9.6-15.3	12.14	0.98	0.13	8.07
X <sub>31</sub>	58	5.1-7.4	6.24	0.40	0.05	6.41
% longitudo capitis lateralis						
X <sub>8</sub>	58	26.9-33.2	30.11	1.17	0.15	3.89
X <sub>9</sub>	58	29.4-36.0	33.55	1.40	0.18	4.17
X <sub>10</sub>	58	29.1-38.3	32.47	1.96	0.26	6.04
X <sub>11</sub>	58	33.7-41.9	37.82	1.80	0.24	4.76
X <sub>12</sub>	58	47.5-57.5	51.45	2.23	0.29	4.33
X <sub>13</sub>	58	22.1-26.8	23.91	0.91	0.12	3.81
X <sub>14</sub>	58	31.0-36.3	33.34	1.20	0.16	3.60
X <sub>31</sub>	57	20.7-27.3	23.80	1.31	0.17	5.50

\*Character significant statistically.

Legend of statistical symbol, beneath Table 6.

Test C by Cochran and Cox showed (at the confidence level  $\alpha = 0.05$ ), the significance of differences for following features (Tab. 9): lateral head length (x<sub>4</sub>), preorbital distance (x<sub>8</sub>), horizontal eye diameter (x<sub>9</sub>), length of ventral fin (x<sub>24</sub>), height of adiposal fin (x<sub>29</sub>) and interorbital distance (x<sub>31</sub>). Values of all these characters were higher in males.



Table 8

Metric characters of argentine males expressed in relative values as percent indices  
(in % of longitudo corporis and longitudo capitis lateralis)

Symbol of character	% longitudo corporis					
	n	Range	$\bar{x}$	S	m	V
X <sub>2</sub>	13	113.8-118.2	115.25	1.19	0.33	1.03
X <sub>3</sub>	17	103.4-111.4	106.36	1.64	0.40	1.54
X <sub>4</sub>	17	24.9-28.4	27.11	1.13	0.27	4.17
X <sub>5</sub>	17	41.7-45.3	43.63	1.02	0.25	2.34
X <sub>6</sub>	17	40.3-46.6	44.26	1.65	0.40	3.73
X <sub>7</sub>	17	9.1-11.5	9.93	0.65	0.16	6.55
X <sub>8</sub>	17	7.5-8.9	8.25	0.39	0.09	4.73
X <sub>9</sub>	17	7.9-10.3	9.17	0.61	0.15	6.65
X <sub>10</sub>	17	7.7-10.3	8.81	0.70	0.17	7.95
X <sub>11</sub>	17	8.3-11.1	10.01	0.74	0.18	7.39
X <sub>12</sub>	17	12.2-14.5	13.50	0.64	0.16	4.74
X <sub>13</sub>	17	5.8-6.9	6.35	0.31	0.08	4.88
X <sub>14</sub>	17	7.8-10.2	8.88	0.52	0.13	5.86
X <sub>15</sub>	17	16.9-22.9	18.96	1.44	0.35	7.59
X <sub>16</sub>	17	5.4-6.2	5.79	0.25	0.06	4.32
X <sub>17</sub>	17	49.7-55.2	52.39	1.60	0.39	3.05
X <sub>18</sub>	17	79.3-84.1	80.97	1.29	0.31	1.59
X <sub>19</sub>	17	83.0-87.4	85.00	1.18	0.29	1.39
X <sub>20</sub>	17	7.3-8.9	8.18	0.51	0.12	6.23
X <sub>21</sub>	11	13.1-18.3	15.92	1.41	0.43	8.86
X <sub>22</sub>	17	7.7-9.3	8.58	0.51	0.12	5.94
X <sub>23</sub>	11	6.3-10.2	8.43	1.13	0.34	13.40*
X <sub>24</sub>	17	10.3-12.3	11.14	0.63	0.15	5.66
X <sub>25</sub>	12	11.7-15.9	13.81	1.16	0.33	8.40
X <sub>26</sub>	17	22.0-26.7	24.92	1.50	0.36	6.02
X <sub>27</sub>	17	26.8-32.3	28.57	1.74	0.42	6.09
X <sub>28</sub>	17	2.1-2.5	2.24	0.12	0.03	5.36
X <sub>29</sub>	17	4.6-6.2	5.68	0.40	0.10	7.04
X <sub>30</sub>	17	11.1-14.6	12.32	0.96	0.23	7.79
X <sub>31</sub>	16	5.7-7.2	6.51	0.33	0.08	5.07
% longitudo capitis lateralis						
X <sub>8</sub>	17	29.1-31.5	30.50	0.85	0.21	2.79
X <sub>9</sub>	17	32.0-36.2	33.84	1.23	0.30	3.63
X <sub>10</sub>	17	30.3-36.2	32.52	1.64	0.40	5.04
X <sub>11</sub>	17	35.7-40.6	37.00	2.33	0.57	6.30
X <sub>12</sub>	17	46.4-55.0	49.82	2.10	0.51	4.22
X <sub>13</sub>	17	21.5-25.3	23.39	1.01	0.24	4.32
X <sub>14</sub>	17	28.0-36.0	32.77	1.92	0.47	5.86
X <sub>31</sub>	16	20.2-26.7	24.14	1.67	0.42	6.92

\*Character significant statistically.

Legend of statistical symbol, beneath Table 6.

Height of head (x<sub>12</sub>) was found to be the only feature significant statistically (being higher in females), among the characters related to the lateral head length.

**Table 9**

Analysis of significance of differences (test C) in biometric characters between  
males and females of argentine

Symbol of character	Males			Females			C <sup>0</sup>	C <sub>0.05</sub>
	n	$\bar{x}$	S	n	$\bar{x}$	S		
metric characters - % longitudo corporis								
X <sub>2</sub>	13	115.25	1.19	48	114.56	1.08	1.82	2.15
X <sub>3</sub>	17	106.36	1.64	59	105.57	0.96	1.84	2.11
X <sub>4</sub>	17	27.11	1.13	58	26.43	0.83	2.24*	2.10
X <sub>5</sub>	17	43.63	1.02	59	43.52	1.14	0.37	2.09
X <sub>6</sub>	17	44.26	1.65	59	45.19	1.59	2.01	2.09
X <sub>7</sub>	17	9.93	0.65	59	9.68	0.61	1.38	2.09
X <sub>8</sub>	17	8.25	0.39	59	7.95	0.38	2.73*	2.08
X <sub>9</sub>	17	9.17	0.61	59	8.82	0.40	2.17*	2.09
X <sub>10</sub>	17	8.81	0.70	59	8.47	0.55	1.79	2.10
X <sub>11</sub>	17	10.01	0.74	58	9.99	0.54	0.10	2.10
X <sub>12</sub>	17	13.50	0.64	59	13.60	0.70	0.54	2.08
X <sub>13</sub>	17	6.35	0.31	59	6.30	0.28	0.58	2.09
X <sub>14</sub>	17	8.88	0.52	59	8.79	0.40	0.64	2.10
X <sub>15</sub>	17	18.96	1.44	59	19.71	0.44	1.84	2.09
X <sub>16</sub>	17	5.79	0.25	59	5.66	0.36	1.65	2.07
X <sub>17</sub>	17	52.39	1.60	59	52.52	1.65	0.28	2.09
X <sub>18</sub>	17	80.97	1.29	59	80.69	1.86	0.69	2.08
X <sub>19</sub>	17	85.00	1.18	59	84.81	1.27	0.56	2.09
X <sub>20</sub>	17	8.18	0.51	59	8.18	0.44	0.00	2.09
X <sub>21</sub>	11	15.92	1.41	41	15.95	1.09	0.06	2.20
X <sub>22</sub>	17	8.58	0.51	59	8.50	0.46	0.56	2.09
X <sub>23</sub>	11	8.43	1.13	34	8.15	1.06	0.69	2.18
X <sub>24</sub>	17	11.14	0.63	59	10.47	0.71	3.66*	2.08
X <sub>25</sub>	12	13.81	1.16	32	12.96	1.35	1.99	2.14
X <sub>26</sub>	17	24.92	1.50	59	25.34	1.56	0.98	2.09
X <sub>27</sub>	17	28.57	1.74	59	28.51	1.37	0.12	2.10
X <sub>28</sub>	17	2.24	0.12	59	2.15	0.17	2.40*	2.07
X <sub>29</sub>	17	5.68	0.40	58	5.41	0.63	2.07	2.07
X <sub>30</sub>	17	12.32	0.96	58	12.14	0.98	0.65	2.09
X <sub>31</sub>	16	6.51	0.33	58	6.24	0.40	2.69*	2.09
metric characters - % longitudo capitis lateralis								
X <sub>8</sub>	17	30.50	0.85	58	30.11	1.17	1.48	2.08
X <sub>9</sub>	17	33.84	1.23	58	33.55	1.40	0.80	2.08
X <sub>10</sub>	17	32.52	1.64	58	32.47	1.96	0.10	2.08
X <sub>11</sub>	17	37.00	2.33	58	37.82	1.80	1.30	2.10
X <sub>12</sub>	17	49.82	2.10	58	51.45	2.23	2.70*	2.09
X <sub>13</sub>	17	23.39	1.01	58	23.91	0.91	1.85	2.09
X <sub>14</sub>	17	32.77	1.92	58	33.34	1.20	1.12	2.10
X <sub>31</sub>	16	24.14	1.67	57	23.80	1.31	0.73	2.11
meristic characters								
D	17	11.11	0.60	59	11.25	0.51	0.85	2.10
A	17	14.35	0.60	59	13.91	0.72	2.48*	2.08
C	17	38.94	1.43	59	38.86	1.22	0.20	2.10
V	17	12.17	0.63	59	11.88	0.56	1.66	2.09
P	17	16.94	0.55	59	17.05	0.62	0.68	2.08
sp.br.	17	19.41	0.87	59	19.81	0.77	1.66	2.09
vt.	17	64.35	0.78	58	64.82	0.88	2.06	2.08
l.l.	17	65.82	1.74	59	65.72	1.57	0.20	2.09

\*Character significant statistically.

Legend of statistical symbol, beneath Table 6.

### Meristic characters

Meristic characters of the Atlantic argentines are demonstrated in Tabs 10, 11 and 12.

As can be seen in Tabs mentioned, range of soft rays count in the dorsal fin (D) was identical for the entire material as well as for both sexes separately, being 10-12, with the prevailing number of specimens possessing 11 rays. The mean value of the character examined amounted to 11.22, in females being feebly higher than in males.

In the anal fin (A) the number of rays covered the range from 13 to 15, being the same in the whole sample, males and females, with the average value of 14.01 for all fish (higher in males). Individuals with 14 rays predominated.

The range of number of rays in the caudal fin (C) was markedly varying from 37 to 41. In females, individuals with 39 rays were found most often, whereas in males with 38 rays. The average number in the whole sample was 38.88, being higher in males.

Count of ventral fin rays (V) in all fish and females ranged within 10-13 ones, in males 11-13. The mean was amounted to 11.94 (being higher in males). Most fish possessed 12 rays in this fin.

In the pectoral fin (P) the number of rays ranged from 16 to 19 in the whole sample and females, in males the range found was shorter, amounting to 16-18 rays. Individuals with 17 rays were found most abundantly. Average number for the whole material amounted to 17.02 and was higher in females.

Count of gill rakers (sp.br.) situated on the first gill arch covered the range from 18 to 22, in males - 18-21. Fish with 20 gill rakers predominated. Mean value of this character was 19.72, with the slightly higher value stated in females.

Vertebral number (vt) ranged within 63-66. In females specimens with 64 and 65 vertebrae were prevailing, while in males with 64 ones. Mean amounted to 64.72, being feebly higher in females.

Range of scales number in the lateral line (l.l.) was broad, in females being 63-70 and in males - 63-69. In females individuals with 65, 66 and 67 scales predominated; in males no predomination was found out, with particular values of scales count being nearly of equal number. Average number of scales in all fish amounted to 65.67, with slightly higher values in males.

Coefficient of variation calculated for characters analyzed were low and non significant, according to criteria given by Ruszczyk (1981). The lowest variability was found in the vertebral count and the highest one in the rays number in the anal fin (in the whole sample and females).

Test C by Cochran and Cox (Tab. 9) showed one difference in the range of meristic characters between males and females of the Atlantic argentines, namely in the anal rays count (A), with the average number being higher in males.

Metric characters of argentine in the entire sample

Table 10

Parameter	Number of fish with particular value of character																														n	Range	$\bar{x}$	S	m	v								
	Value of character																																											
	10	11	12	13	14	15	16	17	18	19	20	21	22	37	38	39	40	41	63	64	65	66	67	68	69	70																		
D	4	5	1																												76	10-12	11.22	0.52	0.06	4.70								
A	19					37	20																								76	13-15	14.01	0.71	0.08	5.11								
C															12																19	21	14	10	76	37-41	38.88	1.25	0.14	3.23				
V	1	12	53	10																									76	10-13	11.94	0.58	0.06	4.87										
P											12	51	12	1																		76	16-19	17.02	0.60	0.06	3.56							
sp. br.											7	16	45	7	1																76	18-22	19.72	0.80	0.09	4.08								
vt.																					5	27	27	16														75	63-66	64.72	0.87	0.10	1.34	
l.l.																					6	111	18	16	16	5	3	1											76	63-70	65.67	1.59	0.18	2.41

Metric characters of argentine female

Table 11

Para- meter	Number of fish with particular value of character																														n	Range	$\bar{x}$	S	m	v
	Value of character																																			
	10	11	12	13	14	15	16	17	18	19	20	21	22	37	38	39	40	41	63	64	65	66	67	68	69	70										
D	2	40	17																								59	10-12	11.25	0.51	0.06	4.54				
A				18	28	13																					59	13-15	13.91	0.72	0.09	5.21				
C														10	12	19	12	6									59	37-41	38.86	1.22	0.15	3.15				
V	1	10	43	5																							59	10-13	11.88	0.56	0.07	4.71				
P							9	39	10	1																	59	16-19	17.05	0.62	0.08	3.68				
sp. br.								4	11	37	6	1															59	18-22	19.81	0.77	0.10	3.91				
vt.																				3	19	21	15				58	63-66	64.82	0.88	0.11	1.36				
l.l.																				5	7	15	14	12	3	2	1	59	63-70	65.72	1.56	0.20	2.37			

Table 12

Metric characters of argentine males

Parameter	Number of fish with particular value of character																													
	Value of character																													
	10	11	12	13	14	15	16	17	18	19	20	21	37	38	39	40	41	63	64	65	66	67	68	69	n	Range	$\bar{x}$	S	m	v
D	2	1	1	4																					17	10-12	11.11	0.60	0.14	5.40
A																									17	13-15	14.35	0.60	0.14	4.22
C																									17	37-41	38.94	1.43	0.34	3.68
V																									17	11-13	12.17	0.63	0.15	5.22
P																									17	16-18	16.94	0.55	0.13	3.28
sp. br.																									17	18-21	19.41	0.87	0.21	4.48
vt.																									17	63-66	64.35	0.78	0.18	1.22
l.l.																									17	63-69	65.82	1.74	0.42	2.64

Legend of statistical symbol beneath Table 6.



## DISCUSSION

The material under investigation contained 76 specimens of the Atlantic argentines. Females were prevailing, contributing 77.6% to the whole sample, whereas the count of males was markedly lower, contributing 22.4% to the sample studied.

The total length of Atlantic argentine ranged within 32-50 cm. As Whitehead et al. (1984) and Sauskan (1988) reported, argentines reach 60 cm of total length. According to Żukowski (1971), who investigated populations of Atlantic argentine in NW Atlantic, its length ranged within 13-42 cm, while in NE Atlantic within 10-36 cm. Range of length 32-44 cm is found by Koleśnik (1968) (concerning the NW Atlantic population). Żukowski (1971) stated, that fish attaining length exceeded 40 cm were distributed more abundantly in northeast part of the ocean.

Table 13 demonstrates the comparison of meristic characters of the Atlantic argentine, being available in the literature as well as our own data.

The mean number of rays in the dorsal fin (D) in own data amounted to 11.22 and was lower than the mean given by Żukowski (1971) for population both from the western and eastern part of North Atlantic. Also the range of rays count in this fin (10 - 12) in the present paper was lower than range reported by Żukowski (1971) and Koleśnik (1968), cited above. Individuals with 11 rays predominated markedly, our findings seemed to be in agree closely with those given by Klimaj and Rutkiewicz (1970) and Leim and Scott (1966).

The range of anal fin rays count (A) varied within 13-15 in the sample studied and it is in accordance with data reported by the authors cited above. The mean value of this character for populations from eastern and western part of the North Atlantic (according to Żukowski 1971) amounted to 14.38 and seems to be feebly higher than the one demonstrated in the present paper.

Count of rays in the caudal fin (C) in own study covered the range from 37 to 41, while reported by Bigelov (1964) and Koleśnik (1968) is 33 -39.

In the ventral fin (V) authors found 10-13 rays, whereas Koleśnik (1968) observed the range 11-13. The most frequent number of rays in this fin was 12, what is in agree with data given by Klimaj and Rutkiewicz (1970) as well as by Leim and Scott (1966).

In the pectoral fin (P) the range of rays count (16-19) was convergent with that reported in Bigelov's (1964) and Koleśnik's (1968) works, being only feebly strayed from the range described by Żukowski (1971).



Andrjašev (1954) found in the dorsal, anal and pectoral fins of the Atlantic argentine stiff rays to be existed. This statement found no support neither in our work nor in any papers of the authors cited in Table 13. Generally, stiff rays are not found in fish belonging to the order *Salmoniformes*. Presumably Andrjašev (1954) has meant the form of soft ray occurring in fins in this order; they are not splitted in their ends, however being elastic and segmented.

When comparing all fins rays counts, it may be concluded, that the most variable one was the number of rays in the caudal fin. Remaining fins showed slight range of rays count. Nevertheless all the counts under study (with the exception of ventral fin) were not converged with the data given by other authors, being, as a rule, lower. Presumably it could be resulted from the different number of sample analyzed by different workers.

The range of gill rakers (18-22) was convergent with the data reported by Kolečnik (1968) and inconsiderably lower than the range observed by Bigelov (1964).

The mean number of vertebrae established in our research to 64.72 was almost identical with the value given by Żukowski (1971) for populations from NE Atlantic (64.81). The mean vertebral number of argentine from NW Atlantic is nearly by 1 higher. Andrjašev (1954), Bigelov (1964) and Kolečnik (1968) noted the range varying from 65 to 68.

The scales number in the sample studied ranged within 63-70, being convergent with the range demonstrated by Bigelov (1964). The constant count (66 scales) in the lateral line was found out by Leim and Scott (1966). In Kolečnik (1968) paper the range of 65-72 is noted, while in Andrjaev (1954) - 60-70 scales.

Relatively non-significant differences found in mean values as well as in ranges of variability of meristic characters under study, do not seem to confirm the distinct systematic position existing in populations compared (Tab. 13), but could result from the different ecological background.

## CONCLUSIONS

1. The total length of fish examined from the northeast Atlantic ranged within 32.9 to 49.7 cm. The mean value amounted to 42.8 cm. The most abundant length class was 42.1-44.0 cm one, contributing 31.1% to the whole sample.
2. Meristic characters of population of Atlantic argentine from the northeast Atlantic can be described as follows: D 10-12, A 13-15, C 37-41, V (10) 11-13, P 16-18 (19), sp.br. 18-22, vt. 63-66, l.l. 63-69 (70).
3. The following metric characters may be regarded as high plastic (coefficient of variation over 10%): height of anal fin ( $x_{23}$ ), length of pectoral fin ( $x_{25}$ ) and height of adiposal fin ( $x_{29}$ ).

4. Employing the test C by Cochran and Cox in the population studied the differences statistically significant between males and females were found out in following metric characters:
  - in relation to the body length: lateral head length ( $x_4$ ), preorbital distance ( $x_8$ ), horizontal eye diameter ( $x_9$ ), ventral fin length ( $x_{24}$ ), adiposal fin height ( $x_{29}$ ) and interorbital distance ( $x_{31}$ ) (values of all these characters were higher in males);
  - in relation to the lateral length of head : height of head ( $x_{12}$ ) (higher in females).
5. In the population studied one significant difference between males and females in meristic characters was stated, namely the count of rays in anal fin (being higher in males).

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MORFOMETRIA ARGENTYNY WIELKIEJ *ARGENTINA SILUS* (ASCANIUS, 1775)  
(FAM. *ARGENTINIDAE*, *SALMONIFORMES*) Z PÓŁNOCNO-WSCHODNIEGO  
ATLANTYKU

STRESZCZENIE

Celem badań było określenie zmienności cech wymierzalnych i przeliczalnych argenty ny wielkiej *Argentina silus* (Ascanius, 1775) pochodzącej z pñ.-wsch. Atlantyku. Ponadto zebrany materiał opracowano pod kątem rozkładu długości (l.t.) oraz masy. Powyższe badania przeprowadzono z uwzględnieniem płci.

Cechy merystyczne badanej populacji można ująć w formułę: D 10-12, A 13-15, C 37-41, V (10) 11-13, P 16-18 (19), sp.br. 18-22, vt. 63-66, l.l. 63-69 (70).

W badanej populacji stwierdzono statystycznie istotne różnice w wartościach siedmiu cech wymierzalnych oraz jednej cechy przeliczalnej pomiędzy samcami i samicami (tab. 9).

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