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IDENTIFICATION OF FISH REMAINS FROM EARLY-MEDIAEVAL LAYERS OF THE VEGETABLE MARKET EXCAVATION SITE IN SZCZECIN, POLAND

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Background. Considerable amounts of fish bones and scales were discovered in 1953–1963, in an archaeological excavation pit situated in a former Vegetable Market in Szczecin, on the left bank of the Odra River.
Materials and methods. Bone remaines comprising 725 labelled collections from various dated sediment layers were identified. Individual bones were compared to those of corresponding extant fish species from water bodies near Szczecin and were identified to bone type and assigned to species. The scales were identified as well.
Results. A total of 10 085 (76.2%) bone remains, out of 13 229, could be identified. They belonged to 20 fish species. Most abundant were remains of carp bream (*Abramis brama*), zander (*Sander lucioperca*), roach (*Rutilus rutilus*), tench (*Tinca tinca*), wels catfish (*Silurus glanis*), European perch (*Perca fluviatilis*), northern pike (*Esox lucius*), and sturgeon (*Acipenser sturio*).
Conclusions. The majority of fish species targeted by early-mediaeval fishermen are also very important in the present-day fisheries in the area. It can be presumed that intensive sturgeon fishery in early Middle Ages markedly contributed to the species' extinction from the area.

Key words: archaeological excavations, early Middle Ages, fish remains.

INTRODUCTION

In 1953–1963, the Polish Academy of Sciences Archaeological Laboratory of the Institute of Material Culture (At present Archeological Laboratory, Institute of Archaeology and Etnography, Polish Academy of Sciences.) was involved in archaeological excavations in Szczecin, on the left bank of the Western Odra River, at

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a site called the Vegetable Market and located at the feet of the Pomeranian Dukes' Castle (Fig. 1). Exploration of the Vegetable Market pit revealed numerous layers dated, according to Dworaczyk and Kowalska (2004), to the 10th–13th century (Table 1). In addition to numerous artefacts of human material culture, the early-mediaeval layers of the pit contained considerable amounts of animal bone remains, including those of fish (Kubasiewicz and Gawlikowski 1967, Leciejewicz et al. 1972, Rulewicz 1974, 1994). Some of those remains were identified (Chełkowski unpublished) and the findings were published (Leciejewicz et al. 1972, Rulewicz 1974, 1994). A further, substantial batch of fish bones recovered from the pit was included in a collection of animal bones forwarded by the Archaeological Laboratory to be examined by specialists of the Division of Animal Anatomy, Agricultural University of Szczecin. When processing the items, Kubasiewicz and Gawlikowski (1967) analysed in detail the mammalian remains, while only enumerating the fish bones.

The present paper focuses on all the fish bones excavated from the early-mediaeval layers of the Vegetable Market, i.e. the items inventoried by the authors mentioned above, the objects analysed by Chełkowski (unpublished), and the remains handed over by the Archaeological Laboratory. The study described was aimed at determining the composition of fish consumed in the area of the present-day Szczecin during early Middle Ages.

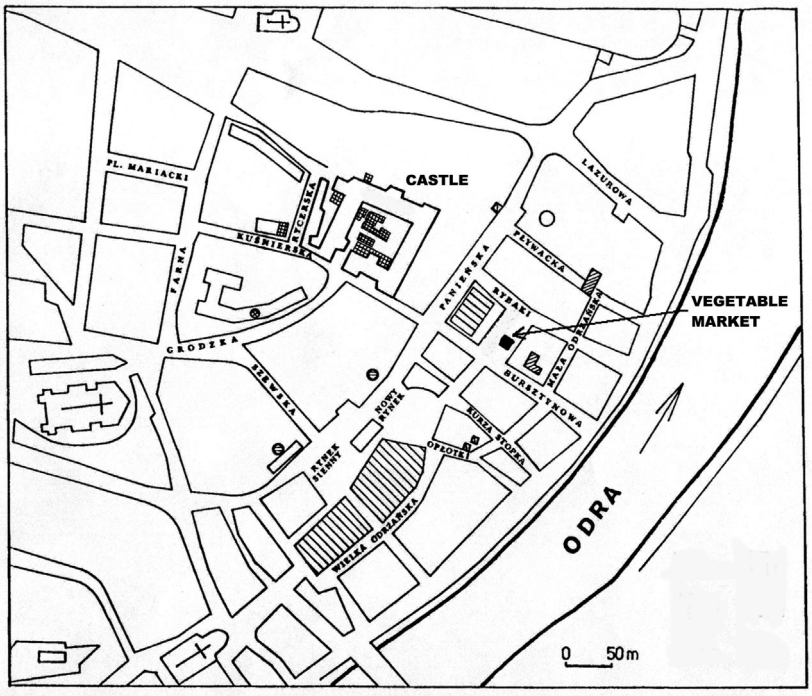

Fig. 1. Location of the Vegetable Market archaeological site in Szczecin (modified from Dworaczyk and Kowalska 2004)

Table 1

Summary of the study materials extracted from early-mediaeval sediment layers in the Vegetable Market in Szczecin

Layer	Chronology of cultural layers	No. of assemblages		No. of bones					
		Bones	Scales	Identified		Unidentified		Total	
				n	%	n	%	n	%
IV	Beginning of 5th decade of 13th century	5	—	13	61.9	8	38.1	21	0.16
V	End of 4th decade of 13th century	7	—	73	94.8	4	5.2	77	0.58
VI	4th decade of 13th century	4	—	22	100.0	—	0.0	22	0.17
VII	end of 2nd–end of 3rd decades of 13th century	83	5	1934	88.0	263	12.0	2197	16.61
VIII	1st quarter of 13th century	43	—	379	84.4	70	15.6	449	3.39
IX	end of 12th–beginning of 13th centuries	31	1	224	82.4	48	17.6	272	2.06
X	end of 8th–end of 9th decade of 12th century	44	8	529	78.5	145	21.5	674	5.10
XI	end of 3rd–beginning of 4th quarter of 12th century	13	1	240	69.0	108	31.0	348	2.63
XII	3rd quarter of 12th century	13	—	83	81.4	19	18.6	102	0.77
XIII	end of 2nd–beginning of 3rd quarter of 12th century	16	3	180	79.3	47	20.7	227	1.72
XIV	end of 2nd quarter of 12th century	13	1	134	82.7	28	17.3	162	1.22
XV	2nd quarter of 12th century	19	5	112	78.3	31	21.7	143	1.08
XVI	end of 1st–beginning of 2nd quarter of 12th century	17	5	283	57.5	209	42.5	492	3.72
XVII	1st quarter of 12th century (turn of 1st and 2nd decade of 12th century?)	12	1	229	65.1	123	34.9	352	2.66
XVIII	beginning of 12th century	14	4	934	70.3	394	29.7	1328	10.04
XIX	beginning of 12th century	16	7	979	70.0	420	30.0	1399	10.57
XX	end of 11th century	15	1	259	80.2	64	19.8	323	2.44
XXI	end of 11th century	53	10	657	84.4	121	15.6	778	5.88
XXII	beginning of 4th quarter of 11th century	22	2	271	75.3	89	24.7	360	2.72
XXIII	end of 3rd quarter of 11th century	9	3	120	71.9	47	28.1	167	1.26
XXIV	3rd quarter of 11th century	53	17	439	83.5	87	16.5	526	3.98
XXV	end of 2nd–beginning of 3rd quarter of 11th century	16	8	60	76.9	18	23.1	78	0.59
XXVI	end of 1st–beginning of 2nd quarter of 11th century	35	9	136	79.1	36	20.9	172	1.30
XXVII	turn of 10th and 11th centuries–beginning of 11th century	7	1	30	90.9	3	9.1	33	0.25
XXVIII	9th decade–beginning of 10th decade of 10th century	51	3	488	77.3	143	22.7	631	4.77
XXIX	7th–8th decade of 10th century	26	3	653	64.3	362	35.7	1015	7.67
XXX	6th decade of 10th century	9	1	90	52.9	80	47.1	170	1.28
XXXI	4th–5th decade of 10th century	34	9	302	69.6	132	30.4	434	3.28
XXXII	3rd decade of 10th century, past 920 at the earliest	34	10	213	83.5	42	16.5	255	1.97
XXXIII	*terminus ante quem*: 2nd decade of 10th century at the earliest	9	—	19	86.4	3	13.6	22	0.17
No. of items		725	118	10 085		3144		13 229	
%					76.2		23.8		100.00

MATERIALS AND METHODS

The excavation site known in the archaeological literature as the Vegetable Market in Szczecin covered 100 m^2 and was more than 10 m deep (Leciejewicz et al. 1972, Rulewicz 1974). During exploration, the dig surface was divided into squares marked A, B, C, and D, each square being further subdivided into four plots. Thus the pit surface was ultimately divided into 16 plots marked by consecutive letters of the Latin alphabet, starting from **a**.

Exploration of the pit allowed to identify 29 early-mediaeval sediment layers (IV to XXXII), supplemented by the oldest layer XXXIII that formed a boggy, muddy surface. In addition to fish remains, that layer was found to contain a wreck of a large clinker strake boat (Rulewicz 1974, 1994). Taken together, the early-mediaeval layers, from layer IV (youngest) to layer XXXII (oldest), were 7.7 m thick, the deepest-lying layer XXXIII being about 1 m thick. The chronology of the layers as well as the description of the fish bones and scales are summarised in Table 1.

Prior to identification, the bone remains from individual layers, squares, and plots were mechanically cleaned, washed in water, dried, labelled, and stored as assemblages in paper bags placed in cardboard boxes. During pit exploration, fish scales uncovered were saved as well. The scales were dried, labelled, and stored like the fish bones. Neither the bones nor scales were treated with any preservative. This study disregards small assemblages of fish remains from a few layers, mainly from transects.

The entire Vegetable Market collection contains 725 labelled bone and 118 scale assemblages (Table 1). The assemblages differed in the number of items they contained. The number of bone assemblages recovered from a layer varied 5 found in layer IV to 83 extracted from layer VII.

The scales were absent from 6 layers (IV, V, VI, VIII, XII, and XXXIII); in the remaining layers, the number of scale assemblages varied from 1 in layers IX, XI, XIV, XVII, XX, XXVII, and XXX to 17 in layer XXIV.

The fish species consumed in the area of the early-mediaeval Vegetable Market were identified from bones and scales in individual assemblages, the data obtained being pooled for each layer and for the entire pit.

Individual fish bones were identified to type and ascribed to a fish species species based mostly on examination with naked eye or, occasionally, under a 5× magnification. During identification, reference was made to comparative materials (Kaj 1957, Makowiecki 1993) consisting of skeletons of fish species occurring at present in the Odra estuary, i.e. in waters adjoining the Vegetable Market. A number (5–6) of skeletons, varying in size and weight, of most species were available, which greatly facilitated identification.

The sturgeon remains were identified with reference to two sturgeon exhibits made available by the Faculty of Food Science and Fisheries, Agricultural University of Szczecin and to a sturgeon exhibit shown at the Museum of Fisheries in Świnoujście.

Analysis of an assemblage was completed by enumeration of bones belonging to individual fish species. The number of unidentified bones was recorded as well.

Scale analysis involved entire scales, picked out at random, that were, after mechanical cleaning, identified with respect to fish species. The scales were identified under a stereomicroscope, in transmitted light, at magnifications 12–24×. The authors' own reference scale collection was used, the collection consisting of scales of fish species inhabiting the Odra estuary at present. In addition, a key to identification of cyprinid scales (Susłowska and Urbanowicz 1984) was used as well.

During identification of fish remains recovered from the Vegetable Market dig, numerous literature sources (Suworow 1954, Urbanowicz 1956, Janec-Susłowska 1957, Kaj 1957, Horoszewicz 1960, Lebedev 1960, Susłowska 1968, Grodziński 1971, Ninua 1976, Susłowska and Urbanowicz 1984, Rolik and Rembiszewski 1987, Makowiecki 1993, 2003, Baruš and Oliva 1995, Marciniak 1996, Brylińska 2000, Chełkowski and Filipiak 2000, Filipiak and Chełkowski 2000) were consulted.

To illustrate the identification procedure used in this study, results of analysis of a fish bone collection from the early-mediaeval sediment layer IV are presented (Table 2).

Table 2

Identification of bone remains in the early-mediaeval layer IV of the Vegetable Market

No.	Species	Bone	Bone assemblage					Total
			1	2	3	4	5	
1	Northern pike, *Esox lucius*	cleithrum			1			
		maxilla			1			
		vertebra				1		3
2	Carp bream, *Abramis brama*	cleithrum			1			1
3	Tench, *Tinca tinca*	cleithrum	1					1
4	Wels catfish, *Silurus glanis*	lepidotrichia			1			
		palatine					1	2
5	Zander, *Sander lucioperca*	articular		1				
		ceratohyal				1		
		parasphenoid			1	1		
		preopercle		1				
		vertebra				1		6
	Total, identified		1	2	5	4	1	13
	Total, unidentified			1	7			8
	Grand total		1	3	12	4	1	21

The layer supplied 5 assemblages consisting of a total of 13 bones identified as belonging to 5 fish species and 8 unidentifiable bones. Pike bones (a total of 3 items) were encountered in assemblage 3 and 4. Single bones of tench, carp bream were found in assemblages 1 and 3, and wels in 3 and 5. Assemblages 2, 3, and 4 yielded a total of 6 zander bones. All other bone and scale assemblages were analysed in a similar manner.

RESULTS

Analyses of the bone and scale collections showed that fish remains were present in 30 early-mediaeval layers of the Vegetable Market; the species composition of the fish remains was determined (Table 3).

Layer IV supplied 5 fish bone assemblage; results of the analysis were presented above, in the Materials and Methods chapter, as an example of procedures used in the study (Table 2).

The abundance of fish remains in the 725 assemblages analysed varied widely, from 1 bone in, e.g. layer XXIV of plots **f** and **g** or in layer XXIV of plot **i** to 207 bones in layer XIX of plot **h**. A single assemblage contained an average of 18.2 bones.

The bone assemblages consisted of entire bones and their parts of various sizes. The bones regarded as whole were, too, damaged to a larger or smaller extent.

Those bones that, due to a lack of clearly expressed morphological characteristics, could not be ascribed to any species, were dominated by fin rays, ribs or their parts, fragments of flat gill cover bones, vertebrae, some bones of the neuro- and branchiocranium, as well as the fin ray supports (pterygiophore) of single fins and the hypurals from the terminal part of the vertebral column.

Similar was the case of the 118 scale assemblages. Most of the scales found were crumbled. However, whole scales amenable to species identification were present as well.

The entire bone collection extracted from the early-mediaeval layers of the Vegetable Market consisted of 13 229 bones 10 085 of which (76.2%) were identified with respect to the bone type and the fish species; the remaining 3144 bones (23.8%) could not be identified.

The 30 layers forming the stratigraphic profile of the pit differed in the amount of fish remains they contained. The highest number of bones was found in layer VII that supplied 2197 items (16.6%), followed by layer: XIX (1015 items or 10.6%), XVIII (1328 or 10.0%), and XXIX (1015 or 7.7%). The remaining layers supplied much fewer bone remains: from 21 bones (0.2%) found in layer IV to 778 bones (5.9%) in layer XXI.

The proportion of bones identified to type and species ranged from 52.9% in layer XXX to 100% in layer VI (Table 1). Individual sediment layers differed markedly from one another both in the number of bones they contained and in the proportion of identified bones.

Table 3

Number of bones ascribed to individuals fish species the remains of which were found in the early-mediaeval sediment layer of Vegetable Market; species identified from scales marked by bold type

No.	Species	Sediment layer															
		IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX
1	Sturgeon, *Acipenser sturio*		5	4	65	17	4	9	6	3	4	15	15	1		3	5
2	Twaite shad, *Alosa fallax*									1							1
3	Northern pike, *Esox lucius*	3	2		**48**	6	5	4	**11**	2	2	4	1	**3**	2	42	51
4	Zope, *Abramis ballerus*				10			6	6	5			1	5		9	
5	Carp bream, *Abramis brama*	1	10	7	**469**	94	**44**	**261**	**81**	39	**85**	**44**	**34**	**152**	**112**	**535**	**426**
6	Asp, *Aspius aspius*		1		33	9	3	7	13	2		1		3	1	25	17
7	White bream, *Blicca bjoerkna*																
8	Crucian carp, *Carassius carassius*		1			1											2
9	European chub, *Leuciscus cephalus*				3	2	1		1		1		1				5
10	Ide, *Leuciscus idus*				4		2	4			3		1	1			3
11	Ziege, *Pelecus cultratus*						1										
12	Roach, *Rutilus rutilus*		26	1	**578**	85	**27**	**34**	**17**	3	**17**	**7**	**9**	**30**	**17**	**41**	**65**
13	Rudd, *Scardinius erythrophthalmus*				5			1									
14	Tench, *Tinca tinca*	1	7	2	72	12	9	21	7	1	11	7	3	13	2	38	30
15	Baltic vimba, *Vimba vimba*				3												1
16	Wels catfish, *Silurus glanis*	2	9	2	145	47	48	60	22	5	12	18	9	3	2	19	20
17	European eel, *Anguilla anguilla*				5		12							1	1		5
18	Ruffe, *Gymnocephalus cernuus*				4									1			
19	European perch, *Perca fluviatilis*		4		**64**	6	**2**	**9**	**15**	2	**4**	**4**	**1**	**20**	18	**32**	**43**
20	Zander, *Sander lucioperca*	6	8	6	**426**	100	66	**113**	61	20	41	34	**37**	**50**	**74**	190	305
Total number of identifiable bones		13	73	22	1934	379	224	529	240	83	180	134	112	283	229	934	979
Total number of species identified		5	10	6	16	11	14	12	11	11	10	9	11	13	9	11	15
Number of species identified from bonesi		5	10	6	16	11	13	12	11	11	10	9	11	13	9	10	15
Number of species identified from scales					5		4	4	4		3	3	4	5	3	4	4

Table 3 (cont.)

No.	Species	Sediment layer XX	XXI	XXII	XXIII	XXIV	XXV	XXVI	XXVII	XXVIII	XXIX	XXX	XXXI	XXXII	XXXIII	Total Items	%
1	Sturgeon, *Acipenser sturio*	5	38	8	12	43	3	12	2	1	6	1	11	8	2	308	3.1
2	Twaite shad, *Alosa fallax*															2	0.0
3	Northern pike, *Esox lucius*	27	49	12	2	30	**7**	**9**	1	36	65	11	27	12	1	475	4.7
4	Zope, *Abramis ballerus*	2				2					1		2			49	0.5
5	Carp bream, *Abramis brama*	**100**	**204**	**90**	**38**	**125**	**9**	**32**	**4**	**84**	**104**	**14**	**63**	**36**		3297	32.7
6	Asp, *Aspius aspius*	7	8	9	5	6	3			15	12	3	5	**2**		190	1.9
7	White bream, *Blicca bjoerkna*			1							3					4	0.0
8	Crucian carp, *Carassius carassius*					1				4	7		1	4		21	0.2
9	European chub, *Leuciscus cephalus*			1	1	2										18	0.2
10	Ide, *Leuciscus idus*	3	2	8						2	3		4	5		45	0.4
11	Ziege, *Pelecus cultratus*															1	0.0
12	Roach, *Rutilus rutilus*	**20**	**67**	**33**	**15**	**57**	**10**	**11**	**2**	**43**	**40**	11	**23**	**19**		1308	13.0
13	Rudd, *Scardinius erythrophthalmus*			1				1		**2**	1	1		**1**		13	0.1
14	Tench, *Tinca tinca*	8	32	22	13	54	4	30	12	127	193	22	48	52	5	858	8.5
15	Baltic vimba, *Vimba vimba*		**1**	1						2						8	0.1
16	Wels catfish, *Silurus glanis*	19	46	18	9	29	9	11	7	67	48	7	39	36	1	769	7.6
17	European eel, *Anguilla anguilla*		3		1	3		2		13	11		8	1		66	0.7
18	Ruffe, *Gymnocephalus cernuus*															5	0.0
19	European perch, *Perca fluviatilis*	6	**18**	**13**	**7**	**16**	1	**4**		**60**	94	5	33	14	3	498	4.9
20	Zander, *Sander lucioperca*	62	**189**	**54**	**17**	71	**14**	**24**	2	32	65	15	38	23	7	2150	21.3
Total number of identifiable bones		259	657	271	120	439	60	136	30	488	653	90	302	213	19	10085	100.0
Total number of species identified		11	13	14	11	14	11	10	7	14	15	10	15	15	6		
Number of species identified from bonesi		11	12	14	11	13	9	10	7	14	15	10	13	13	6		
Number of species identified from scales		2	6	4	4	4	6	5	2	4	2	1	4	6			

Earlier (older) layers, from layer XXXIII to XVI, contained more unidentifiable bones, compared to later (younger) layers, from layer XV to V (Fig. 2). The high proportion of unidentified bones in layer IV could be an artefact produced by the generally low number of bones (21) the layer contained.

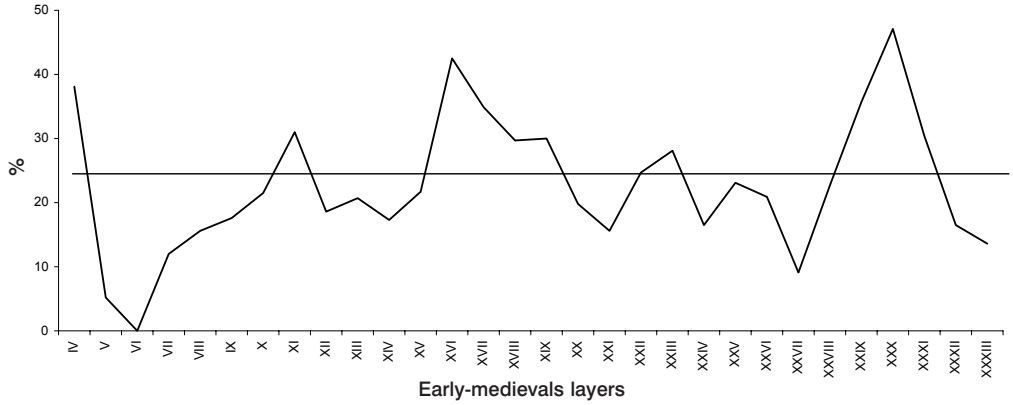

Fig. 2. Proportion of unidentified bones in the fish bone collections from the early--mediaeval sediment layers of the Vegetable Market site throughout the period of study

The bones and scales identified were ascribed to 20 fish species (Table 3). The number of species per layer varied from 5 in layer IV to 16 in layer VII, the latter layer supplying the highest amount of fish remains. The number of species identified by bones and by scales remains a separate problem. The number of species identified from bones was higher, and varied from 5 in layer IV to 16 in layer VII, while the number of species identified from scales ranged from 2 in layers XX and XXVIII to 6 in layer XXI. In principle, identification based on scales was only a confirmation of the presence of a species, already inferred from the bone assemblages. However, 6 layers (IX, XVIII, XXI, XIV, XXVI, and XXXI) provided evidence of rudd (*Scardinius erythrophthalmus*) in the form of scales only. Similar was the case with white bream (*Blicca bjoerkna)* in layers XXV, XXXI, and XXXII and Baltic vimba (*Vimba vimba)* in layer XXXII.

The highest numbers and proportions of identifiable bones were contributed by carp bream (*Abramis brama*; 3297 items or 32.7%), zander (*Sander lucioperca*; 2150 or 21.3%), and roach (*Rutilus rutilus;* 1308 or 13.0%). Numerous were also bones of tench (*Tinca tinca;* 858 or 8.5%), wels catfish (*Silurus glanis*; 769 or 7.6%), European perch (*Perca fluviatilis;* 498 or 4.9%), northern pike (*Esox lucius*; 475 or 4.7%), and sturgeon (*Acipenser sturio;* 308 or 3.1%). On the other hand, the remaining 12 species were identified from much sparser assemblages of items, from 190 bones of asp (*Aspius aspius*) to a single bone of ziege (*Pelecus cultratus*).

The scales analysed were found to belong to 9 fish species. Scales of carp bream, roach, European perch, zander, rudd, northern pike, white bream, Baltic vimba, and asp were present in 24, 23, 16, 11, 8, 5, 3, 2, and 1 layer, respectively (Table 3).

Remains of the sturgeon were present in 28 early-mediaeval layers as a total of 308 bones. The number of bones in a layer ranged from 1 in layers XVI, XXVIII, and XXX each to 65 in layer VII. Numerous sturgeon remains were supplied also by layers XXI and XXIV (Fig. 3).

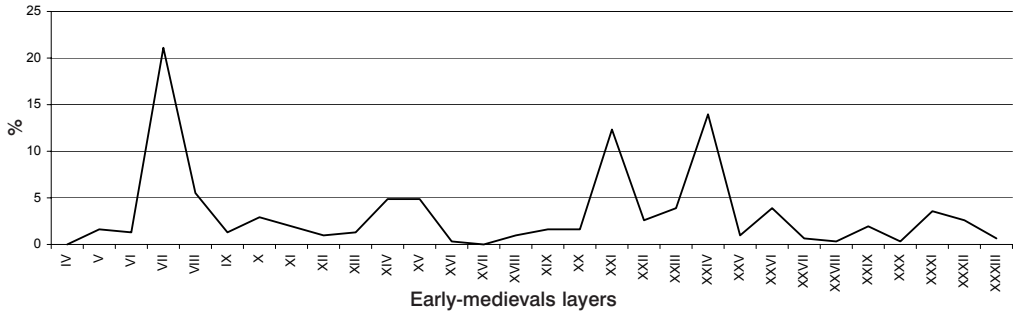

Fig. 3. Proportion of sturgeon (*Acipenser sturio* L.) remains in the early-mediaeval sediment layers of the Vegetable Market site

The sturgeon remains comprised 6 types the most numerous of which were bone plates (127 items or 66.6%). Abundant were also remains of the skull, the dermocranium 89 or 28.9%). On the other hand, there were much fewer fin rays (10 or 3.3%), fulcra that are normally present along the upper part of the heterocercal caudal fin (2 or 0.6%), branchiostegal rays (1 or 0.3%), and the cleithrum (1 or 0.3%) (Table 4).

Table 4

Sturgeon remains in the Vegetable Marked site

Item No.	Type of remains	Amount
1	Bony plates	205
2	Fulcra	2
3	Dermocranium	89
4	Branchiostegal ray	1
5	Cleithrum	1
6	Fin-rays	10
Total		308

Table 5 lists the most frequent among the identified bones of individual fish species. As shown by the table, the best preserved bones include the cleithrum, operculum, hyomandibular, vertebrae, and ribs; the best preserved cyprinid bones are the pharyngeals the morphometry of which is an important diagnostic characters facilitating species identification.

Table 5

The most abundant bone remains of fish species identified in the Vegetable Market site

Fish species	Cleithrum	Parasphenoid	Dentary	Maxilla	Ectopterygoid	Hyomandibular	Lower pharyngeal bone	Opercle	Interopercle	Preopercle	Subopercle	Posttemporal	Vertebra	Rib	Total	
															Identified bones	Bone types
Twaite shad	1							1							2	2
Northern pike	181		79		53										475	21
Zope	11							3		30					49	7
Carp bream	232					133		814	203	694	59		198	719	3297	32
Asp	36						22							24	190	25
White bream							4								4	1
Crucian carp							2	8	2	4	2		2		21	7
European chub	5						4			4					18	7
Ide	17		1				17	3		3				3	45	7
Ziege										1					1	1
Roach							659	204		141					1308	19
Rudd	1					1	10					1			13	4
Tench	172		107			34	58	235	40	99	35				858	20
Baltic vimba	4						1	2			1				8	4
Wels catfish	188												163		769	32
European eel	28		21												66	6
Ruffe										5					5	1
European perch	68							111		105					498	29
Zander	180	236	195	130						303					2150	32

DISCUSSION

The proportion of identifiable bones (76.2%) among the bone remains extracted from the early-mediaeval Vegetable Market was higher than the proportions of bones that could be identified in two archaeological pits in Wolin, also situated on the Odra estuary shore, dated to the similar period of human settlement, and containing numerous fish remains. In Pit 6 (Wolin Miasto), the identifiable bones accounted for 596% of a collection of 16 463 bones (Chełkowski and Filipiak 2000), 73.1% of the 3537 bones being identified in Pit 8 (Wolin Port) (Chełkowski et al. 1998). Similarly, the proportion of identified bones extracted from early-mediaeval layers of an archaeological site in Gdańsk, situated in the Vistula River mouth, was lower and amounted to 70% (Urbanowicz 1965, Susłowska and Urbanowicz 1967).

Compared with the contemporaneous collection of fish remains from Wolin, the Szczecin Vegetable Market fish remains were much less damaged, less crushed, and preserved in a better condition. This might have been the reason why more bones could be identified in the collection examined in this work. Another reason might be the practice of retaining, during exploration, of whole and little damaged fish bones only and ignoring those that were broken down.

The fish remains found in the Vegetable Market represented 20 fish species. In the Wolin Port and Wolin Miasto sites, remains of 17 and 28 species were identified (Chełkowski et al. 1998, Chełkowski and Filipiak 2000). The latter site, in addition to the species represented in the Vegetable Market, provided evidence of Atlantic herring (*Clupea harengus*), allis shad (*Alosa alosa)*, Atlantic salmon (*Salmo salar)*, sea trout (*Salmo trutta*), common whitefish (*Coregonus lavaretus)*, gudgeon (*Gobio gobio)*, burbot (*Lota lota),* and flounder (*Platichthys flesus)* (Table 6). Herring, a typically marine species, occurs occasionally in the downstream reaches of the Odra estuary, i.e. in the northern part of the Szczecin Lagoon. It could not have been caught up the estuary, in the area adjacent to the Vegetable Market. The flounder, also a marine species, occasionally enter the mouth sections of rivers draining into the sea and appears in the Odra estuary up to Lake Dąbie, i.e. an area close to the Vegetable Market. However, no plaice remains were present in the collections analysed in this work. Interestingly, compared to the Wolin-Miasto site, the Vegetable Market collection lacks remains of such species as whitefish, salmon, and trout. Those species are very attractive for consumers and it is difficult to assume that they had not been harvested in the environs of the mediaeval Szczecin. The absence of their remains in the present collection might have resulted from the fact that the species have very delicate bones that decompose fast. That would be also an indirect evidence that, compared to the Wolin collections, mineralisation of the Vegetable Market one proceeded faster.

Per cent contributions of identified bones of many species represented in the Vegetable Market collection are similar to those recorded in the two Wolin sites; for some species, the contributions are different. In all the three sites, the highest contributions were those of carp bream and zander. The two species contributed 32.7

and 21.3%, respectively, to the Vegetable Market collection. A reverse order was observed in the Wolin sites: zander remains were much more numerous than those of carp bream: 39.3 and 26.8%, respectively, in the Wolin Miasto site and 45.2 and 20.9%, respectively, in the Wolin Port one. The respective contributions of northern pike, roach, tench, and wels catfish to the Vegetable Market collection were much higher than those in the Wolin ones, a reverse being the case with European perch (Table 6).

Table 6

Per cent contributions of identifiable bone remains to bone collection extracted from the early-mediaeval layers of archaelogical excavation sites situated on the Odra estuary shores

No.	Species	Vegetable Market	Wolin Town	Wolin Port
1	Sturgeon, *Acipenser sturio* L.	3.05	1.28	11.76
2	Atlantic herring, *Clupea harengus* L.	—	3.30	0.39
3	Allis shad, *Alosa alosa* (L.)	—	2.90	—
4	Twaite shad, *Alosa fallax* (Lacepède)	0.02	0.03	—
5	Common whitefish, *Coregonus lavaretus* L.	—	0.02	—
6	Atlantic salmon, *Salmo salar* L.	—	0.02	—
7	Sea trout, *Salmo trutta* L.	—	0.01	0.08
8	Northern pike, *Esox lucius* L.	4.71	1.32	1.86
9	Zope, *Abramis ballerus* (L.)	0.49	0.05	0.04
10	Carp bream, *Abramis brama* (L.)	32.69	26.82	20.90
11	Asp, *Aspius aspius* (L.)	1.88	0.31	0.43
12	White bream, *Blicca bjoerkna* (L.)	0.04	1.01	—
13	Crucian carp, *Carassius carassius* (L.)	0.21	0.01	—
14	Gudgeon, *Gobio gobio* (L.)	—	+	—
15	European chub, *Leuciscus cephalus* (L.)	0.18	0.14	—
16	Ide, *Leuciscus idus* (L.)	0.45	0.29	0.31
17	Ziege, *Pelecus cultratus* (L.)	0.01	0.03	—
18	Roach, *Rutilus rutilus* (L.)	12.97	6.77	5.26
19	Rudd, *Scardinius erytrophthalmus* (L.)	0.13	0.08	—
20	Tench, *Tinca tinca* (L.)	8.52	0.91	0.43
21	Baltic vimba, *Vimba vimba* (L.)	0.08	0.09	0.08
22	Wels catfish, *Silurus glanis* L.	7.63	0.16	0.27
23	European eel, *Anguilla anguilla* L.	0.65	0.88	0.62
24	Burbot, *Lota lota* L.	—	0.04	—
25	Ruffe, *Gymnocephalus cernuus* (L.)	0.04	0.14	0.15
26	European perch, *Perca fluviatilis* L.	4.93	14.98	12.19
27	Zander, *Sander lucioperca* (L.)	21.32	39.26	45.23
28	Flounder, *Platichthys flesus* L.	—	0.19	—

+ species identification based on scales only

The three collections differ markedly in the contribution of sturgeon remains to the number of identified bones: the highest contribution (11.8%) was that in the Wolin Port site, followed by the Vegetable Market (3.1%), and the Wolin Miasto site (1.3%)

(Table 6). Contributions of the remaining fish species to the pool of identified bones were low and similar between the three sites.

It has to be remembered that the identification potential of bone remains present in the early-mediaeval sediment layers is limited and bone type- and species-dependent due to the fact that various bones of different fish species differ in their resistance to weathering and decomposition over the period from deposition to recovery during site excavation. The same is true of scales. Bones of some species, e.g. zander, European perch, and cyprinids (older individuals in particular), bulky and hard, are more resistant, compared to skeletal components of salmonids and clupeids that include numerous cartilaginous elements, the bones being porous and soft. Such bones are decomposed relatively fast, whereby most of them did not persist in the early-mediaeval sediment layers. However, despite the low amount or absence of bone remains of salmonids and clupeids, one cannot rule out the possibility of their being harvested at that time by residents of the then Szczecin. The anadromous fish are known to have migrated, in masses, to their spawning areas in the upstream reaches of the Odra River via its estuary.

That various types of fishing gear were widely used in waters neighbouring the Vegetable Market is evidenced by as many as 417 inventoried items of different gear, including nets, recovered from all the early-mediaeval sediment layers of the site (Rulewicz 1994). There is also written evidence indicating a common use of stationary fishing nets in the early-mediaeval Szczecin. The 1243 document issued by Duke Barnim the First, in which city rights were granted to Szczecin, states that Szczecin is granted the right to "...fish freely in the Odra, not with stationary gear, 1 mile upstream and 1 mile downstream [from the city of Szczecin]" (Anonymous 1868).

The location of early-mediaeval human settlements around the Vegetable Market in Szczecin, in the direct vicinity of numerous water areas making up the Odra estuary supporting economically valuable fish species, was doubtless enhancing fishing activities. As can be presumed, the fish were a valuable food source of the then residents of the area. Numerous remains of economically important fish species were found, too, in the early-mediaeval (9th–12th centuries) sediment layers of Wolin, also located in the Odra estuary (Chełkowski and Filipiak 2000, Filipiak and Chełkowski 2000).

CONCLUSIONS

Results of studies on fish remains extracted from early-mediaeval layers of the Vegetable Market allow concluding that:

- The identifiable bone and scale remains belonged to 20 fish species and were non-uniformly distributed among the 30 layers explored.
- The largest proportion of bone remains was supplied by carp bream (*Abramis brama*), zander (*Sander lucioperca)*, and roach (*Rutilus rutilus*). The respective contributions of tench (*Tinca tinca),* wels catfish (*Silurus glanis)*, European perch (*Perca fluviatilis*), northern pike (*Esox lucius*), and sturgeon (*Acipenser sturio*)

were fairly considerable, too, while the remaining 12 species contributed much less to the total pool of bone remains analysed.

- The fish remains analysed in this work were remnants of human consumption.
- The species identified by the fish remains extracted from the early-mediaeval deposit layers as well as the structure of the species composition indicate that the fish were caught in the Odra estuary, i.e. in the waters neighbouring the Vegetable Market.
- Remains of numerous commercial fish species, occurring in all the early-mediaeval sediment layers provide clear evidence that the then residents of the area took ample advantage of fish resources of the Odra estuary. The fisheries, thus, played a substantial economic role and the fish were important part of the diet.

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