Acta zoologica cracoviensia, **47**(1-2): 27-47, Kraków, 30 June, 2004

Bird remains from a rock-shelter in Krucza Skała (Central Poland)*

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Received: 3 Apr., 2004
Accepted for publication: 15 May, 2004

BOCHEŃSKI Z., TOMEK T. 2004. Bird remains from a rock-shelter in Krucza Skała (Central Poland). *Acta zooologica cracoviensia*, **47**(1-2): 27-47.

Abstract. Bird bone remains consisting of 2477 skeletal fragments belonging to at least 488 bird individuals of 116 taxa are described, the great majority of them identified to the species level. They are characteristic of various habitats and all European climatic zones. They accumulated in the Late Glacial period of the Vistulian and the Holocene. 11 bird taxa have not been recorded from Poland as fossils.

Key words: fossil birds, Central Poland, Vistulian Late Glacial, Holocene.

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I. INTRODUCTION

The rock-shelter in the Krucza Skała rock is one of two archaeological and palaeontological localities situated in the Kroczyce Rocks in the middle part of the Częstochowa Upland, central Poland (Fig. 1). Materials from the Deszczowa Cave, and among them the data on fossil birds were published earlier (BOCHEŃSKI, TOMEK 2000). Materials from these localities differ with respect to the number of remains, number of identified bird species, as well as age. They are, however, complementary to each other and give a good picture of the development of the bird fauna in this part of Central Poland.

Excavations in a rock-shelter in Krucza Skała rock directed by Prof. K. CYREK were done by the staff of Archaeological-Etnographic Museum in Łódź, and took place in 1991 and 1992. They were accomplished both in the rock-shelter and in front of its entrance "under the overhang". Besides rich archaeological artifacts plenty of animal remains were found, among them more than two thousand identified fragments of bird skeletons.

The locality was described by CYREK (1994); his paper also contains its schematic profile and map. The petrography of sediments was studied by MADEYSKA (1996). Nine layers (1-9) were dis-

*This project was partly supported by grant 6 PO4C 097 20 awarded by the State Committee for Scientific Research of Poland

Fig. 1. Localization of the rock-shelter in Krucza Skała.

tinguished in the rock-shelter, whereas only six layers (I-VI) in front of it . The correlation of particular layers of the profiles in the rock-shelter and in front of the shelter are not clear in all cases. Nevertheless, the deepest clayey layers, 1 in the rock-shelter and I in front, as well as the overlaying rubble layers 2 and II seem to be equivalent. The same is true for the uppermost layers 9 and VI.

Five samples were dated using the radiocarbon method 14C. The oldest date deals with the deepest layer I "under the overhang" and is equal to 12520 ± 70 BP; according to CYREK (oral comm.), it is very probable that the bone intruded from the overlaying layer II. So, all animal remnants accumulated during a short time, i.e. the last 13 thousand radiocarbon years.

A c k n o w l e d g e m e n t s. We are highly indebted to Prof. Dr K. CYREK for passing us the material and for valuable discussion on the stratigraphy of sediments. Prof. Dr A. NADACHOWSKI discussed stratigraphical problems several times and Dr E. KUROCHKIN helped in identification of remains in the case when our osteological collection was too poor. We owe special thanks to Dr C. MOURER-CHAUVIRÉ and Dr T. TYRBERG for their detailed reviews of the manuscript and useful remarks.

II. MATERIAL AND METHODS

Bird remains from the rock-shelter in Krucza Skała rock consist of 2477 identified skeletal fragments. They represent at least 488 individuals belonging to 116 taxa, most of them identified to the species level. Besides them many small fragments such as phalanges, vertebras, or small fragments of the shafts of long bones were left unidentified. All materials excavated from layers 1-9 of the sediment in the rock-shelter are shown in Table I, and from analogous layers I-VI of the sediment in front of the entrance "under the overhang" in Table II.

Table I

Bird remains identified in particular layers inside the rock-shalter in Krucza Skała. The first number refers to the number of identified specimens (NISP), the second to the minimum number of individuals (MNI) in a given layer. MNI is not given, when remains may belong to individuals identified to species level or to specimens coming from transitional sediments between layers in which given species was found

Species	Particular layers																lack of stratigraphy	**Total of bones**
	1	1/2	2	2/3	3	3/4	4	4/5	5	5/6	6	7	7/8	8	8/9	9		
Tachybaptus ruficollis (PALLAS, 1764)					1/1									12/1				**13/2**
Anser albifrons (SCOPOLI, 1769)																1/1		**1/1**
Anser sp. (*anser/fabalis*)				1/1			1/1		2/1						1/1			**5/4**
Branta bernicla (LINNAEUS, 1758)			1/1	1/1			3/1											**5/2**
Tadorna tadorna (LINNAEUS, 1758)				1/1														**1/1**
Anas strepera LINNAEUS, 1758									2/1									**2/1**
Anas crecca LINNAEUS, 1758			1/1	3/2	1/1		1/1		3/1	1	1/1			1/1		2/1		**14/9**
Anas platyrhynchos LINNAEUS, 1758				4/1	3/1	5	7/2	1	6/2		2/1	1/1		1/1	2	4/2	2	**38/9**
Anas querquedula LINNAEUS, 1758							1/1		1/1	1/1		1/1						**4/4**
Anas querquedula/crecca				1				1	1						2	1		**6**
Anas clypeata LINNAEUS, 1758									2/1		2/1							**4/2**
Aythya cf. *nyroca* (GÜLDENSTÄDT, 1770)												1/1						**1/1**
Aythya marila (LINNAEUS, 1761)								1/1										**1/1**
cf. *Somateria mollissima* (LINNAEUS, 1758)											1/1							**1/1**
Bucephala clangula (LINNAEUS, 1758)																1/1		**1/1**
Anatidae (middle sized duck)				2	3	1	3		1		1				2			**13**
Accipiter nisus (LINNAEUS, 1758)																1/1		**1/1**
Accipitridae indet.				1/1					1/1						1/1			**3/3**
Falco tinnunculus LINNAEUS, 1758			1/1	3/1	1/1	11	1/1			1	3/1	1/1		1/1	2	2/1	1	**28/7**
Falco peregrinus TUNSTALL 1771										1/1								**1/1**
Falco sp.				1	1	3	5	3			1			1	1	1		**17**
Lagopus lagopus (LINNAEUS, 1758)			15/2	70/7	20/3	18	12/4	4	37/5	13	24/3			1/1	7	20/4	9	**250/29**
Lagopus mutus (MONTIN, 1776)		1/1		4/1	4/2	6	4/3		2/1	5	2/1	2/1			1	2/1		**33/10**
Lagopus sp.			5	26	15	5	6	1	12	7	11	2	1		4	7	4	**106**
Tetrao tetrix LINNAEUS, 1758		1	18/2	33/4	6/2	11	13/3	21	27/4	2	18/3	4/1		1/1	10	41/4	2	**208/20**
Tetrao urogallus LINNAEUS, 1758			1/1	5/3		3	5/2	2	1/1		2/1	1/1			1	1/1	2	**24/9**

Species	Particular layers																lack of stratigraphy	**Total of bones**
	1	1/2	2	2/3	3	3/4	4	4/5	5	5/6	6	7	7/8	8	8/9	9		
Bonasa bonasia (LINNAEUS, 1758)																2/1		**2/1**
Perdix perdix (LINNAEUS, 1758)				1/1			4/1		5/1	1				1/1	7/2	3/1		**27/7**
Coturnix coturnix (LINNAEUS, 1758)				1/1				1	3/2							1/1	1	**7/4**
Gallus gallus (LINNAEUS, 1758)												1/1				3/1	1	**5/2**
Galliformes indet.		1	5	11	1	2	1	3	9	1	6	1				6	4	**51**
Crex crex (LINNAEUS, 1758)						1/1									1/1			**2/2**
Porzana porzana (LINNAEUS, 1766)									1/1									**1/1**
Gallinula chloropus (LINNAEUS, 1758)									2/1									**2/1**
Fulica atra LINNAEUS, 1758			1/1				1/1							2/1	1	2/1		**7/4**
Vanellus vanellus (LINNAEUS, 1758)		1/1		1/1	2/1	3	1/1		1/1		1/1			1/1		5/3		**16/9**
Pluvialis apricaria (LINNAEUS, 1758)/*P. fulva* (J.F.GMELIN, 1789)			1/1	5/1		4/1				1/1						1/1		**12/4**
Pluvialis squatarola (LINNAEUS, 1758)				2/1	2/1	3/3	3/1	1	3/1	2	1/1					1/1		**18/8**
Scolopax rusticola LINNAEUS, 1758									8/3			1/1			2/1	2/1		**13/6**
Gallinago media (LATHAM 1787)			2/1	4/1		1/1						1/1			1	1/1		**10/5**
Gallinago gallinago (LINNAEUS, 1758)				1/1		1/1						1/1		1/1	1			**5/4**
Gallinago sp.						1					1							**2**
Limosa limosa (LINNAEUS, 1758)				3/1					1/1									**4/2**
Limosa sp.					1/1													**1/1**
Numenius phaeopus (LINNAEUS, 1758)				1/1			1/1								1/1			**3/3**
Tringa totanus (LINNAEUS, 1758)				1/1								1/1				1/1		**3/3**
Actitis hypoleucos (LINNAEUS, 1758)		1		1/1														**2/1**
Arenaria interpres (LINNAEUS, 1758)				1/1		5	5/2				3/1			1/1				**15/5**
Calidris alpina (LINNAEUS, 1758)						2/2										1/1		**3/3**
Philomachus pugnax (LINNAEUS, 1758)		2	3/1	6/2	2/2	2	4/1	1		4	1/1				1/1	4/1	2	**32/8**
Stercorarius sp. (*parasiticus/longicaudus*)			1/1				1/1		1/1									**3/3**
Larus cf.*ridibundus* LINNAEUS, 1766				2/1					3/1							1/1		**6/3**
cf. *Rissa tridactyla* (LINNAEUS, 1758)											1/1							**1/1**
Chlidonias hybridus (PALLAS, 1811)				1/1														**1/1**

Species	Particular layers																lack of stratigraphy	**Total of bones**
	1	1/2	2	2/3	3	3/4	4	4/5	5	5/6	6	7	7/8	8	8/9	9		
Sterna cf. *hirundo* LINNAEUS, 1758					1/1		1/1		1/1	1	1/1							**5/4**
Various Charadriiformes indet.			3		2	3	1	1	3	1	1				1	3		**19**
Columba palumbus LINNAEUS, 1758							3/2		4/1	1		1/1				10/3	1	**20/7**
Columba oenas LINNAEUS, 1758 / *C. livia* J. F. GMELIN 1789					1/1		4/2		6/1						1	2/1		**14/5**
cf. *Tyto alba* (SCOPOLI, 1769)									1/1									**1/1**
Strix aluco LINNAEUS, 1758								1	1/1						4	1/1		**7/2**
Asio flammeus (PONTOPPIDAN, 1763)			1/1							1	1/1							**3/2**
Asio otus (LINNAEUS, 1758) / *flammeus*							1/1		2/1							1/1		**4/3**
Strigiformes (big species)							1		1						1			**3**
Caprimulgus europaeus LINNAEUS, 1758															1/1			**1/1**
Coracias garrulus LINNAEUS, 1758									1/1									**1/1**
Dendrocopos major (LINNAEUS, 1758)											1/1							**1/1**
Picus canus J. F. GMELIN, 1788												1/1						**1/1**
Lullula arborea (LINNAEUS, 1758)			1/1	3/1		1/1						3/1			1	1/1		**10/6**
Alauda arvensis LINNAEUS, 1758						1	1/1		1/1							4/1		**7/3**
Hirundo rustica LINNAEUS, 1758				2/1		4/1	1/1			1/1			1/1		2/1			**11/6**
Anthus trivialis (LINNAEUS, 1758)											1/1							**1/1**
Anthus sp.																1/1		**1/1**
Phoenicurus ochruros (S .G. GMELIN, 1774)												1/1						**1/1**
Oenanthe oenanthe (LINNAEUS, 1758)				1/1					1/1									**2/2**
Turdus merula LINNAEUS, 1758																4/1	1	**5/1**
Turdus pilaris LINNAEUS, 1758																1/1		**1/1**
Turdus philomelos C .L. BREHM, 1831									2/1		2/1	1/1			1	3/1	1	**10/4**
Turdus viscivorus LINNAEUS, 1758										1/1		1/1		1/1	2	1/1		**6/4**
Turdus viscivorus / *pilaris*														1	1			**2**
Turdus sp.									1							1		**2**
Acrocephalus arundinacaeus (LINNAEUS, 1758)											1/1							**1/1**
Sylvidae indet.									1/1							1/1		**2/2**
Muscicapa striata (PALLAS, 1764)							1/1					1/1				1/1		**3/3**
Muscicapidae cf. *Ficedula*																1/1		**1/1**

Species	Particular layers																lack of stratigraphy	**Total of bones**
	1	1/2	2	2/3	3	3/4	4	4/5	5	5/6	6	7	7/8	8	8/9	9		
Parus ater LINNAEUS, 1758																1/1		**1/1**
Parus major LINNAEUS, 1758																1/1		**1/1**
Emberiza citrinella LINNAEUS, 1758								1/1										**1/1**
Fringilla coelebs LINNAEUS, 1758																1/1		**1/1**
Carduelis sp.															1/1			**1/1**
Loxia cf. *curvirostra* LINNAEUS, 1758				1/1														**1/1**
Coccothraustes coccothraustes (LINNAEUS, 1758)									1/1							2/1		**3/2**
Fringillidae indet.	1/1																	**1/1**
Sturnus vulgaris LINNAEUS, 1758																1/1		**1/1**
Garrulus glandarius (LINNAEUS, 1758)												1/1			1	4/2	1	**7/3**
Pica pica (LINNAEUS, 1758)				1/1												1/1		**2/2**
Pyrrhocorax pyrrhocorax. (LINNAEUS, 1758)				1/1														**1/1**
Corvus monedula LINNAEUS, 1758	1/1		3/1	12/2	2/1	1	2/1		4/1		2/1				3/1		1	**31/9**
Corvus frugilegus LINNAEUS, 1758									1/1						2/2			**3/3**
Corvus corone LINNAEUS, 1758			1/1				1/1	1	1/1		2/1				2	3/2		**11/6**
Corvus corone / *frugilegus*					1		1		1					3/1	1			**7**
Corvus corax LINNAEUS, 1758			1/1								1/1							**2/2**
Corvidae indet.									2		1					1		**4**
Passeriformes indet.					1		1								1	4		**7**
Total of identified bones inside the rock-shelter	**2**	**7**	**65**	**219**	**71**	**98**	**102**	**45**	**169**	**47**	**97**	**29**	**2**	**29**	**76**	**173**	**32**	**1263**

The other 298 bone fragments come from the samples in which stratigraphy was not precisely determined (e.g.1/2/3 or IV/II/V) or from samples having no labels (lost?). Among them there are, however, some remains identified as belonging to taxa not represented in samples from sediments of well defined stratigraphy. They are as follows: cf. *Glareola* sp., *Larus canus* LINNAEUS, 1758, *Turdus* cf. *torquatus* LINNAEUS, 1758, *Phylloscopus* cf. *trochilus* (LINNAEUS, 1758), *Parus palustris* LINNAEUS, 1758, and *Montifringilla nivalis* (LINNAEUS, 1766). 45 bone fragments come from samples labeled as "próchnica holoceńska" (i.e. Holocene humus) without designation which part of the locality they came from; they belong to taxa identified to various systematic levels – all these taxa are also represented in the uppermost holocene layers VI or 9. All these remains are not included in Tables I and II.

For palaeoenvironmental analyses only the remains excavated from well defined strata of sediments were used. If a well defined layer contained a sufficient number of securely identified bird species then the thermal index was calculated according to DEMARCQ and MOURER-CHAUVIRÉ (1976).

Table II

Bird remains identified in particular layers in front of the rock-shalter in Krucza Skała. The first number refers to the number of identified specimens (NISP), the second to the minimum number of individuals (MNI) in a given layer. MNI is not given, when remains may belong to individuals identified to species level or to specimens coming from transitional sediments between layers in which given species was found

Species	Particular layers										lack of stratigraphy	**Total of bones**
	I	I/II	II/III	III	III/IV	IV	IV/V	V	V/VI	VI		
Tachybaptus ruficollis (PALLAS, 1764)								9/2		1/1	3	**13/3**
Podiceps cristatus (LINNAEUS, 1758)						1/1		1/1				**2/2**
Podiceps cristatus / *grisegena*								1				**1**
Anser sp (*anser* / *fabalis*)								1/1		1/1		**2/2**
Branta bernicla (LINNAEUS, 1758)										1/1		**1/1**
Anas penelope LINNAEUS, 1758								1/1				**1/1**
Anas crecca LINNAEUS, 1758					1/1		3	5/1		2/1		**11/3**
Anas platyrhynchos LINNAEUS, 1758			1/1		4	1/1	1/1	10/2	2	10/2		**29/7**
Anas querquedula LINNAEUS, 1758							2/1					**2/1**
Anas querquedula / *crecca*						2	1	2		2		**7**
Anas clypeata LINNAEUS, 1758							1	2/1				**3/1**
Aythya marila LINNAEUS, 1761/*A. ferina* (LINNAEUS, 1758)									1/1			**1/1**
cf. *Clangula hyemalis* (LINNAEUS, 1758)						1/1						**1/1**
Melanitta fusca (LINNAEUS, 1758)										1/1		**1/1**
Mergus albellus (LINNAEUS, 1758)				1/1		1/1						**2/2**
Mergus serrator LINNAEUS, 1758 / *M. merganser* LINNAEUS, 1758										1/1		**1/1**
Anatidae (middle sized duck)						1	1	2	1	4		**9**
Accipiter gentilis (LINNAEUS, 1758)										1/1		**1/1**
Buteo buteo (LINNAEUS, 1758)								2/1		1/1		**3/2**
Falco tinnunculus LINNAEUS, 1758				1/1								**1/1**
Falco sp.										2		**2**
Lagopus lagopus (LINNAEUS, 1758)		3/2	6/1	18/3	8	16/4	15	2/1	9	27/4	6	**110/14**
Lagopus mutus (MONTIN, 1776)				3/1	2	1/1	2	2/1	1	6/2		**17/5**
Lagopus sp.		1	1	2	1	7	1		1	4	1	**18**
Tetrao tetrix LINNAEUS, 1758	1/1		1/1	1/1	3	3/1		2/1	1	30/4	2	**44/8**
Tetrao urogallus LINNAEUS, 1758					2/1					10/2		**12/3**
Bonasa bonasia (LINNAEUS, 1758)						1/1						**1/1**
Perdix perdix (LINNAEUS, 1758)				1/1		5/1	3	9/2	1	20/3	2	**41/7**
Coturnix coturnix (LINNAEUS, 1758)					1		1/1			5/1		**7/2**
Gallus gallus (LINNAEUS, 1758)							1	2/1	1	3/1		**7/2**
Galliformes indet.	1	1		2		4		3		3		**14**
Rallus aquaticus LINNAEUS, 1758		1/1					1/1			2/1		**4/3**
Crex crex (LINNAEUS, 1758)				1/1					1	3/1		**5/2**
Porzana parva (SCOPOLI, 1769)								1/1				**1/1**
Porzana porzana (LINNAEUS, 1766)							2	1/1		2/1		**5/2**
Gallinula chloropus (LINNAEUS, 1758)										3/1		**3/1**
Fulica atra LINNAEUS, 1758						1/1		7/3	1	5/1		**14/5**
Vanellus vanellus (LINNAEUS, 1758)				1/1	1	2/1	3	1/1	2	7/1	1	**18/4**
Pluvialis apricaria (LINNAEUS, 1758) / *P. fulva* (J .F. GMELIN),								1/1		1/1		**2/2**

Species	Particular layers										lack of stratigraphy	Total of bones
	I	I/II	II/III	III	III/IV	IV	IV/V	V	V/VI	VI		
Pluvialis squatarola (LINNAEUS, 1758)								1/1		1/1		**2/2**
Scolopax rusticola LINNAEUS, 1758					4	4/2	2	11/2	4/1	10/2	2	**37/7**
Lymnocryptes minimus (BRÜNNICH, 1764)		1/1	1/1									**2/2**
Gallinago media (LATHAM, 1787)								1/1		1/1		**2/2**
Gallinago gallinago (LINNAEUS, 1758)					1		2/1					**3/1**
Limosa sp.								1/1				**1/1**
Numenius phaeopus (LINNAEUS, 1758)				1/1								**1/1**
Arenaria interpres (LINNAEUS, 1758)										1/1		**1/1**
Philomachus pugnax (LINNAEUS, 1758)			1/1		1	2/1	1			1/1		**6/3**
Sterna cf. *hirundo* LINNAEUS, 1758		1/1										**1/1**
Various Charadriiformes indet.				2					1	2		**5**
Streptopelia turtur (LINNAEUS, 1758)										1/1		**1/1**
Columba palumbus LINNAEUS, 1758				3/1	4	4/2	4/1	21/5	7	30/4	2	**75/13**
Columba oenas LINNAEUS, 1758/ *C. livia* J. F. GMELIN 1789					2	6/1	3	15/2	7	18/3		**51/6**
Cuculus canorus LINNAEUS, 1758									1/1		1	**2/1**
Otus scops (LINNAEUS, 1758)										1/1		**1/1**
Strix aluco LINNAEUS, 1758					1/1		2	3/1		4/1		**10/3**
Athene noctua (SCOPOLI, 1769)										1/1		**1/1**
Aegolius funereus (LINNAEUS, 1758)										1/1		**1/1**
Asio flammeus (PONTOPPIDAN, 1763)				1/1			1/1					**2/2**
Asio otus (LINNAEUS, 1758) / *A.flammeus*							1	1		2		**4**
Strigiformes indet (big species)						1/1						**1/1**
Apus apus (LINNAEUS, 1758)										2/1		**2/1**
Coracias garrulus LINNAEUS, 1758								1/1				**1/1**
Dendrocopos major (LINNAEUS, 1758)						1/1				1/1		**2/2**
Dryocopus martius (LINNAEUS, 1758)								1/1				**1/1**
Picus viridis LINNAEUS, 1758							1	1/1				**2/1**
Picus canus J. F. GMELIN, 1788										1/1		**1/1**
Alauda arvensis LINNAEUS, 1758										1/1		**1/1**
Anthus sp.							1/1					**1/1**
Turdus merula LINNAEUS, 1758				1/1			1	3/2		16/2		**21/5**
Turdus pilaris LINNAEUS, 1758								1/1		1/1	1	**3/2**
Turdus philomelos C. L. BREHM 1831								2/1		5/1	1	**8/2**
Turdus viscivorus LINNAEUS, 1758					1		2/2	1/1	1	2/1	1	**8/4**
Turdus viscivorus / *T. pilaris*								1/1	1			**2/1**
Turdus sp.								1	1	7		**9**
Sylvia borin (BODDEART, 1783) /*S. atricapilla* (LINNAEUS, 1758)										1/1		**1/1**
Ficedula hypoleuca (PALLAS, 1764)										1/1		**1/1**
Sitta europaea LINNAEUS, 1758										1/1		**1/1**
Emberiza citrinella LINNAEUS, 1758										1/1		**1/1**
Miliaria calandra (LINNAEUS, 1758)										2/1		**2/1**
Carduelis chloris (LINNAEUS, 1758)										1/1		**1/1**
Coccothraustes coccothraustes (LINNAEUS, 1758)								1/1		4/2		**5/3**
Fringillidae indet.										2		**2**
Sturnus vulgaris LINNAEUS, 1758					1/1			1/1		1/1		**3/3**
Oriolus oriolus (LINNAEUS, 1758)						1/1				1/1		**2/2**
Garrulus glandarius (LINNAEUS, 1758)				1/1		2/1	2	5/1	2	7/1	1	**20/4**

Species	Particular layers										lack of stratigraphy	Total of bones
	I	I/II	II/III	III	III/IV	IV	IV/V	V	V/VI	VI		
Pyrrhocorax pyrrhocorax (LINNAEUS, 1758)				7/1					1/1			**8/2**
Corvus monedula LINNAEUS, 1758				3/1	3	4/1	6	5/2	3	8/2		**32/6**
Corvus frugilegus LINNAEUS, 1758						1/1	4	7/2	2			**14/3**
Corvus corone LINNAEUS, 1758				1/1	6	4/1	2	13/3	1	19/3		**46/8**
Corvus corone / *frugilegus*					2	3	5	8	2	12		**32**
Corvidae indet.						3		1	2	3		**9**
Passeriformes indet.										1		**1**
Total of identified bones in front of the rock-shelter	**2**	**8**	**11**	**51**	**49**	**83**	**78**	**174**	**58**	**333**	**24**	**871**

III. COMMENTS AND DISCUSSION

A. New taxa for the fossil bird fauna of Poland

Eleven bird taxa identified in Krucza Skała have not been found in Poland previously. Each of them is represented by no more than a few bone fragments. They are known from Late Pleistocene European faunas, although the number of localities varies. Also, they all belong to the Polish recent bird fauna – majority are breeding species.

1. The Gadwall, *Anas strepera* – two fragments were found in layer 5 of the cave, dated back to the Alleröd. Krucza Skała lies within the breeding range of the species, which prefers open inland fresh waters (HARRISON 1982). However, according to TOMIAŁOJĆ and STAWARCZYK (2003) it is not a numerous lowland breeder in Poland. It is known from 23 European Late Pleistocene localities (TYRBERG 1998, 2003), all except this one are situated in northern Ural, being in the southern part of the continent, i.e. Krucza Skała is the northernmost.

2. The Ferruginous Duck, *Aythya* cf. *nyroca* – one not absolutely certain fragment comes from layer 7 in the cave, dated back to the end of the Late Glacial. The species was a common breeding bird in Polish lowlands in the 19th century, whereas recently it is very rare (TOMIAŁOJĆ, STAWARCZYK 2003), Krucza Skała lays within the recent breeding range. It is known from 27 European Late Pleistocene localities (TYRBERG 1998, 2003), of which Weimar-Ehringsdorf (Germany) and Krucza Skała are the most northern sites.

3. The Goldeneye, *Bucephala clangula* – one fragment found in the uppermost sediments (layer 9) in the cave accumulated in the Late Holocene. According to HARRISON (1982) it breeds in tree holes in boreal forests near fresh water – in Poland mainly in the northern part of the country (TOMIAŁOJĆ, STAWARCZYK 2003). TYRBERG (1998, 2003) mentions 26 Late Pleistocene localities dispersed in Europe.

4. The Dunlin, *Calidris alpina* – three fragments: two of them found in transitional sediments between Late Pleistocene layers 3/4; another fragment from layer 9 dated back to the Holocene. It breeds in tundra and further south mainly on coastal meadows – during migration may be encountered all over Europe (HARRISON 1982). In Poland it is an extremely rare breeder in the northern part of the country near the Baltic coast and on the Biebrza marshes (TOMIAŁOJĆ, STAWARCZYK 2003). According to TYRBERG (1998, 2003) it was identified in 16 European Late Pleistocene localities, of which only two (in Great Britain: Derbyshire Peak Cave, and in Germany: Stellmoor) are situated in, or close to, the recent breeding range, whereas all the remaining localities, such as Krucza Skała, are more or less far from it.

5. The Kittiwake, cf. *Risa tridactyla* – one fragment only, found in layer 6 of the rock-shelter, dated back to 11.210 ±70y BP. Being a strictly marine species it breeds only on rocky oceanic coasts or islands in the arctic to boreal and even temperate zones (HARRISON 1982). In Poland it is an ir-

regular visitor, met year round all over the country (TOMIAŁOJĆ, STAWARCZYK 2003), and in the Late Pleistocene it must have been similar. Late Pleistocene remains were identified in ten localities (TYRBERG 1998, 2003), of which only two Norwegian and one British lie in or close to the recent breeding areas – the others further south: some of them inland (like Krucza Skała).

6. The Whiskered Tern, *Chlidonias hybridus* – one incomplete coracoideum found on the boundary of layers 2 and 3 inside the rock-shelter, from Dryas "2" or the very beginning of the Alleröd. Its morphology is characteristic of the genus and size points exactly to the Whiskered Tern. According to HARRISON (1982) it bred in temperate to warm temperate zones, on densely overgrown fresh water bodies. In Poland it is now a scarce breeder dispersed nearly all over the lowlands as a result of territorial expansion that took place during the last thirty years most probably from the Ukraine (TOMIAŁOJĆ, STAWARCZYK 2003). The fossil findings concern only one Middle Pleistocene locality in S France listed by TYRBERG (1998), Krucza Skała is the only Late Pleistocene one.

7. The Nightjar, *Caprimulgus europaeus* – one fragment from the Holocene sediments of the rock-shelter (layer 8/9). This migrating bird breeds in the majority of European territory in the boreal to warm temperate zones in various open forests (HARRISON 1982). In Poland it is not a numerous breeding species in the whole country except for the higher parts of the mountains (TOMIAŁOJĆ, STAWARCZYK 2003). Listed from nine Late Pleistocene localities only (TYRBERG 1998, 2003) – all within the recent breeding area. Krucza Skała is the northernmost on the European continent.

8. The Scops Owl, *Otus scops* – one very characteristic fragment from the uppermost layer VI in "under the overhang", dated to the Holocene. This species does not breed in Poland now, being only a sporadic visitor even in northern part of the country (TOMIAŁOJĆ, STAWARCZYK 2003) – the nearest breeding places are situated in Southern Slovakia (DANKO & SAROSSY in: DANKO et al. 2002) and in the Carpathians in western Ukraine (FESENKO, BOKOTEY 2002). According to HARRISON (1982), it breeds in lightly forested regions. TYRBERG (1998, 2003) listed 45 European Late Pleistocene localities lying within its present breeding range. So, Krucza Skała is the northernmost site of its fossil remains, situated to the north of its breeding range.

9. The Grey-headed Woodpecker, *Picus canus* – three bone fragments were identified: one from layer 7 in the rock-shelter dated back to the end of the Late Glacial, the other one from the Holocene (Middle Ages?) layer VI "under the overhang"; the third fragment has no stratigraphy. The bird is widely distributed in the forest belt of the Palaearctic, in Poland it belongs to the breeding fauna mainly in the southern and north-eastern part of the country (TOMIAŁOJĆ, STAWARCZYK 2003). TYRBERG (1998, 2003) mentions 21 Late Pleistocene sites in Europe, two of them situated to the south of the recent breeding area (in Spain and NW Italy).

10. The Pied Flycatcher, *Ficedula hypoleuca* – one bone was identified in Holocene layer VI "under the overhang" and the other one determined as "Muscicapidae: cf. *Ficedula* sp." also in the uppermost layer 9 in the rock-shelter. According to HARRISON (1982) it breeds "in the temperate and western boreal to warm temperate zones" nesting in holes of deciduous trees in forests, parklands etc. In Poland it belongs to widespread species (TOMIAŁOJĆ, STAWARCZYK 2003). All European remains of the genus *Ficedula* are known from 9 Late Pleistocene localities (TYRBERG 1998, 2003).

11. The Golden Oriole, *Oriolus oriolus* – one bone fragment found in layer IV of sediments "under the overhang", dated back to the Late Glacial. The bird breeds in various deciduous forests and parklands of temperate to warm temperate zones of the western part of the Palaearctic (HARRISON 1982). In Poland it is fairly numerous and widespread in lowlands (TOMIAŁOJĆ 1990). TYRBERG (1998) mentions only 11 Late Pleistocene European localities – Krucza Skała is situated to the north of them.

B. Palaeoecological comments

It seems that the absolute majority of bird remains found in Krucza Skała come from owl pellets, and the size of prey that dominate in the thanatocenosis points to the Eagle Owl. In the case of birds

which breed in rock habitat (like the Kestrel, Swift, Swallow and Jackdaw) it is also possible that some of them died in situ, especially the young individuals. However, nothing indicates that bird bones are the results of activity of the rock-shelter's human dwellers.

Plenty of identified taxa represent birds which are now migratory but nothing indicates that they were generally killed during migration. On the contrary, the great majority of bird species found in owl pellet thanatocenoses belong to local breeding faunas (BOCHEŃSKI Z jun. 1990, LORENC 2001a,b). Nevertheless some marine species like the Common Eider, Turnstone and Kittiwake, which never breed inland, must have been migrants or vagrants, even if a bone found in layer 6 and identified as possibly an Eider (see Table III) belonged to an immature bird (indicated by the not completely ossified bone surface).

225 bones of those listed in Tables I and II, were distinguished as not fully ossified, therefore belonging to immature (epiphyses jointed but bone surface not fully ossified, not smooth) or even juvenile individuals (articular surfaces not definitely developed or lacking) (Table III). This precluded a large proportion (especially of juveniles) from being identified to the species level. In the case of the Kestrel the immature birds constitute most of the remains – it may indicate that they bred in rocks in close vicinity or even inside the rock-shelter. A similar situation pertains to the Jackdaw.

Table III

Number of bones of subadultus and juveniles (bold) found in successive series of layers in the Krucza Skała rock-shelter and in front of it. See text for the criteria of age designation. Sediments division as in Table VI and Fig.2

Stage / Taxon	1,1/2, 2, I, I/II	2/3 II/III	3 III	3/4 III/IV	4, 4/5, 5, 5/6, 6 IV	7, 7/8, 8 IV/V, V	8/9 V/VI	9 VI	Lack of stratigraphy	Total
Podiceps cristatus						1				1
Anser sp.					1					1
Branta bernicla								1		1
Anas crecca		3								3
Anas querquedula/crecca									1	1
Anas platyrhynchos		1	2	2	1			2		8
Anas clypeata					1					1
Aythya marila / A. ferina									1	1
cf. *Somateria mollissima*					1					1
Bucephala clangula								1		1
Anatidae (middle sized duck)		1			**1**					2
Accipitridae indet.					**1**		**1**			2
Falco tinnunculus		3	1	10	3		1	2		20
Falco sp.		**1**	1		3			1	5	11
Lagopus lagopus	1	1			**3**, 3		1	**3**	2	14
Lagopus mutus		1			2	1			1	5
Lagopus sp.		1	3	1	**2**, 1				1	9
Tetrao tetrix		1	3		**5**	1		**2**	1	13
Tetrao urogallus		1		**1**	1				1	4
Perdix perdix					1			1	1	3
Coturnix coturnix		1			**2**, 1				1	5
Galliformes indet.	6	**7**			**8**			**1**		22
Crex crex			1							1
Fulica atra						1				1

Stage / Taxon	1,1/2, 2, I, I/II	2/3 II/III	3 III	3/4 III/IV	4, 4/5, 5, 5/6, 6 IV	7, 7/8, 8 IV/V, V	8/9 V/VI	9 VI	Lack of stratigraphy	Total
Vanellus vanellus					1		1	1	1	4
Pluvialis apricaria /*P. fulva*		2								2
Pluvialis squatarola		1			3					4
Scolopax rusticola								1	2	3
Gallinago gallinago									3	3
Philomachus pugnax		1	1						1	3
Larus cf.*ridibundus*		1			2				2	5
Various Charadriiformes indet.	1				2			1	2	6
Columba palumbus					1			2	2	5
Columba oenas /*C. livia*							1	2	4	7
cf. *Tyto alba*					**1**					1
Strix aluco						1		1	**4**	6
Asio flammeus					**1**					1
Asio otus/flammeus					**2**	**1**				3
Strigiformes					**2**		1			3
Hirundo rustica		1				**1**			2	4
Anthus sp.								1		1
Turdus philomelos						1				1
Turdus viscivorus									1	1
Turdus sp.									1	1
Ficedula hypoleuca								1		1
Fringillidae indet.								1	1	2
Pica pica								1		1
Corvus monedula	**1,** 1	5	**1**, 1		**2,** 1		1		1	14
Corvus corone / *frugilegus*						1			1	2
Corvidae indet.					**4**			**1**	1	6
Passeriformes indet.								1	3	4
Total of identified bones	10	33	14	14	63	9	7	28	47	225

The numbers of remains of particular species as well as the numbers of layers in which they were found differ in a high degree. There is not a single species stated in all layers inside and in front of the rock-shelter. Nevertheless, 16 species are found in the majority of layers in both excavations (inside and in front) or at least in one of them (Table IV). They are also distinctly more numerous than the remaining species listed in Tables I and II. All of them with the exception of the Blackbird belong to middle-sized or even large (the Capercaille) birds. It is difficult, however, to explain why, for example, the Kestrel was identified in nearly all layers inside and only in layer III in front of the rock-shelter, whereas the Blackbird only in the Holocene layer 9 inside and in a few both Late Glacial and Holocene layers in front.

The palaeoecological analyses of bird thanatocenoses found in particular layers can not be treated as absolutely certain because of at least three reasons:

(1) Some parts of sediments are dislocated by ancient and later excavations (CYREK 1994: Fig. 3, and oral comm.). It seems that this may explain, at least partly, why in the uppermost Holocene layers 9 and VI numerous remnants of the Willow Grouse were found (though other data indicate that it could survive in central Poland until the middle Holocene) and some other species of recent Arctic distribution and, on the contrary, the bones of the Domestic Hen were found in the Palaeolithic (Late Pleistocene) deposits.

(2) The loose structure of some sediments gave the possibility of sinking some fragments to underlying layers.

Table IV

Comparison of remains frequency of the most common bird species found in particular layers of sediments inside rock-shelter in the Krucza Skała and in front of it. NISP/MNI concern all identified remains (together with those from mixed layers)

Bird species	Inside rock-shelter																In front of rock-shelter									
	Layer's No															NISP	Layer's No									NISP
	1	1/2	2	2/3	3	3/4	4	4/5	5	5/6	6	7	8	8/9	9	/MNI	I/II	II/III	III	III/IV	IV	IV/V	V	V/VI	VI	/MNI
A. crecca			+	+	+		+		+	+	+		+		+	14/9				+		+	+		+	11/3
A. platyrhynchos				+	+	+	+	+	+	+	+	+	+	+	+	38/9		+		+	+	+	+	+	+	29/7
F. tinnunculus			+	+	+	+	+			+	+	+	+	+	+	28/7			+							1/1
L. lagopus			+	+	+	+	+	+	+	+	+		+	+	+	250/29	+	+	+	+	+	+	+	+	+	110/14
L. mutus		+		+	+	+	+		+	+	+	+		+	+	33/10			+	+	+	+	+	+	+	17/5
T. tetrix		+	+	+	+	+	+	+	+	+	+	+	+	+	+	208/20	+	+	+	+	+		+	+	+	40/8
T. urogallus			+	+		+	+	+	+		+	+		+	+	24/9				+					+	8/3
P. perdix			+		+				+	+			+	+	+	22/7			+		+	+	+	+	+	39/7
V. vanellus		+		+	+	+	+		+		+		+		+	16/9			+	+	+	+	+	+	+	18/4
P. squatarola				+	+	+	+	+	+	+	+				+	18/8							+		+	2/2
P. pugnax		+	+	+	+	+	+	+		+	+			+	+	32/8		+		+	+	+			+	6/3
C. palumbus							+		+	+		+			+	19/7			+	+	+	+	+	+	+	75/13
T. merula															+	5/1			+			+	+		+	21/5
G. glandarius												+		+	+	7/3			+		+	+	+	+	+	20/4
C. monedula	+		+	+	+	+	+		+		+			+		31/9			+	+	+	+	+	+	+	32/6
C. corone			+				+	+	+					+	+	11/6			+	+	+	+	+	+	+	46/8

(3) The classification of a given species to even general habitat is not always clear and univocal. For example, the Lapwing or Grey Plover are traditionally assigned to water-and-marsh habitats (i.e. marshes, wet meadows, and so on) in spite of their breeding also far away from water (in cultivated fields, in lichen and grassy tundra); the Kestrel breeds in wide tree hollows but also in rock crevices; the same is true for the Jackdaw. Again traditionally all anatids are treated as water birds and this is true but a few of them (the Goldeneye, Smew, and at least partially other *Mergus* species) breeding in tree hollows need also forests close to fresh waters; so, they are forest indicators only if the remains come from young birds or from the breeding season. On the other hand, a small group of trees is sometimes sufficient for the so called forest birds.

1. Sediments inside the rock-shelter

Two bone fragments found in layer 1 represent Fringillidae and *Corvus monedula.* It is too little for a description of the landscape surrounding the locality. However, the presence of Jackdaw fledgling may indicate breeding of the species in close vicinity, perhaps in some rock crevice or a tree-hole. The other six taxa identified in samples from the boundary between layers 1 and 2 live in humid habitats like marshes or wet meadows (*Vanellus, Philomachus*), stony beaches (*Actitis*), tundra or heath (*Lagopus mutus*), light forest or shrubs (*Tetrao tetrix*). None indicate the presence of an open water-body, nor mature forest.

65 bone fragments of 17 bird taxa were identified in layer 2. All of them except two are represented by single individuals. The richest are remains of *Lagopus lagopus* (15 fragments) but its MNI is only two. Eight species are typical for various humid habitats like moorlands (*Branta, Lagopus mutus*, *Pluvialis*), marshes (*Gallinago, Philomachus*, *Asio flammeus*), and at least partly overgrown water-bodies (*Anas crecca*, *Fulica*). On the other hand *Tetrao urogallus*, *Lullula arborea* and *Corvus corone* are typical of forests. One bone of the Black Grouse was not completely os-

sified so it belonged to a very young bird which hatched in the vicinity of the rock. *Corvus monedula* and *Falco tinnunculus* breed in rock crevices and also in tree holes. So, during the time of sedimentation a mosaic of biotopes surrounding the locality was present – perhaps humid habitats prevailed, but forests, even old stands, were also there, which is indicated by the Capercaillie.

The samples of sediments of the rather thin, sandy layer 3 contained 71 fragments of bones identified as belonging to 12 bird species. Like in layer 2, half of them are typical for various water-and-marsh habitats; two of them (*Lagopus mutus* and *P. squatarola*) breed in the Arctic or in high mountain moorlands. Two species now live in forests, i.e. *L. lagopus* in the northern part of boreal forest, and *T. tetrix* in a wide belt of boreal forest. Rock crevices or tree holes are the breeding places of the Kestrel and Jackdaw.

It is interesting that the number of remains found in the transition (boundary) between layers 2 and 3 is much larger than the sum of remains found in both these layers, being equal to 219 bone fragments (see Table I). At least 15 taxa identified in this part of the sediment were not found in neighboring layers (among them *T. tadorna, Chlidonias hybridus*, and *Loxia* cf. *curvirostra* found in this part of the sediment only).

Layer 4 accumulated at about the middle of the Alleröd (radiocarbon date: 11450 ± 200 BP). It contained bone fragments representing 28 various bird taxa. As in older sediments, these taxa now live in various water-and-marsh habitats (three ducks, Coot, and five Limicolae), various open biotopes such as tundra, meadows and steppe (Ptarmigan, Common Partridge and Skylark), various forested areas including old stands of the taiga type (e.g. Capercaillie, Wood Pigeon, and Crow). In addition to the Kestrel and Jackdaw, the presence of which may be connected with rock crevices, the Swallow, a typical synantropic bird breeding mainly in buildings, had bred in the past also in rocks which had to be its primary habitat.

169 remains were found in samples from layer 5. They belong to 39 bird taxa, again indicating a mosaic of biotopes present near Krucza Skała during the time of sedimentation. There are 11 species typical for various water-and-marsh habitats, among them five ducks of the genus *Anas*, which indicates the presence of rather shallow water bodies, at least partially overgrown; the same is true for the Coot and Moorhen. *Sterna* indicates sandy or gravel beach with scanty herbage. The Ptarmigan and Grey Plover breed in bare tundra, whereas the Partridge, Common Quail and Skylark are characteristic for open steppe which may also be humid. Forest biotopes are represented by 12 species of which the Capercaillie and Tawny Owl breed in mixed old stands, the Crow and Hawfinch nest in the canopies of tall trees and the Roller in tree holes. The most common breeding places of the Song Thrush are in dense young conifers.

23 bird species are represented in the sediment of layer 6. Inhabitants of water-and-marsh habitats, besides four duck species including the Eider living in the boreal zone, consist of two species typical for large marsh areas i.e. the Ruff and Short-eared Owl, and the Great Reed Warbler characteristic for lush reed beds. Forest, parkland or scrub bird fauna is represented by two *Tetrao* species and among others by the Great Spotted Woodpecker which makes nest holes in deciduous tree trunks. Typical open steppe birds are not represented in this sediment, but this may possibly be connected with generally not numerous bird remains.

The remains found in layers 7 and 8 are very poor, consisting of 29 bone fragments each and 20 and 12 individuals, respectively. It is worth mentioning that each species is represented in a particular layer by one individual only. In sediment of layer 7 forest birds evidently prevail being represented by ten species living in old stands (grouse, the Woodcock, Wood Pigeon, Grey-headed Woodpecker) and in brushwood (thrushes). Two species of ducks and three waders belong to typical water-and-marsh birds. The Kestrel and Black Redstart bred probably in rocks close to the rock-shelter. The presence of a bone of the Domestic Hen may be probably explained by dislocation connected with excavation. Among 12 species identified in layer 8, four (the Dabchick, Coot, and ducks) lived on water-bodies, two others (Common Snipe and Lapwing) in marshes or wet meadows, and only two are typical scrub or forest species (the Black Grouse and Mistle Thrush) – in forests the Willow Grouse may also breed. The Turnstone points to sandy or pebbly coasts, but here

was a migrant or vagrant. In the transitional sediment only two bones were found of which that of the Swallow was identified to the species level – it was found neither in the overlying nor in the underlying layer.

The bird fauna found in the Holocene layer 9 inside the Krucza Skała rock-shelter is the richest and most diversified. It consists of 173 identified bone remains belonging to 46 taxa including the Domestic Hen. However, the majority of species are represented by single individuals. The birds living in deciduous or mixed forests prevail distinctly, and four of them i.e. the Black Grouse (at least 4 individuals), Capercaillie, Hazel Hen and Fieldfare, are typical for the European taiga. All together the forest birds consist of species living in all forest layers from the bottom (grouse and Woodcock), brushwood (thrushes), holes in trunks (Starling, and tits), up to the canopy (among others the Sparrow Hawk, Hawfinch, and Crow). Water-and-marsh birds are not so numerous but they also are typical for various habitats like partly overgrown water-bodies (the Coot, Moorhen, and ducks), as well as the marshes and wet meadows (several wading birds). Also birds now living in the Arctic are present, like the Ptarmigan and Grey Plover as well as the Partridge, Common Quail, and Skylark, representing steppe fauna.

2. Sediments in front of the rock-shelter

Similarly to the inside of the rock-shelter, the deepest sediments in front of it contained very scanty bird bone remains. In layer I only two fragments were found, both belonging to the gallinaceans. Eight bone fragments come from the samples collected in the transition between layers I and II. Three of them belonged to the Willow Grouse, two others to the gallinaceans also, and the remaining three represented water-and-marsh habitats: the Water Rail living in thick vegetation in water-bodies, the Jack Snipe breeding in bogs in coniferous forests, and the Common Tern typical for fresh water shores and islands bare or covered with scanty vegetation. No bird bones were found in pure layer II. 11 fragments were found in the transition zone between layers II and III. The most numerous are those of the *Lagopus* grouse; another gallinacean is the Black Grouse. The remaining four fragments belonged to four species of water-and marsh birds i.e. the Mallard and three typical waders living in marshes and bogs.

From sandy layer III, dated back to 11980±70 BP (i.e. the very beginning of the Alleröd or the end of the Dryas "2"), 51 bone remains belonging to 17 bird taxa represented by at least 19 individuals were found. All taxa but the Willow Grouse are represented by single individuals. The Wood Pigeon, Blackbird and Jay are typical forest birds and even the Smew, needs forests for breeding and tree holes near fresh water. Another water-and-marsh birds also lives in various and extensive marshy habitats (the Short-eared Owl). So, if the Ptarmigan, living beyond the timberlines in the Arctic and high mountains and a typical steppe Partridge, is added, the open-country avifauna prevails. The Kestrel, Jackdaw, and especially Red-billed Chough are birds nesting in rock crevices.

Samples from the transition between layers III and IV contained 49 bird bone remains belonging to 18-19 species. Eleven of them need forests for breeding or at least trees, so the representatives of this group of habitats evidently prevail. About half of them breed in old mature stands. Two species of ducks and three charadriids live on water-bodies and marshes. Open tundra and steppe dwellers (the Ptarmigan and Common Quail) are not numerous.

The dominance of forest birds is still conspicuous in remains from layer IV. Among them there is one fragment of the Golden Oriole that lives in the canopies of deciduous trees. Several other species like the Great Spotted Woodpecker, pigeons, the Crow, and Rook also point to mature trees. The Great Crested Grebe, four duck species and Coot can be found within various overgrown water-bodies, but only the Ruff and Lapwing indicate the presence of marshes or wet meadows.

78 bird remains found in transitional sediments between layers IV and V belong to at least 26 taxa. Here, for the first time a bone of the Domestic Hen was identified; it may be, however, connected with dislocation of sediments during ancient and later excavations. The general composition

of bird habitat groups is similar to that in layer IV, i.e. forest species prevail, even those typical for mature stands (pigeons, crows). Of the 26 taxa mentioned above, six were met neither in layer IV nor in V, and 11 species in both of them. Eight species are in common with overlying layer V (one of them is the Domestic Hen), whereas only one with underlying layer IV. This may result from ancient excavations or from the loose structure of sandy Layer V.

174 remains come from layer V. They belonged to at least 53 individuals, representing at least 39 taxa including the Domestic Hen. Various kinds of forest species prevail again, but most of them nest in mature trees – at least five species in holes. Of two identified species of woodpeckers the Black Woodpecker make holes in coniferous trees in forests whereas the Green Woodpecker usually in trees having soft wood, for example in willows growing along rivers. Another hole-dweller is the Roller living in a temperate and warm temperate climate, although Arctic birds were also found in the same sediment of layer V, i.e. the Ptarmigan and Grey Plover. Two species of grebes, four ducks and the Coot live on water-bodies overgrown to a various degree, whereas crakes, the Great Snipe and Lapwing breed in marshes. The Partridge, the only species typical for steppes found in layer V, completes the mosaic of biotopes surrounding Krucza Skała during its accumulation.

In samples from the boundary between layers V and VI 58 bird remains were found. They belong to at least 21 taxa including the Domestic Hen. Three of them were found neither in underlying nor in overlying sediments; they are a typical diving duck i.e. the Scaup or Pochard, Red-billed Chough and Cuckoo – the last is represented by only one bone found in Krucza Skała. All but three other taxa were identified also in neighboring sediments. Altogether, the birds indicate again a mosaic of habitats among which prevail forests.

The uppermost Holocene layer VI contained 333 identified bird remains of at least 80 individuals belonging to 56 taxa including the Domestic Hen. Forest birds and parklands prevail, being represented among others by typical taiga species (the Capercaillie, Black Grouse, Tengmalm's Owl), woodpeckers, pigeons, thrushes and others. More than a dozen species live on water-bodies and marshes (the Dabchick, ducks, several rallids, plovers, and waders). Besides these most numerous groups, at least several species like the Partridge, buntings or the Skylark are characteristic for open steppe habitats; moreover, some other species which nest in forest (for example the Buzzard) forage in open biotopes. Birds nesting in rocks were also identified.

3. Habitat and climate changes during the period of sedimentation

As stated above, the remains of 16 species were found in the majority of sediments (Table IV). They dominate in various degrees. They represent three climatic zones: arctic, boreal, and temperate, but proportionally the latter are less numerous than species representing the temperate zone in the total list of 116 taxa identified in this locality. All other species are much less numerous – and, taking into account the minimum numbers of individuals, many of them are represented by single specimens only.

The real numbers of bird species living in the surroundings of the Krucza Skała rock-shelter are unknown during the accumulation of particular layers of sediment. However, it may be presumed that these numbers in warmer periods could be more or less similar to the recent number, i.e. about 100 species or even more (WALASZ, MIELCZAREK 1992), in spite of the fact that the species composition differed to some degree. The numbers of taxa identified in particular layers balance between a few and 56 and so they constitute between less than one tenth and a half of the breeding bird fauna.

Not all sediment layers distinguished in excavation inside the rock-shelter are correlated with those excavated in front of it. It seems that it can be done only for the deepest sediments (layers 1 and 2 inside, and I and II in front), as well as for the upper-most sediments (surely Holocene layer 9 and VI) – the correlation of the remaining layers may be questionable. It should also be pointed that the stratigraphy of sediments accumulated in about three thousand years of the Late glacial (especially inside layers 1 to 7 or 8) is much more precise than the sediment of ten thousand years of Holocene accumulation (single layers 9 and VI).

The thermic indices calculated on the basis of more numerous bird assemblages stated in well defined sediments according to DEMARCQ and MOURER-CHAUVIRÉ (1976) are given in Table V. They balance between 2.17 in layer 2 inside the rock-shelter up to 2.79 in layer V in front of it. These indices are similar to those calculated by LORENC (2001a) on the basis of recent Eagle Owls' pellets from Scandinavian localities situated between July isotherms 10° and 15 °C.

Table V

Thermal indices (according to DEMARCQ & MOURER-CHAUVIRÉ 1976) calculated from the data on the bird assemblages identified in particular layers of sediments in the rock-shelter and in front of it

Layer	Radiocarbon 14C date BP	No of taxa		MNI		Thermal index
		Total in layer	Used to calculate	Total in layer	Used to calculate	
Inside rock-shelter:						
2		16	16	18	18	39:18 = 2.17
2/3		35	32	50	47	92:38 = 2.42
3		15	13	20	18	37:17 = 2.18
4	11.450±200	28	25	40	37	76:33 = 2.30
5		35	30	46	41	94:36 = 2.61
6	11.210±80	24	21	28	24	53:22 = 2.41
7		20	18*	18	18	49:18 = 2.72
8		13	13	13	13	35:13 = 2.69
7+7/8+8		29	27*	34	32	87:32 = 2.72
9 "sure Holocene"		46	41*	59	52	124:48 = 2.58
In front of rock-shelter:						
III	11.980±70	16	16	18	18	41:17 = 2.41
IV	2.240±35**	22	20	27	25	60:23 = 2.61
V		39	37*	55	52	134:48 = 2.79
VI		58	54*	80	76	181:67 = 2.70

*/ Remains of the Domestic Hen identified from the layer were not used for further calculations.
**/ Bone used for C14 dates (typical Holocene) came from layer IV – it may be connected with dislocation caused by ancient excavation; it may be also an error in the label (CYREK oral comm.).

The fluctuations of thermic indices calculated for succeeding sediments are not parallel to successive stadials and interstadials of the Late Glacial based on radiocarbon dates. For example the index calculated for the sediment series (layers 7-8, V) which could be attributed to the Younger Dryas "3", is higher than those calculated for the Alleröd and Holocene (Table V). This situation is absolutely controversial because according to TYRBERG (1995), the Dryas "3" was a return to fully glacial climatic conditions. The controversy is difficult to explain – if we accept that it is connected only with mixing of sediments (caused by ancient excavations – see CYREK 1994) all other considerations could be doubtful.

Taking all that into account, all excavated bird taxa were generally treated as water-and-marsh, forest (and thicket) habitats, and all remaining taxa treated together (including those which can not be encountered in well identified species, for example *Asio otus/flammeus*: *otus* – forest bird, whereas *flammeus* – typical marsh species). Then we compared the relative share of those three groups in sediments which accumulated in successive time periods (determined after layer sequence and radiocarbon dating of layers I, 4 and 6). The remains found in the layers 1, 1/2, 2, I and I/II were treated together (the radiocarbon date from upper part of layer I: 12520±70 BP points to the Bölling Interstadial), those from layers 4, 4/5, 5, 5/6, 6 and IV to the Alleröd Interstadial

(11820-10800 years BP – date from layer 4: 11450 ±200 BP, and from layer 6: 11210±80 BP). Bone fragments found in layers 9 and VI come from the Holocene (the last 10000 years). The numbers and percentage shares of taxa encountered in the three habitat groups mentioned above are shown in Table VI and Fig.2. It can be seen that the share of forest (and thicket) taxa increases in time generally, whereas that of water-and-marsh taxa decreases. As concerns the Holocene taxa, there is little difference between assemblages inside the rock-shelter and in front of it. In layer 9 (inside) the share of forest birds is a little larger; it may be accidental, but on the other hand it may indicate a small difference in time of sedimentation.

Table VI

General habitat characteristics indicated by bird assemblages found in sediments attributed to successive stages of the sediment accumulation in the Krucza Skała rock-shelter, based on the data from Tables I and II. Numeration of layers: Arabic – inside the rock-shelter, Roman – in front of it. Habitats: "water" – various water-and-marsh, "forest" – forests, thickets, single trees (species breeding in tree hollows or rock crevices are included), "others" – open: tundra, steppes, rocks, this category also includes taxa of not defined habitat. Approximate July temperatures are roughly interpolated after LORENC (2001b)

Layers (without period definitions)	No of taxa	Breeding habitat type						Therm. index	Approx July temp.
		"water"		"forest"		"others"			
		No	%	No	%	No	%		
Holocene:9	46	13	28.3	25	54.3	8	17.4	2.58	15
VI	58	18	31.0	29	50.0	11	19.0	2.70	16
9, VI together	73	23	31.5	38	52.1	12	16.4	2.63	15
7, 7/8, 8, V	51	20	39.2	24	47.1	7	13.7	2.76	16
4,4/5,5,5/6,6,IV	63	28	44.4	23	36.5	12	19.1	2.52	15?
3, III	24	12	50.0	8	33.3	4	16.7	2.38	14?
2/3, II/III	36	19	52.8	11	30.6	6	16.6	2.39	14?
1,1/2,2,I,I/II	23	12	52.2	9	39.1	2	8.7	2.25	13?

As to the Alleröd sediments inside and in front of the rock-shelter – the lists of bird taxa identified in layers 4, 6 and IV were compared. The numbers of these taxa are similar, being 28, 24 and 23, respectively. Eight taxa are common for all three layers – all listed in Table IV as the most common in Krucza Skała. Layer IV is more similar to layer 4 (13 common taxa, among them two pigeon species), than to layer 6 (9 common taxa: only the Great Spotted Woodpecker, besides eight common for all three layers).

4. The Holocene bird remains from Krucza Skała on the background of the recent fauna

The recent bird fauna of Zawiercie district was studied in the 20-ties and 30-ties of the 20th century by MASŁOWSKI (1938). He did not find nine taxa, the remains of which were identified in the Holocene sediments (layers 9 and VI). Four of them belong to arctic species (Brent Goose, two *Lagopus* species and Grey Plover). Three others belong to the boreal taiga species (Capercaillie, Hazel Hen and Tengmalm's Owl) whereas the Scops Owl is a southern European species. As for the Grey-headed Woodpecker, the Kroczyce Rocks are, according to TOMIAŁOJĆ and STAWARCZYK (2003), situated near the north-western boundary of the breeding distribution of the bird. MASŁOWSKI (1938) encountered a few other species, like the Golden Plover and Great Snipe, in

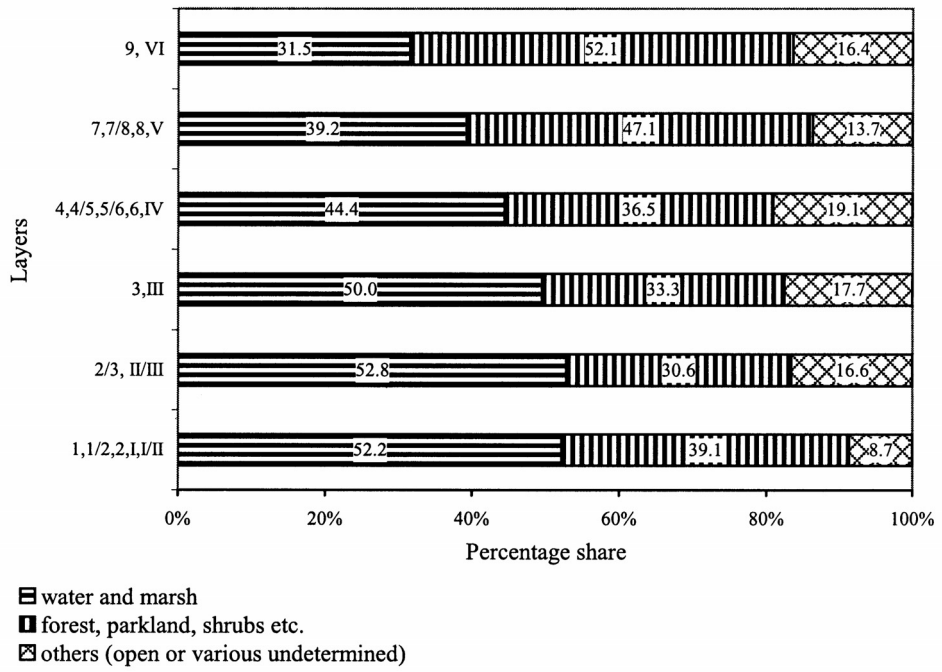

Fig. 2. Percentage share of bird species representing three general groups of habitats during the Late Vistulian and Holocene.

autumn only. All 23 passerine species identified in the Krucza Skała Holocene sediments were listed by MASŁOWSKI (1938) as breeding birds. At least 14 other breeding species were identified in Krucza Skała in sediments older than the Holocene.

More recent (1985-1991) and more detailed data concerning the recent bird fauna are given in the "Atlas of breeding birds in Małopolska" by WALASZ and MIELCZAREK (1992). The Kroczyce Rocks are situated within two atlas rectangles – the data extracted from the maps concern 126 species, so, in spite of a distinctly smaller area, the general number of breeding species is larger than that listed by MASŁOWSKI (1938). Similarly to the list of MASŁOWSKI (1938), it contains all passerine species identified in the Holocene sediments of Krucza Skała. Among non-Passeriformes, this list does not contain the species which were not mentioned by MASŁOWSKI (1938), and those mentioned by him as migrant or wintering species only. Besides these, eight species are lacking which fifty years earlier were listed among the breeding fauna. In the case of the Black Grouse or Corncrake this may be connected with a general tendency of decreasing abundance in the western and central part of Poland (TOMIAŁOJĆ 1990, TOMIAŁOJĆ, STAWARCZYK 2003, GŁOWACIŃSKI 2001); in other cases this is difficult to explain.

IV. CONCLUSIONS

The fossil bird fauna from the rock-shelter in Krucza Skała is one of the richest among those explored in Poland. The number of 116 taxa identified gives it even first place. It accumulated in a relatively short time of about 13 thousand years. The first three thousand years, i.e. the Late Glacial, may be divided into five periods (of various time span) to which particular layers of sediment were

attributed. The division is based in part on petrographic structure of the sediment, and in part on a few radiocarbon dates. Unfortunately, referring these periods, and especially their thermic indices, to cold stadials (the Older Dryas "2" and Younger Dryas "3"), and warm (or warmer) interstadials (the Bölling and Alleröd) is difficult and may be questionable.

It is worth mentioning that several species like the Common Eider, Long-tailed Duck or Turnstone which are now Arctic coastal/maritime birds were identified in the fossil fauna from Krucza Skała and represent migrants. They were included in the calculation of thermal indices which caused lower values than based on the breeding fauna only.

In the oldest period we encountered layers 1, 1/2, 2 inside the rock-shelter, and I and I/II (there are no data on birds from pure layer II) in front of it. The radiocarbon date 12520±70 BP obtained from a bone found in the upper part of layer I points to warm Bölling Interstadial, whereas MADEYSKA (1996) refers the deepest sediment to the Middle Palaeolithic. However, there is no correlation between the deepest sediment inside the rock-shelter described by MADEYSKA (1996) and layer I in front of it (NADACHOWSKI oral comm.). The thermal index calculated from the bird assemblage identified in layers 1, 1/2, 2 and I and I/II is the lowest (see Table V). This may suggest that a few bird bones found there are older than the one used for the 14C date (the Oldest Dryas "1"?, Upper Plenivistulian?).

Distinguishing the sediment from the transition between layers 2 and 3 as well as between II and III was done mainly for the relatively numerous bird assemblage. The thermal index indicates that it accumulated in a warmer period than the previous – possibly in the Bölling Interstadial, but there is no other evidence for it.

The thickness of layers 3 and III differs: the latter is much thicker. The radiocarbon date obtained from a bone (not a bird one) found in layer III is 11980±70 BP, pointing to a short cold Older Dryas "2" stadial, though the thermal index calculated for that layer is relatively high (Table V: 2.41). Whereas the analogous index of thin layer 3 inside the rock-shelter is distinctly lower (Table V: 2.18). The depth at which the bone used for the 14C date was found at is unknown, but speculative try of interpretation is as follows: thin layer 3 accumulated during the Older Dryas "2"; the bone used for 14C date came from the lower part of layer III, whereas bird bones from the other parts of this thick layer could have accumulated even later in the beginning of the Alleröd.

Layers attributed to the middle and second half of the Alleröd Interstadial (4, 4/5, 5, 5/6, 6, and V) mainly on the basis of two radiocarbon dates (11450±200, and 11210±70 BP) accumulated in a generally warmer period than the previous one (Table VI: total index = 2.52) in spite of the fact that layer 4 has the lowest index of this sediment series (Table V: 2.30) which may indicate a cooler episode during the mid-Alleröd.

The general thermal index calculated for bird assemblages from layer series 7, 7/8, 8 and V is the highest (Table VI: 2.76), and the differences among particular layers are rather small and that of layer V is the highest (Table V). There are no radiocarbon dates of these sediments. Chronological sequence indicates that they accumulated either during the last millennium of the Late Glacial i.e. during ca 800 years long Younger Dryas "3" (which seems to be absolutely controversial with thermal indices in spite of the fact that according to RALSKA-JASIEWICZOWA 1991, the climate during the Younger Dryas "3" was not as cold in Poland as in Western Europe), or later in the Holocene..

Environmental changes in the surroundings of Krucza Skała rock-shelter during the Late Glacial and Holocene were as follows. The temperature fluctuated but generally increased (Table VI). The share of water-and-marsh bird species evidently decreased (in the uppermost Holocene layers it constitutes nearly half of that calculated for the layers sedimented during the beginning of accumulation) indicating gradual drainage. On the contrary, the numbers of "forest" bird species increased, though it was not as gradual (see Fig. 2). The share of species characteristic for open habitats and "others" was rather small and fluctuating but one must remember that marshes may be treated as open habitats as well.

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