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The comparative osteology of the humerus in European thrushes (Aves: *Turdus*) including a comparison with other similarly sized genera of passerine birds - preliminary results

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Abstract: 150 skeletal specimens of the six *Turdus* species breeding in Europe were studied, together with 110 specimens belonging to 25 passerine species similar in size to thrushes. The morphology of the humerus allowed the division of the studied birds into four groups. All six *Turdus* species belong to one group together with the genera *Monticola, Zoothera* and *Sturnus.* Morphological and metrical features discriminating representatives of those genera, and between *Turdus* species were analyzed.

Key words: osteology, humerus, *Turdus*, passerines.

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I. INTRODUCTION

Thrushes, as well as corvids, are among the most common passerine birds present in the fossil record of archaeological and palaeontological sites in Europe. However, identification of their skeletal elements to a species level has proven to be very difficult or even impossible based on the current literature. Furthermore, in certain instances it is possible only to make an accurate identification to the generic level (BOCHEŃSKI Z. 1993). The scarce literature to date mainly deals with descriptions of single bones of common species (STORCK 1968, BOCHEŃSKI Z. 1974, LIDAUER 1982, JÁNOSSY 1983, CUISIN 1989). Besides that, most osteological papers describe characters of nonpasserine birds (BACHER 1967, ERBERSDOBLER 1968, KRAFT 1972, FICK 1974, LANGER 1980, KELLNER 1986, OTTO 1981, BOCHEŃSKI Z.M. 1994). Therefore, measurements available in the literature pertain to large or medium sized species and to bones of different shapes than those of passerine birds (von den DRIESCH 1976). This makes comparisons impossible with the smaller and morphologically more complex bones of passerine birds. Additional problems arise in material retrieved from archaeological and palaeontological sites, as the main measurement proposed for bone identification is the total length and most bones found are broken making this measurement impossible. For these reasons passerine bird remains are very difficult to identify. Another complication for researchers working on such material is that it is not always possible to gain access to a rich enough comparative collection to identify bones.

In the European avifauna there are a dozen species of passerine similar in size to thrushes. They are predominantly breeding birds for this area (e.g. representatives of the genera *Sturnus, Lanius, Oriolus* or *Galerida*), but also include wintering and passage migrants breeding at the edge of Europe (e.g. *Eremophila, Melanocorypha, Bombycilla*). Extreme intergeneric morphological similarities in certain families causes also problems with identification of their bones, (e.g. family *Turdidae* with similar genera *Monticola, Zoothera and Turdus*).

Most medium size passerine birds, thrushes and alike, are very frequently preyed upon by owls or diurnal birds of prey and as a result they are commonly encountered in pellets found in Quaternary sites as well as in modern sites.

The purpose of this study is to define morphometric characters of the humerus that can be used to separate the genus *Turdus* from similarly sized of passerine bird genera. It also aims to help identify particular thrushes to species level and to simplify description of remains from excavation sites.

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II. MATERIAL AND METHODS

The results presented here are part of a larger study on the comparative osteology of the wing of European thrushes taking into account other similarly sized genera of passerine birds.

Analyses were based on 150 skeletal specimens representing 6 species of thrushes breeding in Europe. They include:

Redwing *Turdus iliacus* LINNAEUS, 1766 – 24 specimens

Blackbird *Turdus merula* LINNAEUS, 1758 – 18 spec.

Song Thrush *Turdus philomelos* C L BREHM, 1831 – 30 spec.

Fieldfare *Turdus pilaris* LINNAEUS, 1758 – 19 spec.

Ring Ouzel *Turdus torquatus* LINNAEUS, 1758 – 37 spec.

Mistle Thrush *Turdus viscivorus* LINNAEUS, 1758 – 22 spec.

The species of the thrushes occurring in Asia (*Turdus unicolor, T. obscurus, T. naumanni, T. ruficollis*) and Northern America (*T. migratorius*), which are accidental migrants in Europe (CRAMP 1988, 1992, TOMIAŁOJĆ 1990), were not included in the study as the possibility of finding their remains in excavated material is very low.

In this study 18 genera, including 25 species (110 specimens in total), of European passerine birds similar in body size and wing length to the European thrushes (CRAMP 1988, 1992, CRAMP & PERRINS 1993, 1994) were examined. Some genera of passerine birds are represented in Europe by only one species (e.g. Waxwing *Bombycilla garrulus,* Golden Oriole *Oriolus oriolus,* Siberian Jay *Perisoreus infaustus* and Hawfinch *Coccothraustes coccothraustes*) therefore it was necessary to study non-European representatives of these genera to describe characters typical for the entire genus. Other species of these genera often occur in areas far from Europe such as in North America (e.g. Cedar Waxwing *Bombycilla cedorum*, Evening Grosebeak *Coccothraustes vespertinus* and Gray Jay *Perisoreus canadensis*) or in Asia (e.g. Black-naped Oriole *Oriolus chinensis*). Holarctic species of these genera were chosen for comparative studies as they are probably more closely related to the European species than species from the others geographical regions. All species of passerines similar to thrushes studied are listed bellow.

Alaudidae
Calandra Lark *Melanocorypha calandra* (LINNAEUS, 1766) – 3 specimens.
White-winged Lark *Melanocorypha leucoptera* (PALLAS, 1811) – 1 spec.
Black Lark *Melanocorypha yeltoniensis* (J. R. FORSTER, 1767) – 1 spec.
Crested Lark *Galerida cristata (*LINNAEUS, 1758) – 10 spec.
Thekla Lark *Galerida theklae* (C. L. BREHM, 1858) – 3 spec.
Wood Lark *Lullula arborea* (LINNAEUS, 1758) – 4 spec.
Eurasian Sky Lark *Alauda arvensis* LINNAEUS, 1758 – 6 spec.
Shore Lark *Eremophila alpestris* (LINNAEUS, 1758) – 6 spec.
Bombycillidae
Waxwing *Bombycilla garrulus* (LINNAEUS, 1758) – 6 spec.
*Cedar Waxwing *Bombycilla cedorum* VIEILLOT, 1808
Turdidae
Mountain Rock Thrush *Monticola saxatilis* (LINNAEUS, 1766) – 4 spec.
Blue Rock Thrush *Monticola solitarius* (LINNAEUS, 1758) – 7 spec.
White's Thrush *Zoothera dauma* (LATHAM, 1790) – 2 spec.
*Varied Thrush *Zoothera naevia* (J. F. GMELIN, 1789)
Oriolidae
Golden Oriole *Oriolus oriolus* (LINNAEUS, 1758) – 6 spec.
*Black-naped Oriole *Oriolus chinensis* LINNAEUS, 1766
Laniidae
Great Grey Shrike *Lanius excubitor* LINNAEUS, 1758 – 5 spec.
Lesser Grey Shrike *Lanius minor* J. F. GMELIN, 1788 – 2 spec.
Corvidae
Siberian Jay *Perisoreus infaustus* (LINNAEUS, 1758) – 7 spec.
*Grey Jay *Perisoreus canadensis* (LINNAEUS, 1766)
Azure-winged Magpie *Cyanopica cyanus* (PALLAS, 1776) – 5 spec.
Sturnidae
Common Starling *Sturnus vulgaris* LINNAEUS, 1758 – 6 spec.
Spotless Starling *Sturnus unicolor* TEMMINCK, 1820 – 6 spec.
Rose-coloured Starling *Sturnus roseus* (LINNAEUS, 1758) – 2 spec.
Passeridae
Rock Sparrow *Petronia petronia* (LINNAEUS, 1766) – 1 spec.
Snow Finch *Montifringilla nivalis* (LINNAEUS, 1766) – 1 spec.
Fringillidae
Pine Grosbeak *Pinicola enucleator* (LINNAEUS, 1758) – 4 spec.
Hawfinch *Coccothraustes coccothraustes* (LINNAEUS, 1758) – 5 spec.
*Evening Grosbeak *Coccothraustes vespertinus* (W. COOPER, 1825)
Emberizidae
Corn Bunting *Miliaria calandra* (LINNAEUS, 1758) – 7 spec.

* extra European species used only to describe morphological characters for the genera.

The material used comes from the following osteological collections: Institute of Systematics and Evolution of Animals Polish Academy of Sciences, Cracow, Poland; Christian-Albrechts-Universität, Kiel, Germany; Zoologisk Museum, Copenhagen, Denmark; The Natural History Museum, Birds Division, Tring, United Kingdom; Muséum National d'Historie Naturelle, Paris, France; United States National Museum of Natural History, Washington, USA; Canadian Museum of Nature, Ottawa, Canada and Royal Ontario Museum, Toronto, Canada.

For metrical studies only adults were used (with fully grown and ossified bones) while for morphological studies juvenile individuals were also used, because characters were diagnostic enough for comparisons. The nomenclature of the humerus (Fig. 1) was based on several, but not always concordant, sources: LAMBRECHT (1933), BOCK (1962), von den DRIESCH (1976), BAUMEL (1979), KOMÁREK (1979), OTTO (1981), BOCHEŃSKI Z. M. (1994) and TOMEK & BOCHEŃSKI Z. M. (2000). Differences between males and females or juvenile and adults were not studied. Bones were measured to the nearest 0.1 mm with a dial caliper. The measurements taken on humerus are shown in Fig. 2. Not all of the specimens of thrushes studied were used to create scatter diagrams of measurements b/d and c/g (Fig. 5-6). Five specimens per species were randomly chosen, including the minimum and maximum values. Analyses of variance (ANOVA, test F and Kruskal-Wallis) were used to find differences between species in the genus *Turdus* (Table I). Only morphological characters, which occur in at least 66 % of all the specimens of a species, were treated as typical for that species (BOCHEŃSKI Z.M. & TOMEK 1995). This was true for only two characters in the humerus, which are shown in Fig. 7 and Fig. 10.

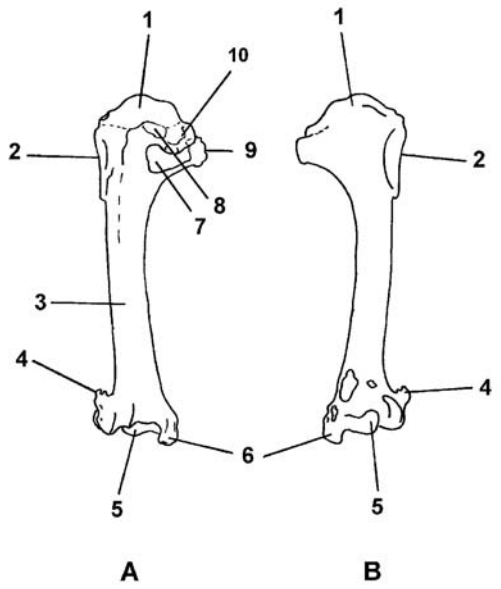

Fig. 1. Humerus: nomenclature. A – caudal view, B – cranial view. 1 – Caput humeri; 2 – Crista pectoralis; 3 – Corpus humeri; 4 – Processus supracondylaris dorsalis; 5 – Condylus ventralis; 6 – Processus flexorius; 7 – First fossa pneumatica; 8 – Second fossa pneumatica; 9 – Crista bicipitalis; 10 – Tuberculum ventrale.

III. RESULTS

The humerus is the largest and most robust bone of the wing and as a result is frequently found in archaeological and palaeontological sites. In most cases bones are found broken, therefore characters of the distal and proximal parts of the humerus are best preserved. This study focussed on meas-

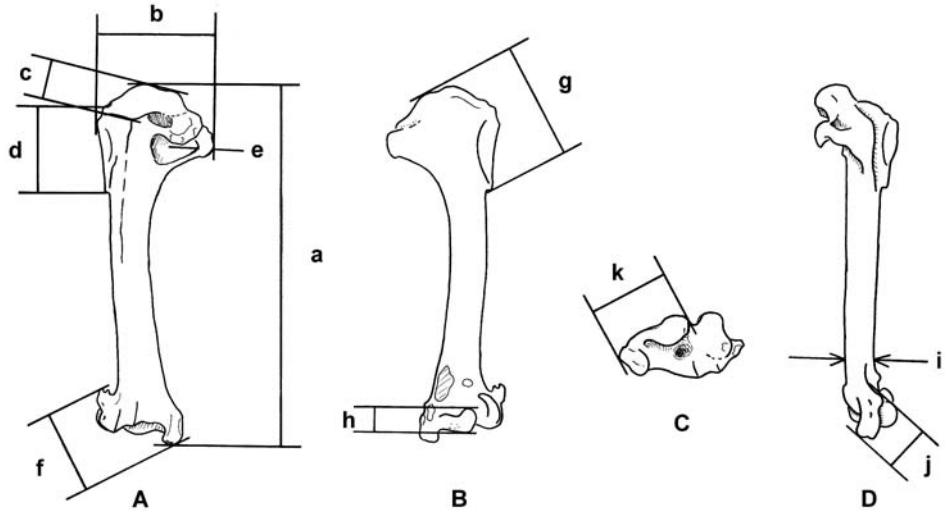

Fig. 2. Humerus. A – caudal view, B – cranial view, C – distal part, distal view, D – ventral view. Measurements: a – total length: distance from the caput humeri to the processus flexorius; b – proximal width: distance from the crista bicipitalis to the crista pectoralis; c – depth of the caput humeri; d – length of the crista pectoralis; e – maximal width of the edge of the crista bicipitalis; f – distal width: distance from the processus supracondylaris dorsalis to the processus flexorius; g – distance from the caput humeri to the distal extreme of the crista pectoralis; h – height of the condylus ventralis; i – diameter of the shaft, measured at the distal part of the corpus humeri; j – height of the processus flexorius; k – distance from the end of the condylus ventralis to the edge of the processus flexorius.

urements in these areas. However, the total length of the humerus was shown to be the most reliable for identifying species (Table I). Eleven measurements of the humerus are described and used to identify thrushes and other similarly sized genera of passerine birds. The most fragile parts of the humerus are the processus supracondylaris dorsalis and the edge of the crista pectoralis. Damage to the bones was most frequently observed in these regions.

Identification of genus *Turdus*

All the 110 specimens belonging to the 25 species similar to thrushes in wing length were measured. Most measurements separate 5 genera as being smaller than thrushes (*Lullula, Eremophila, Petronia, Montifringilla and Miliaria*) and 1 genus as being larger than thrushes (*Zoothera*) (Table II, Fig. 3). The former might be excluded from this study, however, it was only possible to examine one or two specimens of these genera so they were included.

Eight of the genera studied are most similar in size to the thrushes: *Melanocorypha, Galerida, Monticola, Oriolus, Lanius, Perisoreus, Cyanopica* and *Sturnus*. For these genera 9 to 11 measurements, from a total of 11, are the same as in *Turdus* (Table II, Fig. 3). In the remaining genera: *Alauda, Bombycilla, Pinicola* and *Coccothraustes*, 7 to 8 measurements place them in the size range of *Turdus*.

Morphological characters of the humerus divide the genera of passerines similar to thrushes into 4 different groups. These characters appear in the proximal part of humerus and relate to the development of the first and second fossa pneumatica and to the length of the crista pectoralis. Figure 4 presents representative species of these four morphological types. However, these groups do not

Table I

Results of ANOVA calculated for every pair of species of European thrushes and for every measurement. The table was divided in two; the lower part contains pairs of species which differ in size. Symbols: – no statistically significant differences between species (p>0.05); + species differ significantly (p=0.000) or brackets shows value of "p"; K – Kruskal – Wallis test was used; TI – *Turdus iliacus*, TM – *Turdus merula*, TPH – *Turdus philomelos*, TPI – *Turdus pilaris,* TT – *Turdus torquatus*, TV – *Turdus viscivorus*

Pairs of species	Measurements (as in Fig. 2)										
	a	b	c	d	e	f	g	h	i	j	k
TM-TPI	+ (0.0098)	+	+ (0.0003)	–	+ (0.0022)	+	+ (0.0019)	+	+ K	+	+
TM-TT	+	+	+	–	+	+	+ (0.0017)	+ K	+	+	+
TT-TPI	+ (0.0366)	–	–	+ (0.0151)	+	–	+ K	–	+ K (0.0122)	–	–
TV-TPI	+	+ (0.0008)	+ (0.0002)	+	+ (0.0030)	+ (0.0005)	+	+ (0.0001)	–	+ (0.0020)	+
TV-TT	+	+	+ (0.0028)	+	+	+	+	+ K	+ (0.0228)	+ (0.0158)	+
TM-TI	+	+	+ (0.0001)	+	–	+	+	+	+	+ (0.0001)	+
TM-TPH	+	+ K	+	+ K	–	+	+	+ K	+	+ K	+
TI-TPH	+ K	+ (0.0033)	–	–	–	–	–	+ K (0.0367)	–	– K	+ (0.0014)
TV-TM	+	+	+	+	–	+	+	+	+	+	+
TV-TI	+	+	+	+	–	+	+	+	+	+	+
TV-TPH	+ K	+ K	+	+	–	+	+ K	+ K	+	+ K	+
TT-TI	+	+	+	+	+	+	+	+	+	+	+
TT-TPH	+	+ K	+ K	+	+	+	+ K	+	+	+ K	+ K
TPI-TI	+	+	+	+	+	+	+	+	+ K	+	+
TPI-TPH	+ K	+ K	+	+	+ (0.0003)	+ K	+ K	+ K	+ K	+	+

represent a systematic division of the species analysed they simply reflect morphological similarities of the humerus. In group I (Fig. 4 A) which includes the genera *Oriolus, Lanius* and *Bombycilla* the first fossa pneumatica of the humerus is well developed but the second fossa pneumatica is absent, the crista pectoralis is short compared to the proximal width of the bone and the general appearance of the proximal part of the humerus is "more rounded". Group II (Fig. 4 B) includes the genera *Sturnus, Monticola, Turdus* and *Zoothera*. In this group the second fossa pneumatica is fully developed and separated by a medial bar from the first fossa pneumatica, the crista pectoralis is short compared to the proximal width of the bone and the general appearance of the proximal part of the humerus is "more square-shaped". Group III (Fig. 4 C), is typified by the genera *Coccothraustes*

Table II

Comparison of genera according to the percentages of the results taken in every measurement which overlap with other members of the genus *Turdus* (e.g. Fig. 3). Symbols: "+" 100 % of interval of results overlap the interval of the same measurement of genus *Turdus*; " –" 0 % overlapping; "50" 50 % overlapping; "↗" more than 50 % overlapping; "↘" less than 50 % overlapping

Genus	Measurements (as in Fig. 2)											Sum of measurements overlapping the interval of results in *Turdus* in:	
	a	b	c	d	e	f	g	h	i	j	k	more than 50 %	less than 50 %
Melanocorypha	+	+	+	+	+	+	↗	+	+	↗	↗	11	–
Galerida	+	↘	↗	+	+	50	↗	+	↗	↗	↘	9	2
Lullula	–	–	–	+	–	–	↘	↘	–	–	–	1	10
Alauda	↗	–	↗	+	+	–	50	50	↘	↗	–	7	4
Eremophila	↘	–	↗	50	↘	–	–	50	↘	↘	↘	3	8
Bombycilla	–	50	+	↘	↗	+	–	+	+	+	+	8	3
Monticola	↗	+	↗	+	↗	+	+	+	+	+	+	11	–
Zoothera	–	–	50	↘	+	↘	↘	50	↘	↘	↗	4	7
Oriolus	+	+	+	+	+	+	+	+	+	+	+	11	–
Lanius	+	↗	+	↗	↗	+	↗	+	+	+	+	11	–
Perisoreus	+	+	+	↗	+	+	+	+	+	+	+	11	–
Cyanopica	+	+	+	↘	+	+	↗	+	+	+	+	10	1
Sturnus	+	+	+	↗	+	+	+	+	+	+	+	11	–
Petronia	–	–	+	–	+	–	–	50	–	50	–	4	7
Montifringilla	–	–	+	+	–	–	–	+	–	+	–	4	7
Pinicola	–	↘	+	+	+	↗	↘	+	↘	50	+	7	4
Coccothraustes	–	+	+	–	+	↗	–	+	50	+	+	8	3
Miliaria	↘	–	+	–	+	↘	–	+	–	↘	↘	3	8

and *Pinicola* as well as *Petronia, Montifringilla* and *Miliaria.* Here, the first and second fossa pneumatica are fully developed and united, creating a single large fossa (medial bar is too small to separate both fossae), the crista pectoralis is short compared to the proximal width of the bone and the general appearance of the proximal part of humerus is "more square-shaped". Finally, group IV (Fig. 4 D) is characterised by the Corvidae (*Perisoreus*, *Cyanopica*) and Alaudidae (*Melanocorypha*, *Alauda, Galerida, Eremophila and Lullula).* Here the first fossa pneumatica is clearly shown but the second fossa pneumatica is very slightly developed, the crista pectoralis is long compared to the proximal width of the bone (exception *Melanocorypha*) and the general appearance of the proximal part of the humerus is "more rectangular".

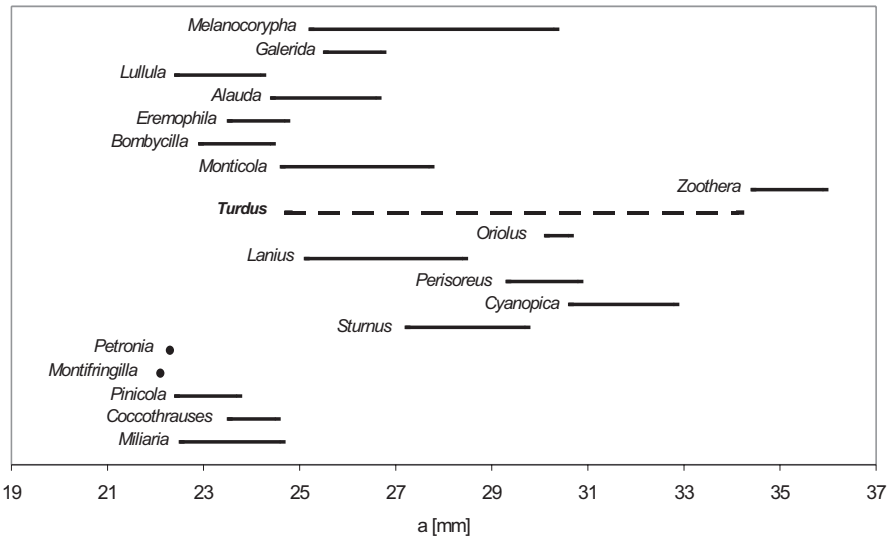

Fig. 3. Humerus, measurement "a – total length" in six European thrushes, compared with other genera similar to thrushes in size.

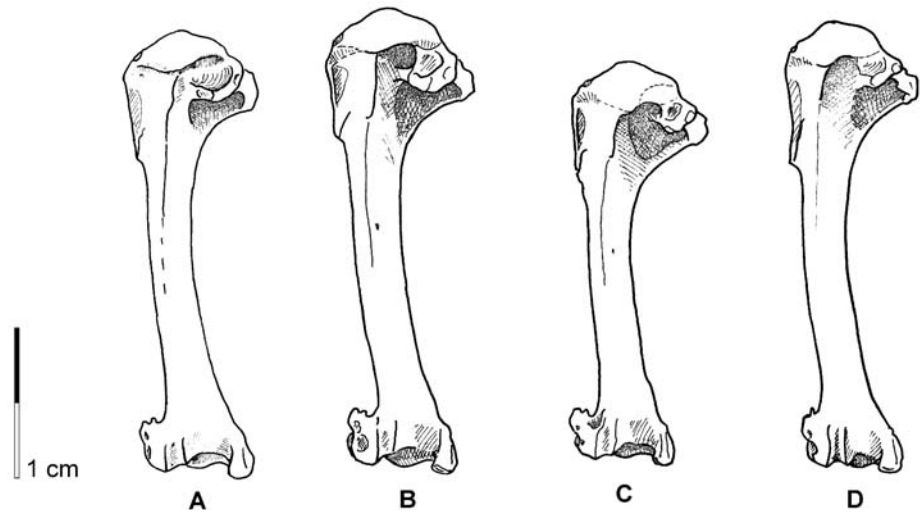

Fig. 4. Examples of the types of humeral shape used to divide all the studied genera of passerine birds of similar size to thrushes in to four morphologically different groups. A – *Lanius*, B – *Sturnus*, C – *Coccothraustes*, D – *Alauda.*

The genus *Turdus* is placed in group II, being very similar to the genera *Monticola, Zoothera* and *Sturnus.* No measurements help to differentiate the genus *Turdus* from *Sturnus and Monticola;* the single species which can be identified is the Mistle Thrush which is larger than *Monticola* and *Sturnus*. However, it is possible to distinguish *Sturnus* as being larger than *Monticola* by using measurements "c", "h" and "j" and by referring to the scatter diagrams of measurements b/d and c/g (Fig. 5-6).

The shape of the crista pectoralis (Fig. 7.) is different among the genera in group II and can easily be used for their identification. *Zoothera* is the exception, because the first of the two specimens examined has a state typical of thrushes while the second has a state typical of starlings. However, the large size of *Zoothera* helps to separate this genus. The other morphological characters exam-

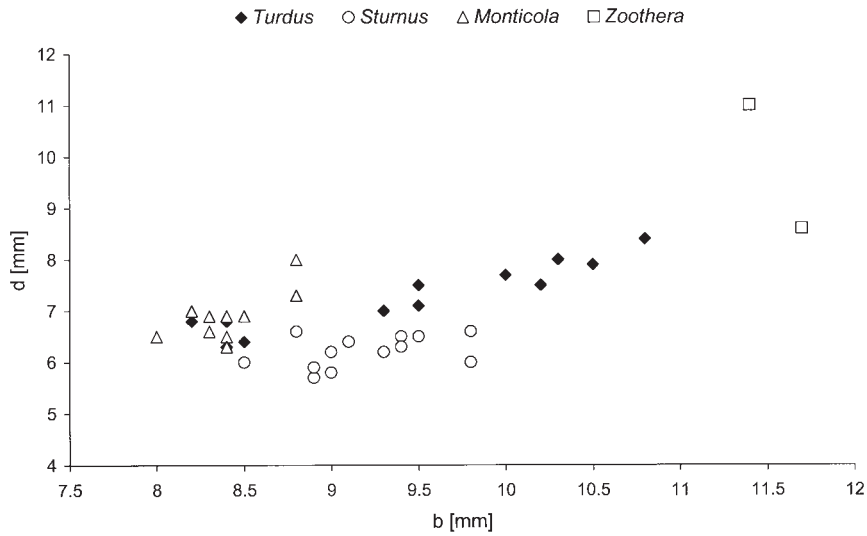

Fig. 5. Scatter diagram of measurements b/d in the humerus.

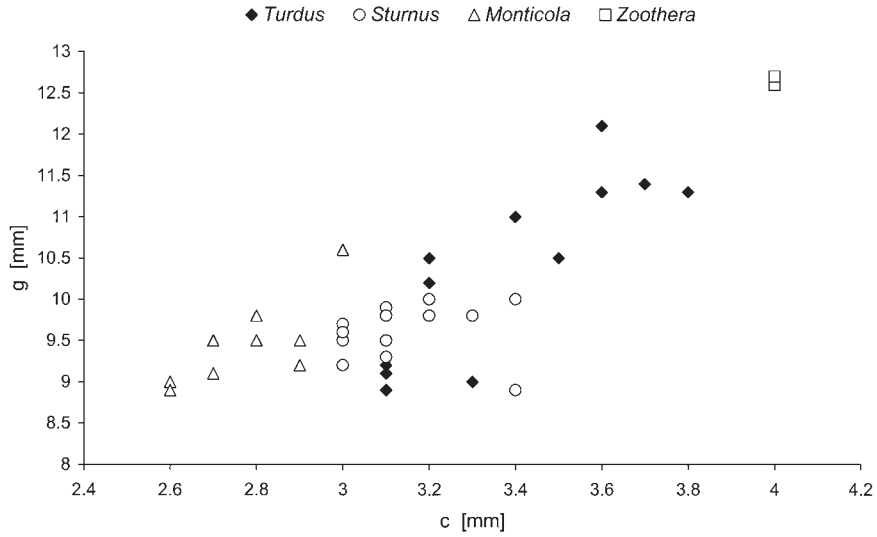

Fig. 6. Scatter diagram of measurements c/g in the humerus.

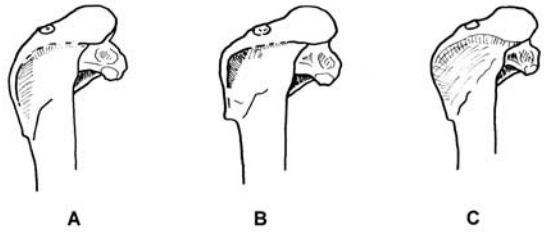

Fig. 7. Morphological character that shows differences between the genera *Turdus, Sturnus* and *Monticola*. Humerus, proximal part, dorsal view. State A: edge of the crista pectoralis moderately rounded and with callosity - typical for genus *Turdus* (N = 11, A = 100 %); State B: edge of the crista pectoralis more square-shaped and folded - typical for genus *Sturnus* (N = 8, B = 100 %); State C: edge of the crista pectoralis more rounded, without any callosity or fold, surface depressed - typical for genus *Monticola* (N = 6, C = 100 %).

ined during this study did not show clear differences and cannot be used to differentiate the thrushes until perhaps more specimens of the genus *Monticola* have been investigated.

Identification of *Turdus* species

Measurements of wing bones other than those of the humerus (ulna, radius, carpometacarpus and phalanx I digiti majoris) isolate the 6 European species of thrushes into 4 groups. These 4 groups are based on the size of the bones and are as follows, getting progressively larger: Group 1) the smallest thrushes, very similar to each other: the Redwing and the Song Thrush, Group 2) one species: the Blackbird, Group 3) larger and very similar to each other: the Fieldfare and the Ring Ouzel, Group 4) the largest thrush: the Mistle Thrush.

In the humerus the above pattern is not that clear (see Fig. 8-9). This is why it is necessary to take different measurements specific for each pair of closely related of thrush species (Table I). The most interesting measurement of the humerus is "e – the maximal width of the edge of the crista bicipi-

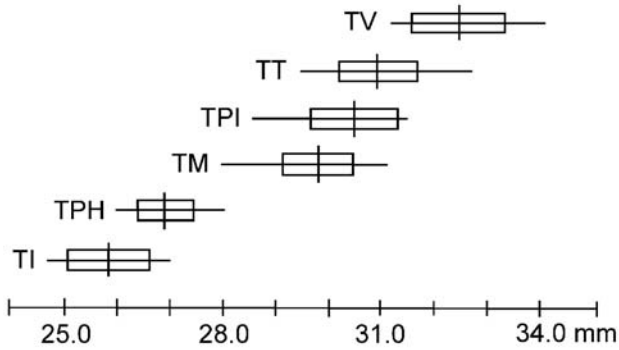

Fig. 8. Diagram of min. and max. values, arithmetic mean and standard deviation (SD) for measurement "a" - total length of humerus of European thrushes. TI - *Turdus iliacus*, TM - *Turdus merula*, TPH - *Turdus philomelos*, TPI - *Turdus pilaris,* TT - *Turdus torquatus*, TV - *Turdus viscivorus*.

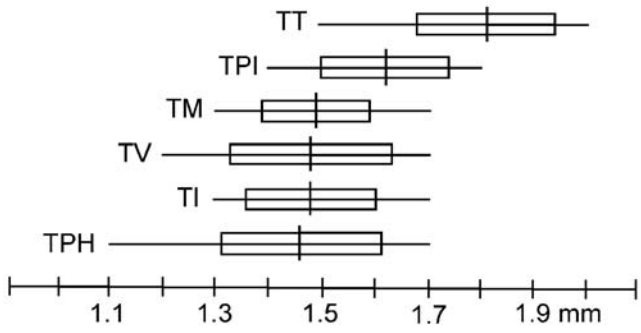

Fig. 9. Diagram of min. and max. values, arithmetic mean and standard deviation (SD) for measurement "e - maximal width of the edge of crista bicipitalis" of the humerus in European thrushes. (Description see Fig. 8).

talis" (Fig. 9), which places the larger Mistle Thrush with the smaller Redwing, Song Thrush and Blackbird. For the Ring Ouzel measurement "e" can also be useful because it characterises this species as the largest of all thrushes. It should be pointed out, however that measurement "e" is the smallest dimension used in this study and hence is more prone to measurement error.

It is easy to differentiate the Blackbird from the Mistle Thrush and both from other groups of thrushes such as the smallest in Group 1 (Song Thrush and Redwing) and the larger ones in Group 3 (the Ring Ouzel and the Fieldfare). However, it is very difficult to differentiate species in the last two groups because they appear to be very similar. ANOVA (Table I) shows that those species can be differentiated although in practice this is very difficult to do (Fig. 8-9). No morphological character of the humerus was found to differentiate those species. Only one morphological character (Fig. 10), which occur in at least 66 % of all the specimens, was found to distinguish Mistle Thrush from all other species. However, the high probability that the processus supracondylaris dorsalis is broken in excavated material reduces the chances of identifying their bones.

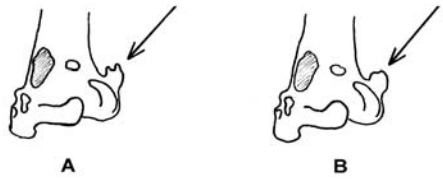

Fig. 10. Morphological character of the humerus which shows significant difference between *Turdus viscivorus* and the other species of thrushes. Distal part, cranial view. State A: processus supracondylaris dorsalis is divided into two apices. State B: processus s. d. is not or is very slightly divided. State AB: intermediate between state A and B.
Results:
Turdus viscivorus: N = 21, A = 66.7 % (N = 14), B = 14.3 % (N = 3), AB = 19 % (N=4); *Turdus pilaris:* uncharacteristic: (N = 16, B = 50 %, A = 37.5 %, AB = 12.5 %); *Turdus torquatus:* N = 35, B = 68.6 % (N = 24), A = 22.9 % (N = 8), AB = 8.6 %(N = 3); *Turdus merula:* N = 18, B = 83.3 % (N = 15), A = 16.7 (N = 3); *Turdus philomelos:* N = 29, B = 69.0 % (N = 20), A = 20.7 % (N = 6), AB = 10.3 % (N= 3); *Turdus iliacus:* N = 21, B = 71.4 % (N = 15), A = 23.8 % (N= 6), AB = 4.8 % (N = 1).

IV. DISCUSSION

Skeletal elements of small Oscines are difficult to identify because they possess a very complex, but homogenous morphological structure within each taxon. Anatomical features are difficult to interpret resulting in problematic identification of species and even genera (BOCK 1962, JÁNOSSY 1983).

The main controversy involves the shape of the proximal part of the humerus (WETMORE 1957, BOCK 1962, JÁNOSSY 1983) as opposed to the distal part, which does not seem to exhibit important morphological differences between the genera except in size. The development of two fossae pneumatica was found to be a good taxonomic character in passerines (ASHLEY 1941, WETMORE 1957, BOCK 1962). The general conclusion was that families possessing a single fossa pneumatica were more primitive than those having double fossae. The development of double pneumatic fossae can result in increased development of muscles involved in vertical flight (ASHLEY 1941). This conclusion contrasts to that of WETMORE (1957) and BOCK (1962) who claim that a fully developed fossa is also present in many passerine birds that do not fly vertically. MAYR (1958) and BERGER (1957) hypothesis was that a single pneumatic fossa could be a secondarily simplified trait in some groups of birds and therefore does not prove their primitive state.

The division of the genera in the passerines analysed into four morphological groups proposed in this study generally follows the divisions made by BOCK (1962) and JÁNOSSY (1983) and also

partly agrees with the conclusions of CUISIN (1989) based on the configuration of the skull. Genera belonging to group I: *Oriolus*, *Lanius* and *Bombycilla* were found to be similar to each other and have a single fossa pneumatica. However, my opinion differs from that of JÁNOSSY (1983) who views these genera as being closely related to the Alaudidae. Unlike the genera mentioned above the family Alaudidae have a slightly developed second fossa, a less robust humerus and a longer crista pectoralis; this was also pointed out by BOCK (1962).

Genera belonging to group II (*Turdus, Sturnus, Monticola*) were described by the authors mentioned as being closely related to each other based on their fully developed first and second pneumatic fossa. BOCK (1962) describes the fossae as clearly separated with a strong medial bar, as opposed to JÁNOSSY (1983) who describes *Turdus* as having "fossae confluent and medial bar reduced". I disagree with JÁNOSSY's (1983) description of the genus *Turdus* as well as his suggestion that the genus *Pinicola* is similar to *Turdus, Sturnus* and *Monticola*. As opposed to the last three mentioned genera, *Pinicola* has a first and second fossa that are joined forming a large single fossa and the medial bar is reduced as is typical for group III which also includes *Coccothraustes, Miliaria, Petronia* and *Montifringilla*. BOCK (1962) and JÁNOSSY (1983) described the Fringillidae as having the merged fossae mentioned above, which I agree with, but describing *Pinicola* as having a "medial bar absolutely separating the two deep fossae" would be best regarded as a misinterpretation. This mistake probably results from the study of a single atypical specimen by JÁNOSSY (1983). To be sure of my conclusions I have checked humeri of European and Northern American populations of *Pinicola* and they appear to confirm my opinion.

Another suggestion made by BOCK (1962) was that the second fossa in *Turdus* is larger than in *Sturnus* although my observations do not support this. I examined a series of *Turdus merula*, being the closest in size to starlings, and found that both genera can have a small or a large second fossa pneumatica. However, this problem could be solved by studying a larger sample of specimens. CUISIN (1989) also found that in the morphology of the skull *Turdus* and *Monticola* are very similar to each other. However, this author found that *Turdus* is much more homogenous than *Monticola* which can show more intraspecific variations. It should be pointed out that this author only studied three specimens of the genus *Monticola*.

In morphological group IV I have placed the Alaudidae and the Corvidae as families having the most morphologically similar humeri compared to the other genera studied. Both families have a fully developed first fossa pneumatica, a very shallow second fossa and a long crista pectoralis. This description contradicts with BOCK (1962) who view Corvidae as having only a single fossa pneumatica. However, he was studying large crows which do not show as much fine morphological details as the small corvids, *Perisoreus* and *Cyanopica*, investigated here.

The division of the genera of studied Oscines into four morphological groups based on the structure of humerus, presented in this study, allows their identification to be achieved although it can not be treated as a systematic classification. These divisions do not possess systematic value without considering other morphological characters found in the whole skeleton such as: cranial and postcranial features. Evidence of relationships between passerine birds must be based on the hole skeleton. Postcranial skeletal characters can be used to check taxonomic conclusions based on cranial features to exclude eventual convergence resulting from feeding habits (BOCK 1962).

Identification of thrushes species is more difficult. I have found it very difficult to distinguish closely related species like the Song Thrush from the Redwing and the Ring Ouzel from the Fieldfare. Although those species can be separated from the Blackbird and the Mistle Thrush. However, all measurements of the thrush species overlap to some extent. Current conclusions do not agree with the suggestions of JÁNOSSY (1983) and CUISIN (1989). JÁNOSSY (1983) presented absolute differences in size between thrushes, which could only be true for a small series of specimens as analysed by that author. The current study, which is based on larger series, challenges these clearly separated intervals. CUISIN (1989) found that only the Song Thrush and the Redwing can be separated by size from the rest of the thrushes. According to CUISIN thrushes show a high degree of homogeneity in the skull which makes them impossible to identify. The current study of the humerus increases the possibility of identifying species of European thrushes.

V. REFERENCES

ASHLEY J. F. 1941. The study of the structure of the humerus in the Corvidae. *Condor*, **43**: 184-195.

BACHER A. 1967. Vergleichend morphologische Untersuchungen an Einzelknochen des postkranialen Skeletts in Mitteleuropa vorkommender Schwäne und Gänse. Inaugural Dissertation der Tierärztlichen Fakultät der Ludwig-Maximilians-Universität München.

BAUMEL J. J. [ed]. 1979. Nomina anatomica avium, an annotated anatomical dictionary of birds. Academic Press London, New York, Toronto, Sydney, San Francisco.

BERGER A. J. 1957. On the anatomy and relationships of *Fregilupus varius,* an extinct starling from the Mascarene Inlands. *Bulletin American Museum of Natural History*, **113**: 225-272.

BOCK W. J. 1962. The pneumatic fossa of the humerus in the Passeres. *The Auk*, **79**: 425-443.

BOCHEŃSKI Z. 1974. The birds of the Late Quaternary of Poland. PWN, Warszawa-Kraków. [In Polish with English summary].

BOCHEŃSKI Z. 1993. Catalogue of fossil and subfossil birds of Poland. *Acta zoologica cracoviensia,* **36**(2): 329-460.

BOCHEŃSKI Z. M. 1994. The comparative osteology of grebes (Aves: Podicipediformes) and its systematic implications. *Acta zoologica cracoviensia*, **37**(1): 191-346.

BOCHEŃSKI Z. M. & TOMEK T. 1995. How many comparative skeletons do we need to identify a bird bone? *Courrier Forschungsinstitut Senckenberg*, **181**: 357-361.

CRAMP S. (ed). 1988. The Birds of the Western Palearctic, Vol V. Oxford Univ. Press, Oxford, London, New York.

CRAMP S. (ed). 1992. The Birds of the Western Palearctic, Vol VI. Oxford Univ. Press, Oxford, London, New York.

CRAMP S., PERRINS C. M. (eds). 1993. The Birds of the Western Palearctic, Vol VII. Oxford Univ. Press, Oxford, London, New York.

CRAMP S., PERRINS C. M. (eds). 1994. The Birds of the Western Palearctic, Vol VIII - IX. Oxford Univ. Press, Oxford, London, New York.

CUISIN J. 1989. L'Identification des cranes de Passereaux (*Passeriformes: Aves*). Universite de Bourgogne.

DRIESCH von den A. 1976. Das Vermessen von Tierknochen aus vor- und frühgeschichtlichen Siedlungen, (part describing birds): 90-114. München.

ERBERSDOBLER K. 1968. Vergleichend morphologische Untersuchungen an Einzelknochen des postkranialen Skeletts in Mitteleuropa vorkommender mittelgroßer Hühnervögel. Inaugural Dissertation der Tierärztlichen Fakultät der Ludwig-Maximilians-Universität München.

FICK O. 1974. Vergleichend morphologische Untersuchungen an Einzelknochen europäischer Taubenarten. Inaugural Dissertation der Tierärztlichen Fakultät der Ludwig-Maximilians-Universität München.

JÁNOSSY D. 1983. Humeri of Central European Smaller Passeriformes. *Fragmenta mineralogica et palaeontomologica*, **11**: 85-112.

KELLNER M. 1986. Vergleichend morphologische Untersuchungen an Einzelknochen des postkranialen Skeletts in Europa vorkommender Ardeidae. Inaugural Dissertation der Tierärztlichen Fakultät der Ludwig-Maximilians-Universität München.

KOMÁREK V. 1979. Anatomia avium domesticarum. Diel I. Priroda, Bratislava.

KRAFT E. 1972. Vergleichend morphologische Untersuchungen an Einzelknochen nord- und mitteleuropäischer kleinerer Hühnervögel. Inaugural Dissertation der Tierärztlichen Fakultät der Ludwig-Maximilians-Universität München.

LEMBRECHT K. 1933. Handbuch der Palaeornithologie. Gebrüder Borntraeger Berlin.

LANGER G. 1980. Vergleichend morphologische Untersuchungen an Einzelknochen in Mitteleuropa vorkommender mittelgroßer Eulenarten. Inaugural Dissertation der Tierärztlichen Fakultät der Ludwig-Maximilians-Universität München.

LIDAUER R. M. 1982. Die Variabilität von Längenmaßen und Gewicht an Skelettelementen der Singdrossel unter Berücksichtigung der Meßfehler. *Seevögel*, Sonderband: 77-82.

MAYR E. 1958. The sequence of songbird families. *Condor*, **60**: 194-195.

OTTO Ch. 1981. Vergleichend morphologische Untersuchungen an Einzelknochen in Zentraleuropa vorkommender mittelgrosser Accipitridae I. Schädel, Brustbein, Schultergürtel und Vorderextremität. Inaugural Dissertation der Tierärztlichen Fakultät der Ludwig-Maximilians-Universität München.

STORK H. J. 1968. Morphologische Untersuchungen an Drosseln. *Zeitschrift für Wissenchaftliche Zoologie*, **178**: 72-185.

TOMEK T., BOCHEŃSKI Z. M. 2000. The comparative osteology of European corvids (Aves: Corvidae*)*, with a key to the identification of their skeletal elements. Publications of the Institute of Systematics and Evolutions of Animals, Polish Academy of Sciences, Kraków.

WETMORE A. 1957. The classification of the oscine Passeriformes. *Condor*, **59**: 207-209.