ACTA ZOOL. CRACOV.	26	6	167—228	KRAKÓW, 31. XII. 1982

Mieczysław WOLSAN

A Comparative Analysis of the Ribs of Ungulates for Archaeozoological Purposes

[With 14 figs.]

Analiza porównawcza żeber ssaków kopytnych dla archeozoologów

Abstract. Ribs have been compared in respect of morphology in the following species of the ungulates: *Alces alces* (L.), *Bison bonasus* (L.), *Bos primigenius* BOJ., *Bos taurus* L., *Capra hircus* L., *Capreolus capreolus* (L.), *Cervus elaphus* L., *Coelodonta antiquitatis* (BLUM.), *Dama dama* (L.), *Equus caballus* L., *Mammuthus primigenius* (BLUM.), *Ovis aries* L., *Rangifer tarandus* (L.), *Rupicapra rupicapra* (L.), and *Sus scrofa* L., and the intraspecific serial variation of these bones has been characterized, in order to make it possible for archaeozoologists to identify the above-mentioned species on the basis of ribs and their fragments.

CONTENTS

I. Introduction 168
II. Material and methods 169
III. Results 172
1. Os costale 172
1.1. Number of pairs of ribs 172
1.2. Length of os costale 173
1.3. Curvature of os costale 176
2. Dorsal end of rib 176
2.1. Caput costae 176
2.2. Tuberculum costae 177
2.3. Collum costae 183
3. Corpus costae 183
3.1. Transverse section through corpus costae 183
3.2. Breadth of corpus costae 183
3.2.1. Breadth of corpus costae at points A, B and C 183
3.2.2. Greatest breadth of corpus costae 194
3.2.3. Smallest breadth of corpus costae 198
3.3. Thickness of corpus costae 204
3.3.1. Thickness of corpus costae at points A, B and C 204
3.3.2. Greatest thickness of corpus costae 208
3.3.3. Smallest thickness of corpus costae 210
IV. Discussion 212
1. Os costale 212
1.1. Number of pairs of ribs 212
1.2. Length of os costale 214
1.3. Curvature of os costale 217

2. Dorsal end of rib 218
2.1. Caput costae 218
2.2. Tuberculum costae 219
2.3. Collum costae 220
3. Corpus costae 221
3.1. Transverse section through corpus costae 221
3.2. Breadth of corpus costae 221
3.3. Thickness of corpus costae 224
References 226
Streszczenie 228

I. INTRODUCTION

The objective of work is to make it possible for archaeozoologists to identify species of the ungulates on the basis of the morphology of ribs. In addition to the interspecific comparative analyses of these bones presented here, their intraspecific serial variation has also been characterized.

So far the morphology of ribs has been dealt with in a very general manner, mostly in handbooks (e.g. ELLENBERGER & BAUM, 1932; SISSON, 1945; POPLEWSKI, 1948; KLIMOV, 1950; BARONE, 1976) or in publications on the osteology of a species (e.g. BOJANUS, 1827; BRANDT, 1877; FELIX, 1912; JANICKI, 1938; SZANIAWSKI, 1966). There are, however, no satisfactory methods which could be used in determination of the specific membership of ribs, although they constitute a considerable part of the skeleton and are frequently met with in excavations. The causes are to be sought in the large number of morphologically varying ribs in particular individuals and in the great intraspecific variation of these bones. Their fragmentary state in fossil material is an additional difficulty for the archaeozoologist. The author has therefore attempted to find a method which would make the identification of species possible also on the basis of fragmentary ribs.

The species under study belong to those ungulates whose remains are encountered in European archaelogical excavations.

My sincere thanks go to Dr. Lucjan SYCH (Institute of Systematic and Experimental Zoology, Polish Academy of Sciences, Cracow) who supervised this study and who gave me invaluable advice and assistance throughout every phase of it.

For giving me access to the collections I am grateful to Assist Prof. Wanda MALINOWSKA of the Department of Animal Anatomy, Academy of Agriculture, Cracow, to Dr. Barbara PŁYTYCZ of the H. Hoyer Department of Comparative Anatomy, Jagiellonian University, Cracow, to Dr. Janusz WOJTUSIAK of the Department of Systematic Zoology, Jagiellonian University, Cracow, to Dr. Franciszek KOBRYŃCZUK of the Department of Animal Anatomy, Main School of Farming, Warsaw, and to Mr. Bogdan JAKUCZUN of the Tatra National Park.

II. MATERIAL AND METHODS

The following species were examined:

Alces alces (LINNAEUS, 1758) — elk	N=6
Bison bonasus (LINNAEUS, 1758) — European bison	N=6
Bos taurus LINNAEUS, 1758 — cattle	N=6
Capra hircus LINNAEUS, 1758 — goat	N=6
Capreolus capreolus (LINNAEUS, 1758) — roe-deer	N=6
Cervus elaphus LINNAEUS, 1758 — red deer	N=6
Coelodonta antiquitatis (BLUMENBACH, 1807) — woolly rhinoceros	N=2
Dama dama (LINNAEUS, 1758) — fallow deer	N=6
Equus caballus LINNAEUS, 1758 — horse	N=8
Ovis aries LINNAEUS, 1758 — sheep	N=6
Rangifer tarandus (LINNAEUS, 1758) — reindeer	N=6
Rupicapra rupicapra (LINNAEUS, 1758) — chamois	N=6
Sus scrofa LINNAEUS, 1758 — pig	N=6

The ribs of the domesticated and wild forms of *Sus scrofa* L. are similar; the author had too scanty material at his disposal to be able to recognize the small differences found as sufficient to discriminate these forms. The observations and discussion presented in the paper refer to the domestic form. Part IV of this paper, devoted to discussion, includes data on the ribs of the aurochs, *Bos primigenius* BOJANUS, 1827, and mammoth, *Mammuthus primigenius* (BLUMENBACH, 1799), quoted from available literature.

Adult specimens were examined. The specimen of *Coelodonta antiquitatis* (BLUM.) of an indeterminate sex, derived from Podbaba near Prague (Czechoslovakia) and stored in the Zoological Museum, Jagiellonian University, Cracow, is an exception, which BORSUK-BIAŁYNICKA (1973) placed in the young-adult group. Some earlier authors (STACH, 1930; BIEDA, 1969) claim that the female of this species found at Starunia (Ukrainian SSR — USSR) in 1929, one of the two specimens examined in this paper, being in the possession of the Institute of Systematic and Experimental Zoology, Polish Academy of Sciences, Cracow, was a young animal. However, some characters of the skull (ossified nasal septum, erupted third molar) indicate its adult age.

On account of the sexual dimorphism of ribs (KOCH, 1932; JANICKI, 1938; JUŚKO, 1953; KOBRYŃ, 1973) attempts were made to include equal numbers of females and males in the study material.

The author dealt only with the bony parts of ribs (ossa costalia).

The specimens examined come from the collections of the Institute of Systematic and Experimental Zoology, Polish Academy of Sciences, Cracow, the Department of Animal Anatomy, Academy of Agriculture, Cracow, the H. Hoyer Department of Comparative Anatomy and the Zoological Museum,

Jagiellonian University, Cracow, the Department of Animal Anatomy, Main School of Farming, Warsaw, the Tatra National Park and, in several cases, immediately from dissections.

Definitions of measurements

1. Length of os costale along its curvature — the shortest distance between facies articularis capitis costae and the distal point of substantia compacta, measured along margo anterior (Fig. 1a, 1—1).

Points A, B and C are placed successively at two-tenths, five-tenths and nine-tenths of this length, measuring from the dorsal end towards the ventral (Figs. 1a and 3).

2. Greatest diameter of caput costae — the greatest distance between the

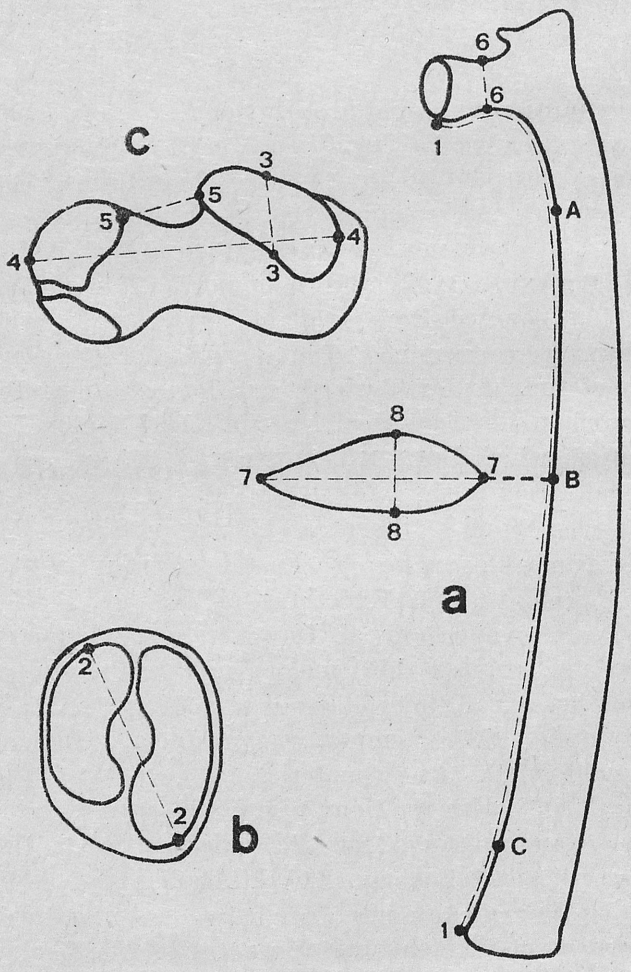

Fig. 1. Measurements applied in this study (for explanation see Defs. 1—8 in the text)

point of facies articularis capitis costae anterior and the point of facies articularis capitis costae posterior (Fig. 1b, 2—2).

3. Diameter of tuberculum costae — the diameter of facies articularis tuberculi costae (Fig. 1c, 3—3).

4. Spread of the dorsal end of the rib — the greatest distance between the proximal point of caput costae and the point of facies articularis tuberculi costae (Fig. 1c, 4—4).

5. Length of collum costae — the shortest distance between facies articularis capitis costae posterior and facies articularis tuberculi costae (Fig. 1c, 5—5).

6. Breadth of collum costae — the shortest distance between margo an-

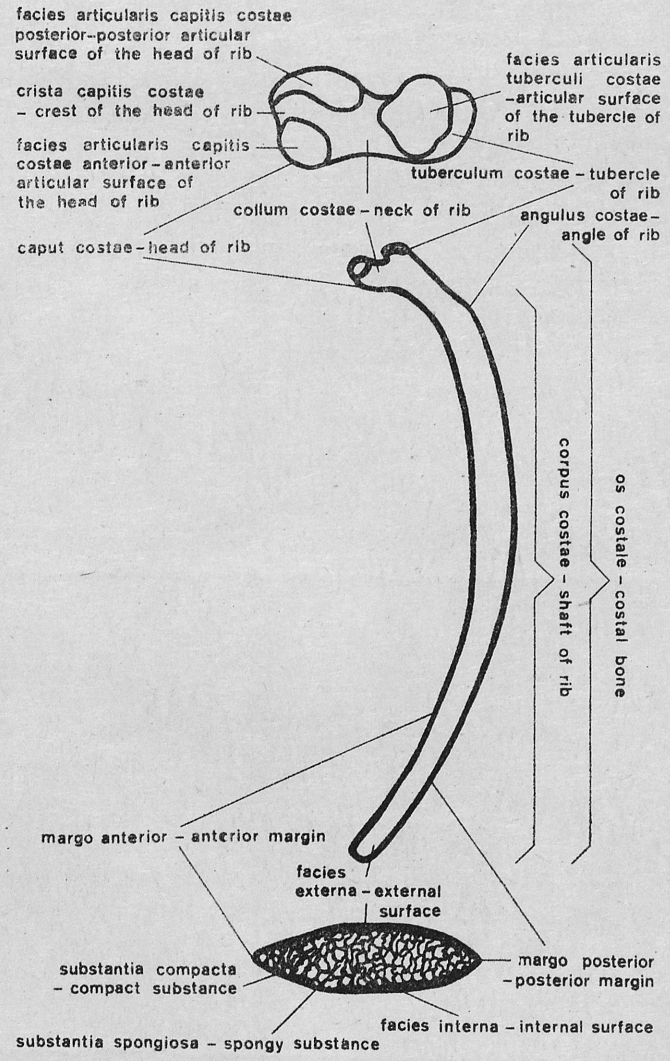

Fig. 2. Explanations of anatomical terms used

terior and the edge that extends dorsally between caput costae and tuberculum costae (Fig. 1a, 6—6).

7. Breadth of corpus costae — the distance bwtween margo anterior and margo posterior (Fig. 1a, 7—7).

8. Thickness of corpus costae — the distance between facies externa and facies interna, measured along the straight line perpendicular to the line that passes through margo anterior and margo posterior (Fig. 1a, 8—8).

Some of the definitions of measurements are based on those in DUERST (1930) and partly modificated. The remaining ones have been proposed by the author. The measurements were taken by means of a slide caliper and a string was used to measure the length of os costale along its curvature.

The mean values of the measurements are given in tables and graphs. The figures in brackets represent the numbers of specimens used to calculate the given values, if they were smaller than the numbers given on p. 169. The symbol "—" indicates that the measurement was not taken because the rib showed pathological lesions, was damaged or lacking, and "abs." is used if its build was the cause of that.

The drawings were made from original specimens; in the case of *Coelodonta antiquitatis* (BLUM.), on the basis of the skeleton from Starunia, in which the ribs of pair III are missing and the remaining ones are mostly damaged (their restorations are given in the drawings). The drawings were made only for 4—5, mostly homologous, ribs, for the serial variation of ribs and variation in shape of a single rib are almost continuous, which permits the reader to conjecture the appearance of the remaining ribs and their regions on the basis of the data given in this paper.

The Latin nomenclature is taken from STELMASIAK (1979) (see Fig. 2).

III. RESULTS

In order to facilitate the use of the data presented in this paper, the observations and discussion are arranged according to the anatomic regions of the rib (see the Contents).

1. Os costale

The basic differences in the morphology of os costale between *Coelodonta antiquitatis* (BLUM.), *Equus caballus* L., *Sus scrofa* L. and the ruminants (exemplified by *Bos taurus* L.) are illustrated in Fig. 3.

1.1. Number of pairs of ribs

Alces alces (L.)	13
Bison bonasus (L.)	14

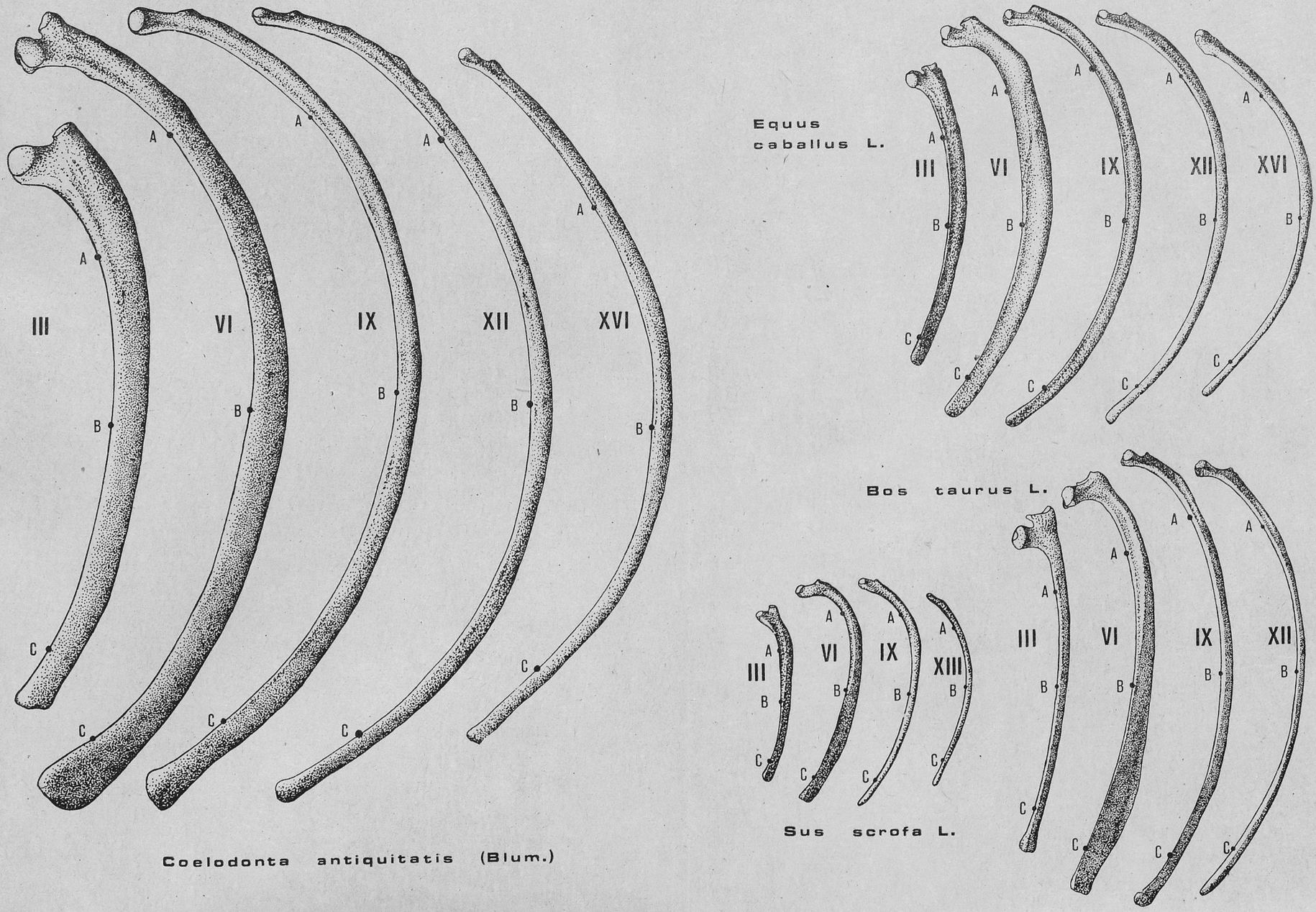

Fig. 3. Left ribs arranged in a plane ($x\frac{1}{6}$); A, B, C — places in which transverse sections were performed (see Def. 1).

Drawings of the ribs of the species examined in this work are also presented in publications of the following authors: *Alces alces* (L.): Pilarski & Roskosz (1959: Pls. II and III) — last posterior ribs: *Bison bonasus* (L.): Janicki (1938: Pl. III) — I—XIV; *Bos taurus* L.: Ellenberger & Baum (1932: Fig. 74) — VII, Sisson (1945: Figs. 127 and 128) — I and VIII, Poplewski (1948: Fig. 93) — VI, Klimov (1950: Fig. 42) — a rib, Nickel et al. (1954: Fig. 60) — XI, Gill et al. (1957: Fig. 64) — a rib, Dobberstein & Hoffmann (1961: Fig. 45) — XI, Krysiak (1975: Fig. 34) — XI, Barone (1976: Pls. 212 and 213) — III and XI, Lutnicki (1977: Pl. XXXIV) — two ribs; *Cervus elaphus* L.: Roskosz & Pytel (1966 Pl.: XIII) — last posterior ribs; *Coelodonta antiquitatis* (Blum.): Lubicz-Niezabitowski (1914b: Pl. LV) — I, Gordeev & Žernakov (1957: Pl. III) — I—XIX; *Equus caballus* L.: Chauveau (1890: Fig. 55) — V and IX, Hoyer (1927: Fig. 42) — VII, Elleberger & Baum (1932: Figs. 75 and 91) — IV, Sisson (1945: Figs. 22—24 and 27) — I and VIII, Poplewski (1948: Fig. 92) — VI, Klimov (1950: Fig. 42) — a rib, Nickel et al. (1954: Figs. 61 and 62) — III and XIII, Gill et al. (1957: Fig. 64) — a rib, Dobberstein & Hoffmann (1961: Figs. 48 and 49) — III and XIII, Krysiak (1975: Fig. 34) — III and XIII, Barone (1976: Pls. 209 and 210) — III and XI, Lutincki (1977: Pl. XXXIV) — two ribs; *Ovis aries* L.: Ellenberger & Baum (1932: Fig. 73) — VIII, Lutnicki (1977: Pl. XXXIV) — a rib; *Sus scrofa* L.: Ellenberger & Baum (1932: Fig. 72) — VIII, Sisson (1945: Figs. 175 and 176) — I and VIII, Klimov (1950: Fig. 42) — a rib, Nickel et al. (1954: Fig. 59) — XI, Gill et al. (1957: Fig. 64) — a rib. Dobberstein & Hoffmann (1961: Fig. 46) — XI, Krysiak (1975: Fig. 34) — XI, Lutnicki (1977: Pl. XXXIV) — a rib

Bos taurus L.	13
Capra hircus L.	13
Capreolus capreolus (L.)	13
Cervus elaphus L.	13
Coelodonta antiquitatis (BLUM.)	17—18 *
Dama dama (L.)	13
Equus caballus L.	18
Ovis aries L.	13
Rangifer tarandus (L.)	14
Rupicapra rupicapra	13
Sus scrofa L.	14—16 (14 — N=4, 15 — N=1, 16 — N=1)

1.2. Length of os costale

(On the basis of measurements of the length of os costale along its curvature — Def. 1)

It increases starting from rib I, which is the shortest, to the group of ribs (last sternal and first asternal ribs) which are more or less equal in this respect, and next decreases to the last posterior rib (Figs. 3 and 4; Table 1).

The following pairs of ribs reach the maximum length:

Alces alces (L.)	VIII or IX (VIII — N=1, IX — N=5)
Bison bonasus (L.)	IX or X (IX — N=2, X — N=4)
Bos taurus L.	IX or X (IX — N=4, X — N=2)
Capra hircus L.	VII, VIII or IX (VII — N=1, VIII — N=4, IX — N=1)
Capreolus capreolus (L.)	VIII or IX (VIII — N=1, IX — N=5)
Cervus elaphus L.	IX (N=6)
Coelodonta antiquitatis (BLUM.)	X (N=2)
Dama dama (L.)	IX (N=5)
Equus caballus L.	IX or X (IX — N=1, X — N=7)

* Neither of the examined specimens of *Coelodonta antiquitatis* (BLUM.) has a complete set of ribs. However, as regards the specimen from Starunia, it may be stated for certain on the basis of the bones preserved that it had 18 pairs of ribs originally. It is much more difficult to determine the number of the pairs of these bones in the specimen from Podbaba. BORSUK-BIAŁYNICKA (1973) writes that it had probably 18 thoracic vertebrae (of which two are not mounted) and 4 lumbar vertebrae. This indicates the occurrence of 18 pairs of ribs. Nevertheless, in addition to the uncomplete skeleton mounted in the Zoological Museum, Jagiellonian University, Cracow, there are also some bony elements of *Coelodonta antiquitatis* (BLUM.), of which at least several ribs and a vertebra or two belonged, in my opinion, to this specimen. One of the vertebrae probably comes from the lumbar region of the vertebral column, which would suggest that the specimen from Podbaba had 5 lumbar and 17 thoracic vertebrae and then 17 pairs of ribs. That is not quite sure though, because both the detached vertebrae and most of those mounted were damaged and partly restored, not always quite in accordance with the original state. Moreover, the skeleton is mounted, which adds to the difficulties in comparison. It can be stated beyond doubt only that primarily this specimen had not fewer than 16 pairs of ribs and not more than 18.

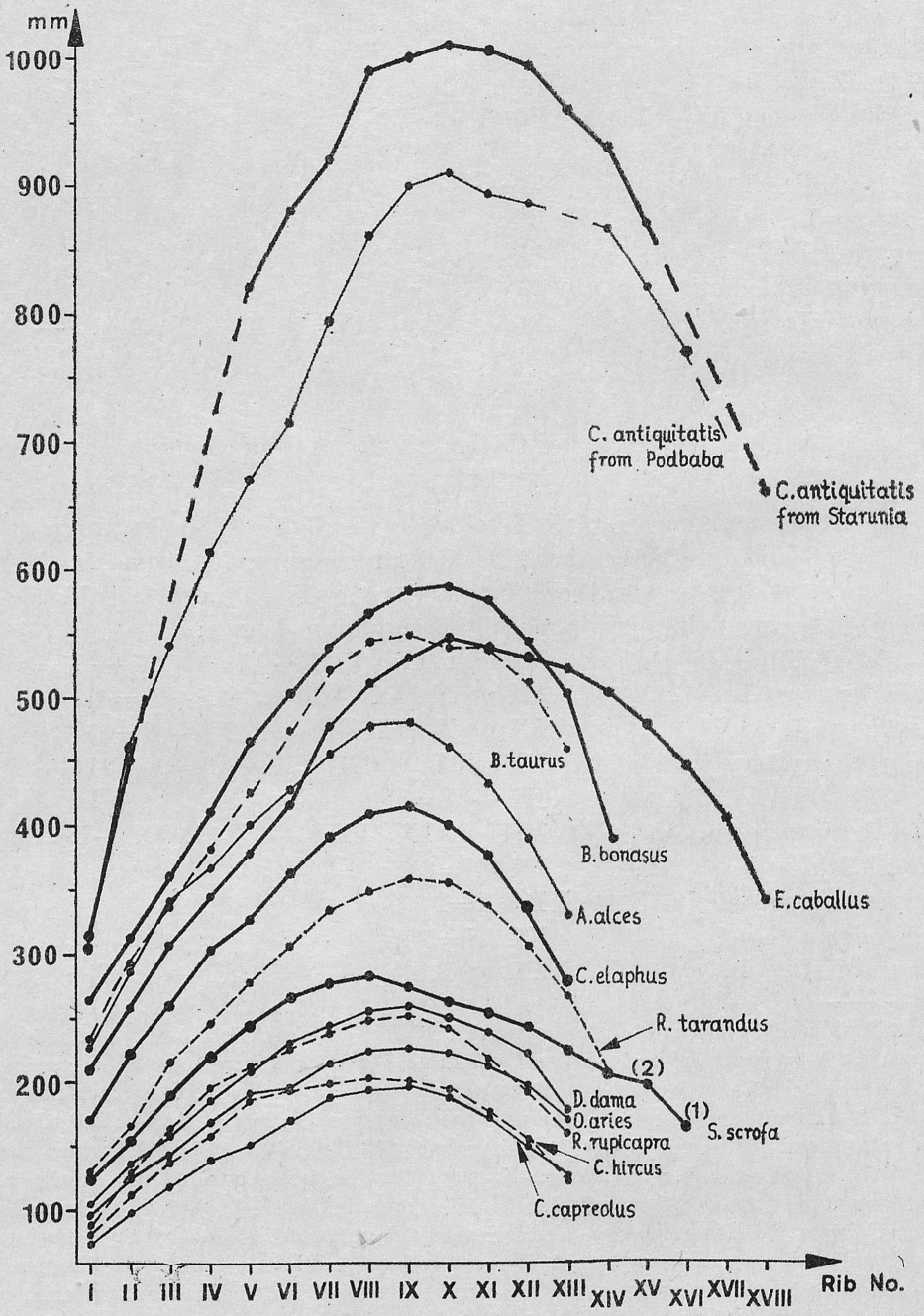

Fig. 4. Curves representing serial variation in the length of os costale along its curvature (Def. 1; see Table 1) — for details see p. 172

The length of os costale along its curvature, in mm (Def. 1; see Fig. 4) — for details see p. 172

The numerical values of the length along the curvature are given also by BOJANUS (1827) for ribs I and IX of *Bison bonasus* (L.) (along margo posterior), by KOCH (1932: Table 22) for chosen ribs of 20 specimens of this species, by JANICKI (1938: Table 44) for the ribs of 3 specimens of the same species, by SZANIAWSKI (1966: Table 3) for the ribs of 22 specimens of *Cervus elaphus* L. and by KOBRYŃ (1973: Table 3) for the ribs of the specimens mentioned in the foot-note on p. 218. ALLEN (cited by MOHR, 1952) gives the lengths for several ribs of *Bison bonasus* (L.), JUŚKO (1953: Table IX) — for the ribs of 8 specimens of this species, ROSKOSZ & PYTEL (1966) — for several ribs of pair XIV of *Cervus elaphus* L., and LEISERING et al. (1890) and ELLENBERGER & BAUM (1932) — for several ribs of *Equus caballus* L.

Species / Rib	Alces alces (L.)	Bison bonasus (L.)	Bos taurus L.	Capra hircus L.	Capreolus capreolus (L.)	Cervus elaphus L.	Coelodonta antiquitatis (Blum.) Starunia	Coelodonta antiquitatis (Blum.) Podbaba	Dama dama (L.)	Equus caballus L.	Ovis aries L.	Rangifer tarandus (L.)	Rupicapra rupicapra (L.)	Sus scrofa L.
I	229	264	232	81	73	170	315	305	103	211	95	128	88	125
II	287	312	294	112	99	222	450	460	135	258	126	166	128	153
III	340	361	337	138	121	261	-	540	160	305	141	215	162	190
IV	367	410	380	158	140	302	-	615	187	344	168	245	195	220
V	400	464	424	186	153	325	820	670	210	377	189	277	212	244
VI	428	503	473	195	170	362	880	715	230	416	196	305	227	265
VII	454	539	520	199	189	389	920	795	244	476	215	334	238	277
VIII	476	566	544	202	195	408	990	860	256	510	224	347	248	283
IX	479	584	547	199	197	414	1000	900	260	531	226	360	252	273
X	459	587	540	194	189	399	1010	910	251	544	222	357	242	263
XI	433	576	538	173	172	376	1005	895	238	538	212	338	217	255
XII	391	543	510	154	151	335	995	885	222	531	196	306	192	242
XIII	331	502	457	124	125	277	960	-	178	521	170	266	160	224
XIV		390					930	865		502		206		206
XV							670	820		477				(2) 198
XVI							-	770		445				(1) 185
XVII							-	-		405				
XVIII							660			341				

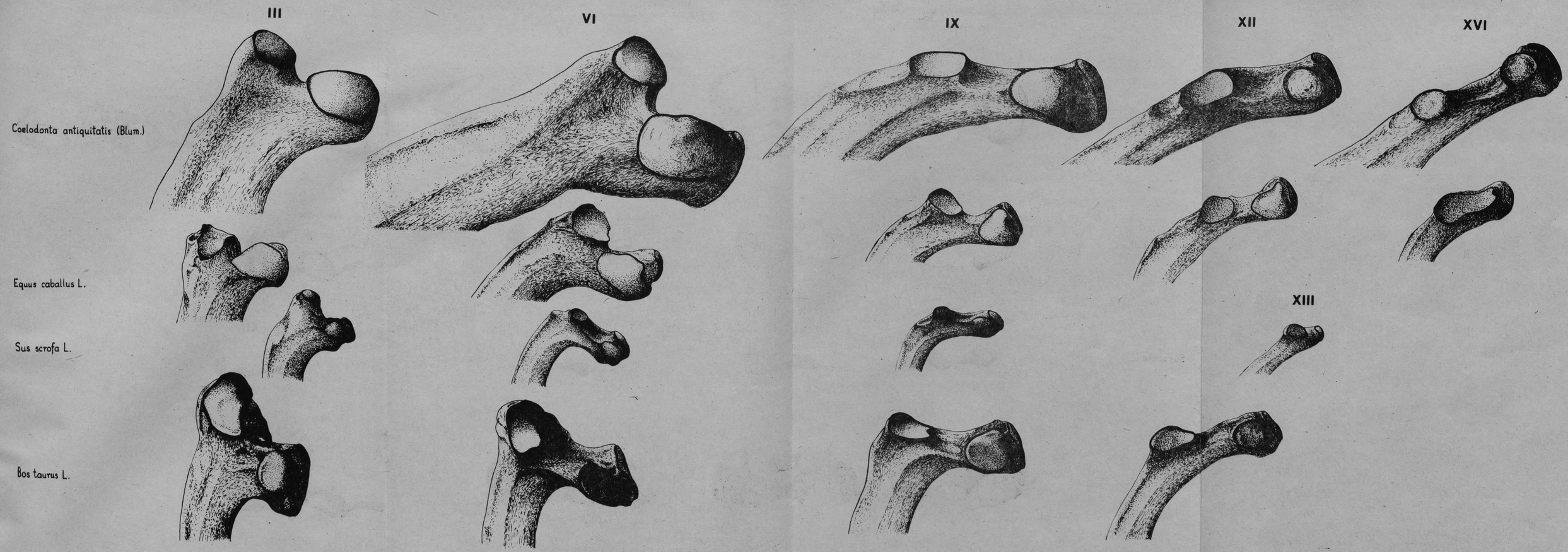

Fig. 5. Dorsal ends of left ribs in ventral view (natural size).

Drawings of the dorsal ends of the ribs of the species examined in this work are also presented in publications of the following authors: *Coelodonta antiquitatis* (Blum.): Brandt (1877: Pl. VII) — two ribs; *Equus caballus* L.: Nickel et al. (1954: Figs. 55—57) — II, VII and XVII, Dorberstein & Hoffmann (1961: Figs. 42—44) — II, VII and XVII, Krysiak (1975: Fig. 35) — II, VII and XVII, Barone (1976: Pl. 211) — I, V, IX, XV and XVII, Lutnicki (1977: Pl. XXXIV) — a rib

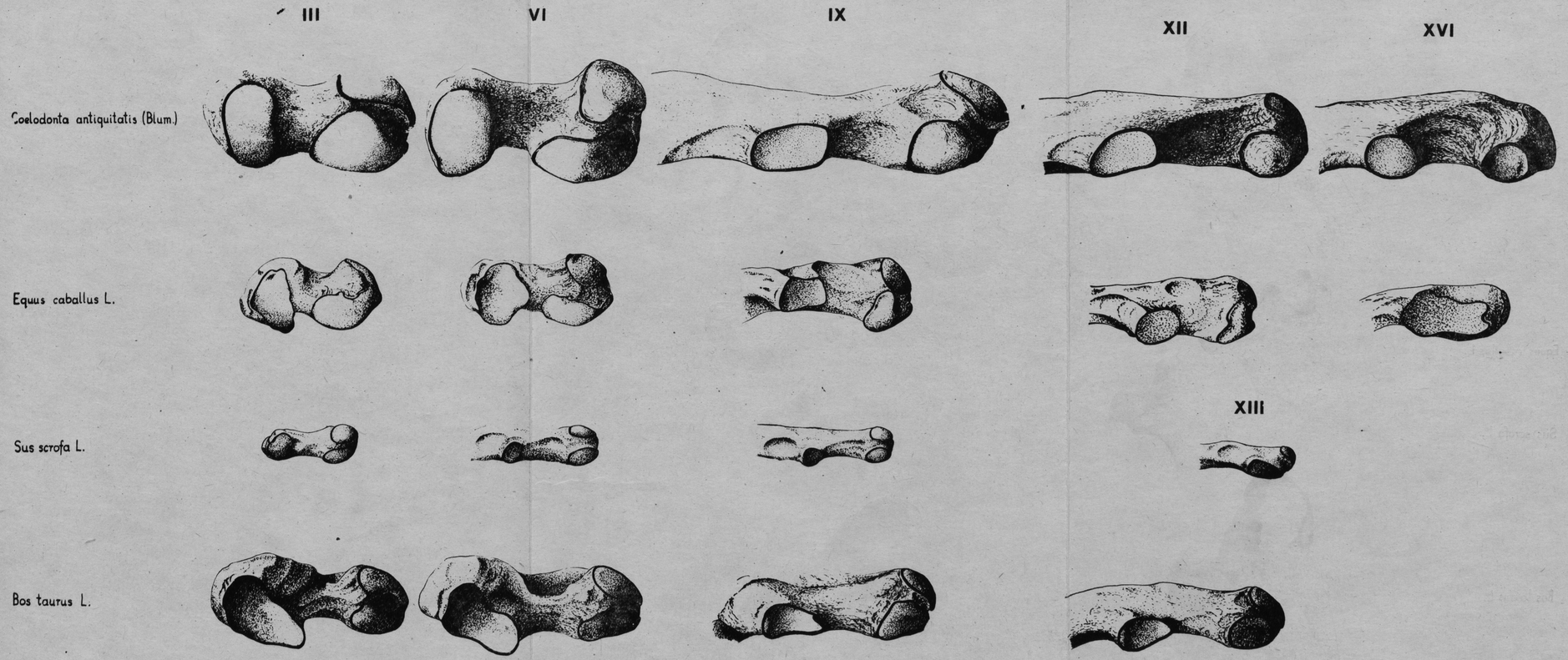

Fig. 6. Dorsal ends of left ribs in dorsal view (natural size) — see Fig. 5

Ovis aries L.	VIII or IX (VIII — N=2, IX — N=4)
Rangifer tarandus (L.)	VIII, IX or X (VIII — N=1, IX — N=4, X — N=1)
Rupicapra rupicapra (L.)	VIII or IX (VIII — N=1, IX — N=5)
Sus scrofa L.	VII or VIII (VII — N=1, VIII — N=5)

1.3. Curvature of os costale (Fig. 3)

The degree of the bend in corpus costae increases from rib I, in which corpus costae is almost straight, to the group of the ribs with the smallest curvature radius, to decrease slightly in the last few posterior ribs.

In the first anterior ribs collum costae and corpus costae form an approximately right angle; it gradually becomes more obtuse in the following ribs, approaching 180° in the last posterior ribs. This angle is generally less obtuse in the artiodactyls under study than in the perissodactyls.

The perissodactyls examined have their ribs generally more bent than the artiodactyls. The ribs of *Coelodonta antiquitatis* (BLUM.) are more bent than those of *Equus caballus* L., and in the artiodactyls the degree of bend generally increases with decrease in the body size; in the smallest species it reaches similar values to those in the perissodactyls. The anterior ribs of *Sus scrofa* L. are particularly remarkably bent in the region of angulus costae.

2. Dorsal end of rib

The differences in the morphology of the dorsal end of the rib between *Coelodonta antiquitatis* (BLUM.), *Equus caballus* L., *Sus scrofa* L. and *Bos taurus* L. are illustrated in Figs. 5 and 6; some small differences are observed here in the ruminants examined but, as regards determination of species, they are of no major importance, owing to the comparatively great intraspecific variation of this region of the rib.

2.1. Caput costae

The morphology of facies articularis capitis costae anterior and facies articularis capitis costae posterior permits the discrimination of *Coelodonta antiquitatis* (BLUM.), *Equus caballus* L., *Sus scrofa* L. and the ruminants (Figs. 5 and 6).

In *Sus scrofa* L. the above-mentioned articular surfaces are separated from each other by crista capitis costae (in the case of the skeleton with 16 pairs of ribs no facies articularis capitis costae anterior was found on the last posterior pair of ribs). As regards *Coelodonta antiquitatis* (BLUM.), these surfaces were observed to touch each other only on the ribs of pair V in the specimen from Starunia (the ribs of pairs XVIII of this specimen lack facies articularis capitis costae posterior). In *Equus caballus* L. they are frequently contiguous

on the first anterior ribs (in one specimen this was also seen in pair XVIII). The contact of the articular surfaces of caput costae on the anterior ribs (occasionally also on the posterior ones) is a particularly frequent occurrence in the ruminants (most frequent in *Bos taurus* L.).

In *Equus caballus* L. and *Sus scrofa* L. it comes to the junction of facies articularis capitis costae posterior with facies articularis tuberculi costae on the last posterior ribs (see Section 2.3).

In *Equus caballus* L. the greatest diameter of caput costae (Def. 2) generally decreases from the first anterior ribs to the last posterior ones and in *Coelodonta antiquitatis* (BLUM.) it grows to pair V and next decreases. In the artiodactyls examined it increases distinctly on the last posterior ribs, whereas on the preceding ones it either generally increases (*Ovis aries* L. and *Sus scrofa* L.) or decreases (remaining species) (Fig. 7; Table 2).

2.2. Tuberculum costae

The prominence of tuberculum costae decreases gradually from the anterior ribs to the posterior; it reaches a particularly great height on the anterior ribs of *Sus scrofa* L. (Figs. 3 and 5).

The size of facies articularis tuberculi costae generally decreases from the anterior ribs to the posterior (Figs. 5 and 6; Tables 3a and 3b). On the last posterior ribs of *Coelodonta antiquitatis* (BLUM.), *Equus caballus* L. and *Sus scrofa* L. this articular surface is very elongate, in the case of the last two species owing to the junction with facies articularis capitis costae posterior (see Section 2.3.). In the ruminants examined tuberculum costae is often reduced to a small process void of any articular surface. No facies articularis tuberculi costae was found on the following ribs:

Alces alces (L.)	XIII (N=4)
Bison bonasus (L.)	XIV (N=4)
Bos taurus L.	XIII (N=6)
Capra hircus L.	XI (N=2), XII and XIII (N=6)
Capreolus capreolus (L.)	XI, XII and XIII (N=6)
Cervus elaphus L.	XII (N=2) ahd XIII (N=6)
Dama dama (L.)	XII and XIII (N=6)
Ovis aries L.	XII (N=3) and XIII (N=6)
Rangifer tarandus (L.)	XIV (N=1)
Rupicapra rupicapra (L.)	XIII (N=2)

In *Coelodonta antiquitatis* (BLUM.), *Equus caballus* L. and *Sus scrofa* L. the outline of facies articularis tuberculi costae is subcircular on most ribs and in the ruminants examined it resembles an ellipse (Figs. 5 and 6; Table 4).

This surface is flat or nearly flat on all the ribs of *Coelodonta antiquitatis* (BLUM.), *Equus caballus* L. and *Sus scrofa* L.; in the ruminants examined it is concave (less so on the first anterior ribs than on the following ones) except the last posterior ribs, on which it becomes flat (Figs. 3, 5 and 6).

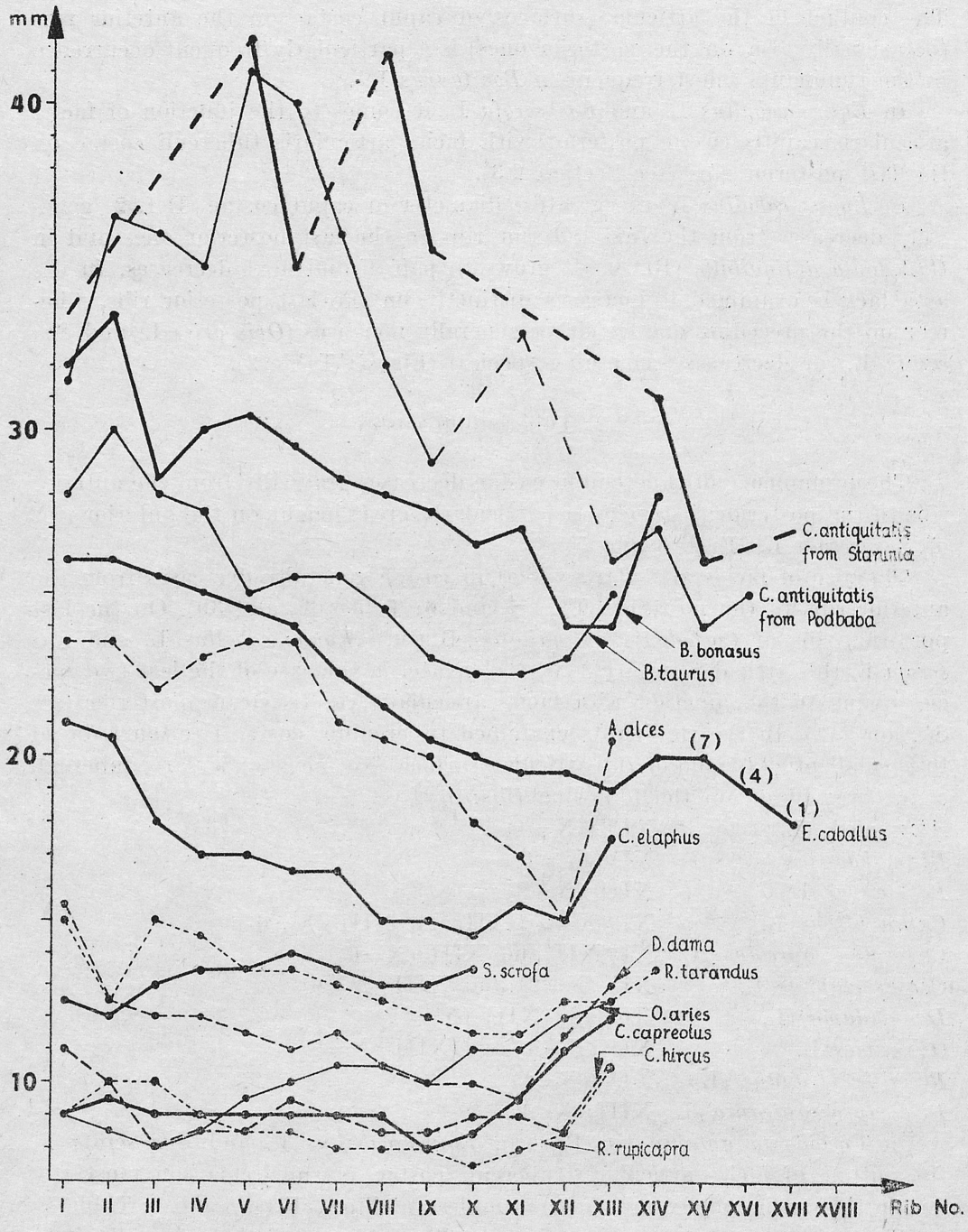

Fig. 7. Curves representing serial variation in the greatest diameter of caput costae (Def. 2: see Table 2) — for details see p. 172

Table 2

The greatest diameter of caput costae, in mm (Def. 2; see Fig. 7) — for details see p. 172

JANICKI (1938: Table 44) and KOBRYŃ (1973: Table 7) give the numerical values of the diameter of caput costae for the ribs of, respectively, 3 specimens of *Bison bonasus* (L.) and the specimens mentioned in the foot-note on p. 218

Species / Rib	Alces alces (L.)	Bison bonasus (L.)	Bos taurus L.	Capra hircus L.	Capreolus capreolus (L.)	Cervus elaphus L.	Coelodonta antiquitatis (Blum.) Starunia	Coelodonta antiquitatis (Blum.) Podbaba	Dama dama (L.)	Equus caballus L.	Ovis aries L.	Rangifer tarandus (L.)	Rupicapra rupicapra (L.)	Sus scrofa L.
I	23.5	32.0	28.0	11.0	9.0	21.0	-	31.5	15.5	26.0	9.0	15.0	9.0	12.5
II	23.5	33.5	30.0	10.0	9.5	20.5	-	36.5	12.5	26.0	8.5	12.5	10.0	12.0
III	22.0	28.5	28.0	8.0	9.0	18.0	-	36.0	12.0	25.5	8.0	15.0	10.0	13.0
IV	23.0	30.0	27.5	8.5	9.0	17.0	-	35.0	12.0	25.0	8.5	14.5	9.0	13.5
V	23.5	30.5	25.0	8.5	9.0	17.0	42.0	41.0	11.5	24.5	9.5	13.5	8.5	13.5
VI	23.5	29.5	25.5	9.5	9.0	16.5	35.0	40.0	11.0	24.0	10.0	13.5	8.5	14.0
VII	21.0	28.5	25.5	9.0	9.0	16.5	-	36.0	11.5	22.5	10.5	13.0	8.0	13.5
VIII	20.5	28.0	24.5	8.5	9.0	15.0	41.5	32.0	10.5	21.5	10.5	12.5	8.0	13.0
IX	20.0	27.5	23.0	8.5	8.0	15.0	35.5	29.0	10.0	20.5	10.0	12.0	8.0	13.0
X	18.0	26.5	22.5	9.0	8.5	14.5	-	-	10.0	20.0	11.0	11.5	7.5	13.5
XI	17.0	27.0	22.5	9.0	9.5	15.5	-	33.0	9.5	19.5	11.0	11.5	8.0	abs.
XII	15.0	24.0	23.0	8.5	11.0	15.0	-	-	11.5	19.5	12.0	12.5	8.5	abs.
XIII	20.5	24.0	25.0	10.5	12.0	17.5	-	26.0	13.0	19.0	12.5	12.5	10.5	abs.
XIV		28.0					31.0	27.0		20.0		13.5		abs.
XV							26.0	24.0		(7) 20.0 (1) abs.				(2) abs.
XVI							-	25.0		(4) 19.0 (4) abs.				(1) abs.
XVII							-	-		(1) 18.0 (7) abs.				
XVIII							abs.			abs.				

Table 3a

The greatest diameter of tuberculum costae, in mm (Def. 3) — for details see p. 172

JANICKI (1938: Table 44) gives the numerical values of two diameters of tuberculum costae for the ribs of 3 specimens of *Bison bonasus* (L.)

Species / Rib	Alces alces (L.)	Bison bonasus (L.)	Bos taurus L.	Capra hircus L.	Capreolus capreolus (L.)	Cervus elaphus L.	Coelodonta antiquitatis (Blum.) Starunia	Coelodonta antiquitatis (Blum.) Podbaba	Dama dama (L.)	Equus caballus L.	Ovis aries L.	Rangifer tarandus (L.)	Rupicapra rupicapra (L.)	Sus scrofa L.
I	25.0	36.0	28.5	10.0	12.0	23.0	-	30.5	13.5	24.0	16.5	17.0	11.0	12.0
II	24.5	32.5	27.5	9.5	10.5	22.5		25.0	13.5	19.5	14.0	17.0	10.0	9.0
III	23.5	33.5	27.0	10.0	11.0	23.5	-	26.0	15.0	17.5	14.5	16.5	10.5	9.5
IV	23.5	31.0	27.0	10.0	9.5	21.0	-	26.0	12.0	18.0	13.0	15.0	10.5	9.5
V	23.5	29.5	27.0	10.0	9.5	21.0	23.0	24.0	12.5	17.0	12.5	13.0	10.0	9.5
VI	22.5	30.5	27.0	10.0	10.0	20.5	27.0	23.0	12.5	17.5	12.0	13.5	9.5	9.0
VII	20.0	30.5	25.0	9.5	8.5	19.5	21.0	22.5	12.5	16.5	11.5	11.5	9.5	7.0
VIII	19.0	28.5	22.0	7.0	7.5	18.0	-	22.0	8.5	15.0	9.5	9.5	9.0	7.0
IX	17.0	30.5	20.5	6.5	7.0	15.0	-	21.5	8.0	14.5	8.5	9.5	8.0	7.5
X	14.5	30.0	21.5	5.5	8.0	15.5	-	20.0	9.0	14.0	8.0	9.5	6.5	6.5
XI	13.0	25.5	18.5	(4) 4.5 (2) 0.0	0.0	14.0	25.0	21.0	8.5	14.0	8.0	8.0	6.5	15.0*
XII	11.5	25.0	16.0	0.0	0.0	(4) 11.0 (2) 0.0	-	-	0.0	13.5	(3) 7.5 (3) 0.0	8.5	7.0	11.5*
XIII	(2) 14.0 (4) 0.0	26.0	0.0	0.0	0.0	0.0	22.0	22.0	0.0	14.0	0.0	10.0	(4) 5.5 (2) 0.0	11.0*
XIV		(2) 25.0 (4) 0.0					19.0	23.0		14.0		(5) 9.0 (1) 0.0		10.0*
XV							14.0	21.0		(7) 14.0 (1) 27.0 *				(2) 9.0*
XVI							-	20.0		(4) 14.0 (4) 28.0 *				(1) 12.5*
XVII							-	-		(1) 20.0 (7) 27.5 *				
XVIII							28.0			(7) 27.0 * (1) 34.0 **				

* Measurement taken for facies articularis tuberculi costae fused with facies articularis capitis costae posterior.

** Measurement taken for facies articularis tuberculi costae, facies articularis capitis costae posterior and facies articularis capitis costae anterior fused.

Table 3b

The smallest diameter of tuberculum costae, in mm (Def. 3; see Table 3a) — for details see p. 172

Species / Rib	Alces alces (L.)	Bison bonasus (L.)	Bos taurus L.	Capra hircus L.	Capreolus capreolus (L.)	Cervus elaphus L.	Coelodonta antiquitatis (Blum.) Starunia	Coelodonta antiquitatis (Blum.) Podbaba	Dama dama (L.)	Equus caballus L.	Ovis aries L.	Rangifer tarandus (L.)	Rupicapra rupicapra (L.)	Sus scrofa L.
I	19.0	28.0	20.0	7.5	8.0	14.0	-	23.0	10.5	16.5	6.5	12.5	8.0	9.0
II	12.0	20.0	17.5	5.5	6.0	12.5	-	19.0	9.0	13.5	5.0	10.5	7.0	7.0
III	16.0	21.5	17.5	6.5	6.5	11.5	-	19.0	9.0	11.5	5.5	10.0	7.0	6.5
IV	14.5	20.0	17.0	7.0	7.5	10.5	-	20.0	8.5	12.5	6.0	8.5	6.0	7.0
V	12.5	21.0	16.0	6.0	6.5	12.0	19.5	23.5	9.0	13.5	5.5	8.5	6.0	7.0
VI	13.0	20.5	15.0	5.0	6.0	10.0	18.5	22.5	8.0	14.0	5.5	8.0	6.0	7.0
VII	11.5	20.0	14.5	5.5	6.0	8.5	13.0	21.5	6.5	13.5	5.5	7.5	7.0	5.5
VIII	10.5	16.5	12.0	5.5	5.5	9.5	-	19.5	6.0	12.5	4.5	6.5	6.5	6.5
IX	10.0	19.5	11.0	5.0	5.0	9.0	-	19.0	4.5	10.5	5.5	5.5	6.0	6.0
X	9.0	16.5	9.5	3.5	5.0	8.5	-	18.5	4.0	10.0	5.0	6.0	5.0	5.5
XI	9.0	15.0	9.0	(4) 3.5 (2) 0.0	0.0	7.0	18.0	13.5	4.0	11.0	6.0	6.0	5.0	5.5 *
XII	9.0	15.0	8.5	0.0	0.0	(4) 7.0 (2) 0.0	-	-	0.0	11.0	(3) 4.0 (3) 0.0	6.5	3.5	6.0 *
XIII	(2) 10.5 (4) 0.0	15.0	0.0	0.0	0.0	0.0	18.0	15.0	0.0	11.5	0.0	5.5	(4) 3.0 (2) 0.0	7.0 *
XIV		(2) 14.0 (4) 0.0					15.0	15.0		12.5		(5) 5.0 (1) 0.0		7.0 *
XV							10.0	13.5		(7) 11.5 (1) 10.0 *				(2) 6.5 *
XVI							-	11.5		(4) 12.5 (4) 9.5 *				(1) 7.5 *
XVII							-	-		(1) 12.5 (7) 9.5 *				
XVIII							14.0			(7) 10.0 * (1) 10.0 **				

* Measurement taken for facies articularis tuberculi costae fused with facies articularis capitis costae posterior.

** Measurement taken for facies articularis tuberculi costae, facies articularis capitis costae posterior and facies articularis capitis costae anterior fused.

Table 4

The $\frac{\text{greatest diameter of tuberculum costae}}{\text{smallest diameter of tuberculum costae}}$ index (see Tables 3 a and 3 b) — for details see p. 172

Species / Rib	Alces alces (L.)	Bison bonasus (L.)	Bos taurus L.	Capra hircus L.	Capreolus capreolus (L.)	Cervus elaphus L.	Coelodonta antiquitatis (Blum.) Starunia	Coelodonta antiquitatis (Blum.) Podbabs	Dama dama (L.)	Equus caballus L.	Ovis aries L.	Rangifer tarandus (L.)	Rupicapra rupicapra (L.)	Sus scrofa L.
I	1.3	1.3	1.4	1.3	1.5	1.6	-	1.3	1.3	1.5	2.5	1.4	1.4	1.3
II	2.0	1.6	1.6	1.7	1.8	1.8	-	1.3	1.5	1.4	2.8	1.6	1.4	1.3
III	1.5	1.6	1.5	1.5	1.7	2.0	-	1.4	1.7	1.5	2.6	1.7	1.5	1.5
IV	1.6	1.6	1.6	1.4	1.3	2.0	-	1.3	1.4	1.4	2.2	1.8	1.8	1.4
V	1.9	1.4	1.7	1.7	1.5	1.8	1.2	1.0	1.4	1.3	2.3	1.5	1.7	1.4
VI	1.7	1.5	1.8	2.0	1.7	2.1	1.5	1.0	1.6	1.3	2.2	1.7	1.6	1.3
VII	1.7	1.5	1.7	1.7	1.4	2.3	1.6	1.0	1.9	1.2	2.1	1.5	1.4	1.3
VIII	1.8	1.7	1.8	1.3	1.4	1.9	-	1.1	1.4	1.2	2.1	1.5	1.4	1.1
IX	1.7	1.6	1.9	1.3	1.4	1.7	-	1.1	1.8	1.4	1.5	1.7	1.3	1.3
X	1.6	1.8	2.3	1.6	1.6	1.8	-	1.1	2.3	1.4	1.6	1.6	1.3	1.2
XI	1.4	1.7	2.1	(4) 1.3 (2) abs.	abs.	2.0	1.4	1.6	2.1	1.3	1.3	1.3	1.3	2.7 *
XII	1.3	1.7	1.9	abs.	abs.	(4) 1.6 (2) abs.	-	-	abs.	1.2	(3) 1.9 (3) abs.	1.3	2.0	1.9 *
XIII	(2) 1.3 (4) abs.	1.7	abs.	abs.	abs.	abs.	1.2	1.5	abs.	1.2	abs.	1.8	(4) 1.8 (2) abs.	1.6 *
XIV		(2) 1.8 (4) abs.					1.3	1.5		1.1		(5) 1.8 (1) abs.		1.4 *
XV							1.4	1.6		(7) 1.2 (1) 2.7 *				(2) 1.4 *
XVI							-	1.7		(4) 1.1 (4) 2.9 *				(1) 1.7 *
XVII							-	-		(1) 1.6 (7) 2.9 *				
XVIII							2.0			(7) 2.7 * (1) 3.4 **				

* Measurement taken for facies articularis tuberculi costae fused with facies articularis capitis costae posterior.

** Measurement taken for facies articularis tuberculi costae, facies articularis capitis costae posterior and facies articularis capitis costae anterior fused

2.3. Collum costae

Its length increases starting from the first anterior ribs to the group of ribs on which it reaches a maximum and next decreases (Figs. 6 and 8; Tables 5 and 6) so that eventually facies articularis capitis costae posterior becomes united with facies articularis tuberculi costae on ribs XV—XVIII (XV — N=1, XVI — N=4, XVII — N=7, XVIII — N=8) in *Equus caballus* L., and on ribs XI—XVI (N=6) in *Sus scrofa* L. The contiguity of these surfaces was found neither in the examined ruminants, in which collum costae is particularly conspicuous, nor in *Coelodonta antiquitatis* (BLUM.).

The serial variation of the breadth of collum costae (Def. 6) is illustrated in Fig. 9 on the basis of the values given in Table 7.

3. Corpus costae

The basic differences in the morphology of corpus costae between *Coelodonta antiquitatis* (BLUM.), *Equus caballus* L., *Sus scrofa* L. and the ruminants (exemplified by *Bos taurus* L.) are shown in Fig. 3.

3.1. Transverse section through corpus costae (Fig. 10)

Its morphology permits the discrimination of all the species under study. In determining the specific membership of a fragment and the serial number of a rib, the investigator should give attention mainly to the relation of the corpus costae to the thickness, the shape of facies externa and facies interna, the sharpness of margo anterior and margo posterior and the size of section, and in determining the region of corpus costae, additionally to the structure of substantia spongiosa, which is distinctly different in the A, B and C regions, and the relation of substantia compacta to substantia spongiosa.

3.2. Breadth of corpus costae (Def. 7)

3.2.1. Breadth of corpus costae at points A, B and C (Figs. 11 A—C; Table 8)

Alces alces (L.)

At A rib VI is the broadest and XIII the narrowest.
At B rib III or V is the broadest and XI or XII the narrowest.
At C rib I is the broadest and XI the narrowest.

Bison bonasus (L.)

At A rib V or VI is the broadest and XI or XIV the narrowest.
At B rib VII or VIII is the broadest and XII, XIII or XIV the narrowest.
At C rib I is the broadest and XIII or XIV the narrowest.

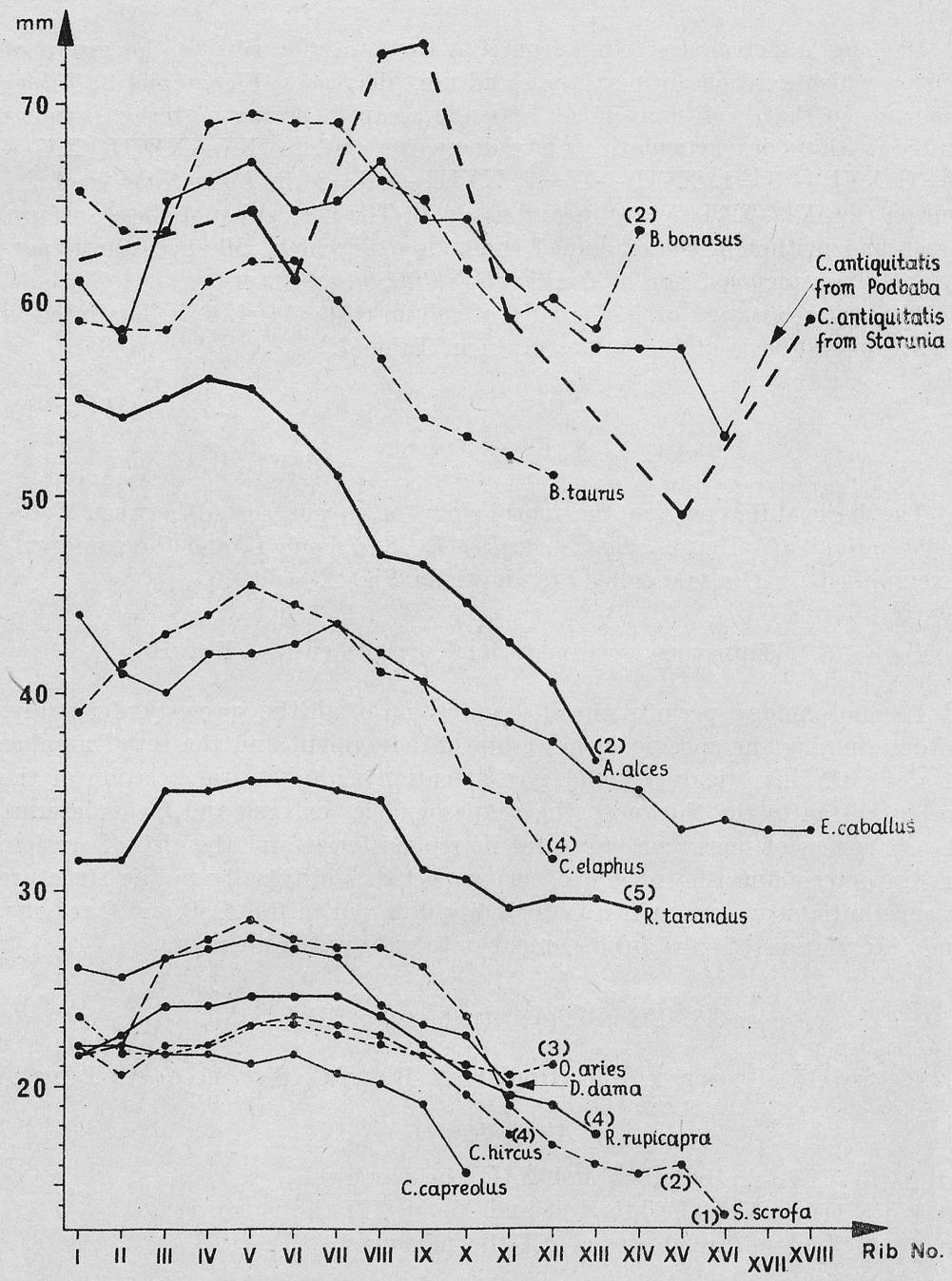

Fig. 8. Curves representing serial variation in the spread of the dorsal end of the rib (Def. 4; see Table 5) — for details see p. 172

Table 5

The spread of the dorsal end of the rib, in mm (Def. 4; see Fig. 8) — for details see p, 172

The numerical values of the spread of the dorsal end are given also by BOJANUS (1827) for ribs I and IX of *Bison bonasus* (L.)

Species / Rib	Alces alces (L.)	Bison bonasus (L.)	Bos taurus L.	Capra hircus L.	Capreolus capreolus (L.)	Cervus elaphus L.	Coelodonta antiquitatis (Blum.) Starunia	Coelodonta antiquitatis (Blum.) Podbaba	Dama dama (L.)	Equus caballus L.	Ovis aries L.	Rangifer tarandus (L.)	Rupicapra rupicapra (L.)	Sus scrofa L.
I	55.0	65.5	59.0	22.0	22.0	39.0	-	61.0	26.0	44.0	23.5	31.5	21.5	21.5
II	54.0	63.5	58.5	20.5	22.0	41.5	-	58.0	25.5	41.0	21.5	31.5	22.5	22.0
III	55.0	63.5	58.5	22.0	21.5	43.0	-	65.0	26.5	40.0	21.5	35.0	24.0	26.5
IV	56.0	69.0	61.0	22.0	21.5	44.0	-	66.0	27.0	42.0	22.0	35.0	24.0	27.5
V	55.5	69.5	62.0	23.0	21.0	45.5	64.5	67.0	27.5	42.0	23.0	35.5	24.5	28.5
VI	53.5	69.0	62.0	23.5	21.5	44.5	61.0	64.5	27.0	42.5	23.0	35.5	24.5	27.5
VII	51.0	69.0	60.0	23.0	20.5	43.5	-	65.0	26.5	43.5	22.5	35.0	24.5	27.0
VIII	47.0	66.0	57.0	22.5	20.0	41.0	72.5	67.0	24.0	42.0	22.0	34.5	23.5	27.0
IX	46.5	65.0	54.0	21.5	19.0	40.5	73.0	64.0	23.0	40.5	21.5	31.0	22.0	26.0
X	44.5	61.5	53.0	19.5	15.5	35.5	-	64.0	22.5	39.0	21.0	30.5	20.5	23.5
XI	42.5	59.0	52.0	(4) 17.5 (2) abs.	abs.	34.5	59.0	61.0	20.0	38.5	20.5	29.0	19.5	19.0
XII	40.5	60.0	51.0	abs.	abs.	(4) 31.5 (2) abs.	-	-	abs.	37.5	(3) 21.0 (3) abs.	29.5	19.0	17.0
XIII	(2) 36.5 (4) abs.	58.5	abs.	abs.	abs.	abs.	-	57.5	abs.	35.5	abs.	29.5	(4) 17.5 (2) abs.	16.0
XIV		(2) 63.5 (4) abs.					-	57.5		35.0		(5) 29.0 (1) abs.		15.5
XV							49.0	57.5		33.0				(2) 16.0
XVI							-	53.0		33.5				(1) 13.5
XVII							-	-		33.0				
XVIII							59.0			33.0				

The length of collum costae, in mm (Def. 5) — for details see p. 172.

The numerical values of the length of collum costae are given also by JANICKI (1938: Table 44) for the ribs of 3 specimens of *Bison bonasus* L.

Species / Rib	Alces alces (L.)	Bison bonasus (L.)	Bos taurus L.	Capra hircus L.	Capreolus capreolus (L.)	Cervus elaphus L.	Coelodonta antiquitatis (Blum.) Starunia	Coelodonta antiquitatis (Blum.) Podbaba	Dama dama (L.)	Equus caballus L.	Ovis aries L.	Rangifer tarandus (L.)	Rupicapra rupicapra (L.)	Sus scrofa L.
I	13.0	7.5	14.0	6.0	5.0	7.5	-	10.0	5.0	7.5	4.0	7.0	6.5	4.5
II	16.0	11.5	15.0	8.0	7.0	10.0	-	13.0	6.5	5.5	7.5	8.5	7.0	5.5
III	18.5	16.0	16.0	8.5	8.0	11.5	-	11.5	9.0	6.5	6.0	11.0	7.5	8.0
IV	19.0	17.5	15.5	9.0	6.0	16.0	-	15.0	7.0	7.0	8.5	10.0	8.0	9.0
V	19.5	18.5	18.0	8.0	6.5	16.5	7.0	5.0	7.5	6.5	8.5	10.0	9.0	9.5
VI	17.5	22.5	19.0	8.5	7.0	15.5	9.0	9.0	9.5	8.0	7.5	11.5	10.5	10.0
VII	16.5	19.5	18.0	9.0	7.0	13.5	-	14.0	9.0	10.5	5.5	12.0	11.0	10.5
VIII	16.0	19.5	17.5	10.5	8.0	13.0	11.0	13.0	9.0	13.0	5.5	15.0	9.5	10.0
IX	17.5	15.5	17.5	10.5	7.5	13.5	20.0	11.0	8.5	13.0	7.0	13.5	9.5	10.5
X	18.0	14.0	17.0	10.5	7.5	12.0	23.0	-	8.5	12.0	2.5	13.5	9.5	7.5
XI	17.5	16.5	18.0	(4) 8.5 (2) abs.	abs.	10.0	16.0	13.5	4.0	11.5	3.0	13.0	8.0	0.0
XII	18.0	18.5	21.0	abs.	abs.	(4) 12.0 (2) abs.	-	-	abs.	10.5	(3) 3.5 (3) abs.	11.5	6.0	0.0
XIII	(2) 8.0 (4) abs.	18.0	abs.	abs.	abs.	abs.	-	8.5	abs.	10.0	abs.	10.0	(4) 3.0 (2) abs.	0.0
XIV		(2) 9.0 (4) abs.					-	9.5		6.5		(5) 9.5 (1) abs.		0.0
XV							19.0	14.0		(7) 5.5 (1) 0.0				(2) 0.0
XVI							-	14.5		(4) 4.0 (4) 0.0				(1) 0.0
XVII							-	-		(1) 1.0 (7) 0.0				
XVIII							abs.			0.0				

Bos taurus L.

At A rib VI, VII or VIII (most frequently VIII) is the broadest and XIII the narrowest.
At B rib VII or VIII is the broadest and XIIII the narrowest.
At C rib I, VI or VII (most frequently I) is the broadest and XIII the narrowest.

Capra hircus L.

At A rib I, V, VI or VII (most frequently VI) is the broadest and XI, XII or XIII the narrowest.
At B rib I, III, IV or, most frequently, VII is the broadest and XIII the narrowest.
At C rib I is the broadest and X, XI, XII or XIII the narrowest.

Capreolus capreolus (L.)

At A rib III, IV, V or VI (most frequently V) is the broadest and XI, XII or XIII the narrowest.
At B rib III, IV or V is the broadest and X or XIII the narrowest.
At C rib I or V is the broadest and XII or XIII the narrowest.

Cervus elaphus L.

At A rib IV, V or VI is the broadest and XII or XIII the narrowest.
At B rib IV, VI or VII is the broadest and XII or XIII the narrowest.
At C rib VI is the broadest and XI the narrowest.

Coelodonta antiquitatis (Blum.)

At A rib IV (in the specimen from Starunia) or V (in the one from Podbaba) is the broadest and the last posterior are the narrowest.
At B rib V is the broadest and the last posterior are the narrowest.
At C rib I (in the specimen from Podbaba) or VI (in the one from Starunia) is the broadest and the last posterior are the narrowest.

Dama dama (L.)

At A rib VI is the broadest and XII the narrowest.
At B rib VII is the broadest and XIII the narrowest.
At C rib I is the broadest and XII the narrowest.

Equus caballus L.

At A rib V or, more frequently, VI is the broadest and XIV, XV, XVI or XVII (most frequently XVI) the narrowest.
At B rib VI is the broadest and XIV, XV or XVIII (most frequently XIV) the narrowest.
At C rib I or VI is the broadest and XVIII the narrowest.

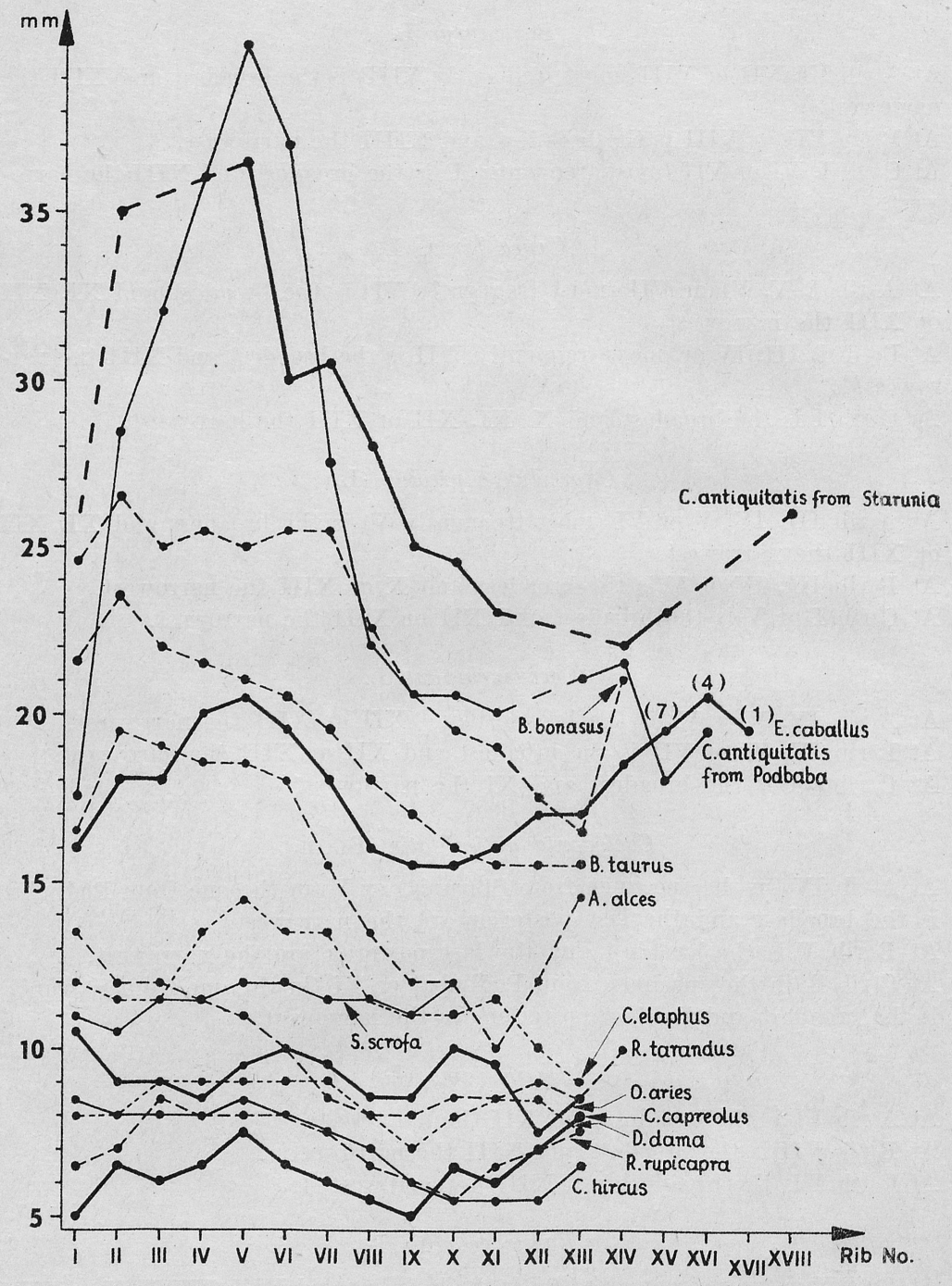

Fig. 9. Curves representating serial variation in the breadth of collum costae (Def. 6; see Table 7) — for details see p. 172

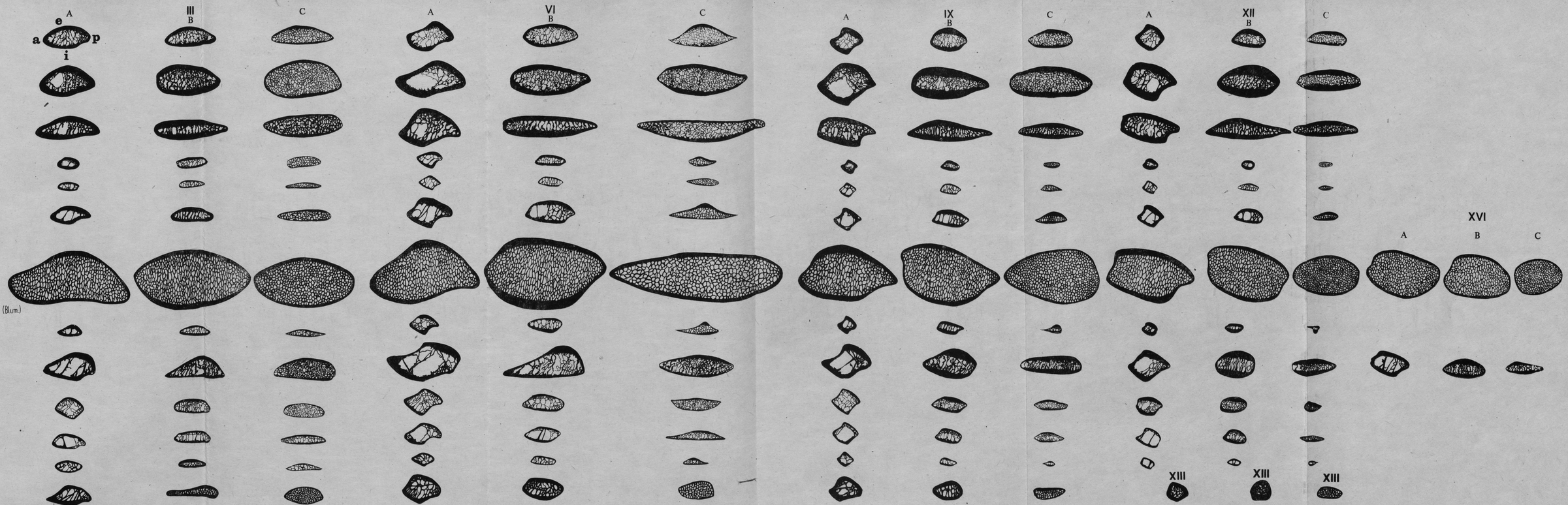

Fig. 10. Transverse section through left ribs at points A, B and C (see Def. 1 and Figs. 1 and 3), all in the same position (natural size); a — margo anterior, e — facies externa, i — facies interna, p — margo posterior.

Drawings of the transverse section of corpus costae in the species examined in this work are given also by Poplewski (1948: Fig. 94) for *Bos taurus* L. (in the dorsal and the ventral part of a rib), *Equus caballus* L. and *Sus scrofa* L. (both in the middle part of a rib), and by Frechkop (1958: Fig. 1) for *Alces alces* (L.), *Bos taurus* L., *Capra hircus* L., *Equus caballus* L., *Ovis aries* L., *Rangifer tarandus* (L.) and *Sus scrofa* L. (all at one-fourth of the length rib V_1 measuring from caput costae)

The breadth of collum costae, in mm (Def. 6; see Fig. 9) — for details see p. 172

The numerical values of the breadth of collum costae are given also by KOCH (1932: Table 22) for chosen ribs of 20 specimens of *Bison bonasus* (L.) and JANICKI (1938: Table 44) for the ribs of 3 specimens of the same species.

Species / Rib	Alces alces (L.)	Bison bonasus (L.)	Bos taurus L.	Capra hirous L.	Capreolus capreolus (L.)	Cervus elaphus L.	Coelodonta antiquitatis (Blum.) Starunia	Coelodonta antiquitatis (Blum.) Podbaba	Dama dama (L.)	Equus caballus L.	Ovis aries L.	Rangifer tarandus (L.)	Rupicapra rupicapra (L.)	Sus scrofa L.
I	16.5	24.5	21.5	8.5	5.0	12.0	-	17.5	8.0	16.0	10.5	13.5	6.5	11.0
II	19.5	26.5	23.5	8.0	6.5	11.5	35.0	28.5	8.0	18.0	9.0	12.0	7.0	10.5
III	19.0	25.0	22.0	8.0	6.0	11.5	-	32.0	9.0	18.0	9.0	12.0	8.5	11.5
IV	18.5	25.5	21.5	8.0	6.5	13.5	-	36.0	9.0	20.0	8.5	11.5	8.0	11.5
V	18.5	25.0	21.0	8.5	7.5	14.5	36.5	40.0	9.0	20.5	9.5	11.0	8.0	12.0
VI	18.0	25.5	20.5	8.0	6.5	13.5	30.0	37.0	9.0	19.5	10.0	10.0	8.0	12.0
VII	15.5	25.5	19.5	7.5	6.0	13.5	30.5	27.5	9.0	18.0	9.5	8.5	7.5	11.5
VIII	13.5	22.5	18.0	7.0	5.5	11.5	28.0	22.0	8.0	16.0	8.5	8.0	6.5	11.5
IX	12.0	20.5	17.0	6.0	5.0	11.0	25.0	20.5	7.0	15.5	8.5	8.0	6.0	11.0
X	12.0	19.5	16.0	5.5	6.5	11.0	24.5	20.5	8.0	15.5	10.0	8.5	5.5	12.0
XI	10.0	19.0	15.5	5.5	6.0	11.5	23.0	20.0	8.5	16.0	9.5	8.5	6.5	abs.
XII	12.0	17.5	15.5	5.5	7.0	10.0	-	-	8.5	17.0	7.5	9.0	7.0	abs.
XIII	14.5	16.5	15.5	6.5	8.0	9.0	-	21.0	7.5	17.0	8.5	8.5	7.5	abs.
XIV		21.0					22.0	21.5		18.5		10.0		abs.
XV							23.0	18.0		(7) 19.5 (1) abs.				(2) abs.
XVI							-	19.5		(4) 20.5 (4) abs.				(1) abs.
XVII							-	-		(1) 19.5 (7) abs.				
XVIII							26.0			abs.				

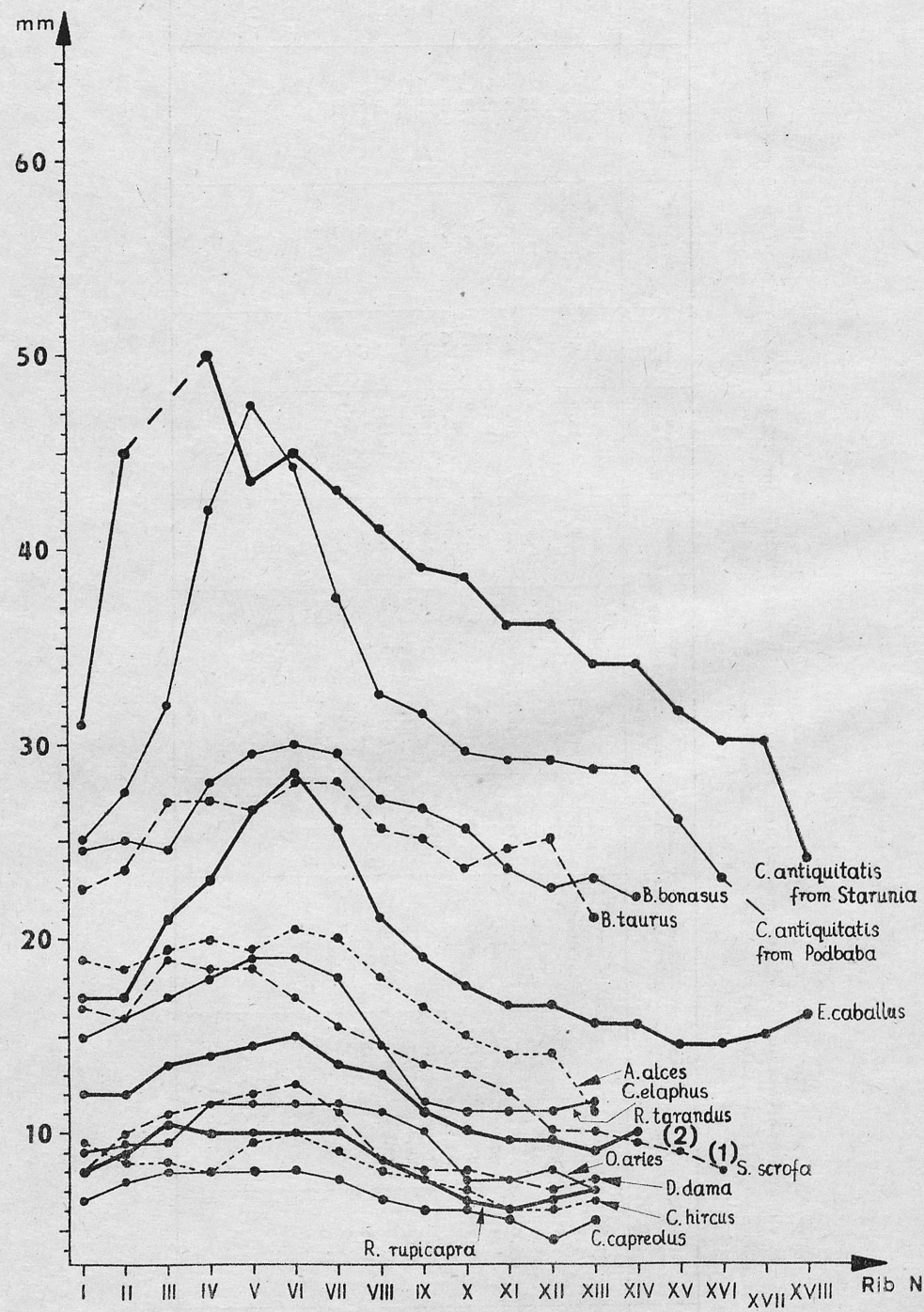

Fig. 11A. Curves representing serial variation in the breadth of corpus costae at point A (Defs. 1 and 7; see Table 8) — for details see p. 172

The breadth of corpus costae at points, A, B and C, in mm (Defs. 1 and 7; see Figs. 11 A—C) — for details see p. 172

JANICKI (1938: Table 44) presents the numerical values of the breadth of corpus costae at the ventral end for the ribs of 3 specimens of *Bison bonasus* (L.), and KOBRYŃ (1973) gives the breadths of corpus costae, both in the middle of its length (in his Table 4) and at the ventral end (in his Table 5), for the ribs of the specimens mentioned in the foot-note on p. 218

Rib \ Species		Alces alces (L.)	Bison bonasus (L.)	Bos taurus L.	Capra hircus L.	Capreolus capreolus (L.)	Cervus elaphus L.	Coelodonta antiquitatis (Blum.) Starunia	Coelodonta antiquitatis (Blum.) Podbaba	Dama dama (L.)	Equus caballus L.	Ovis aries L.	Rangifer tarandus (L.)	Rupicapra rupicapra (L.)	Sus scrofa L.
I	A	19.0	24.5	22.5	9.5	6.5	15.0	31.0	25.0	8.0	17.0	9.0	12.0	8.0	16.5
	B	21.5	28.0	26.0	11.0	8.5	17.5	36.0	36.0	11.0	22.0	12.0	14.5	11.0	18.0
	C	34.5	47.0	55.0	17.5	11.0	27.5	44.5	54.0	18.0	32.0	22.0	20.5	19.5	24.5
II	A	18.5	25.0	23.5	8.5	7.5	16.0	45.0	27.5	10.0	17.0	9.5	12.0	9.0	16.0
	B	21.5	26.0	26.5	10.0	10.0	16.0	45.5	30.0	11.0	20.5	13.0	12.0	10.0	20.5
	C	21.0	24.5	31.0	12.0	9.5	15.5	31.0	29.0	12.0	24.5	13.0	13.0	12.5	16.5
III	A	19.5	24.5	27.0	8.5	8.0	17.0	-	32.0	11.0	21.0	9.5	13.5	10.5	19.0
	B	24.5	28.0	33.0	11.0	10.5	19.0	-	36.0	13.5	23.0	12.5	16.0	11.0	22.5
	C	24.5	25.5	34.0	12.5	11.0	17.5	-	30.0	16.5	25.0	14.0	18.5	12.5	16.5
IV	A	20.0	28.0	27.0	8.0	8.0	18.0	50.0	42.0	11.5	23.0	11.5	14.0	10.0	18.5
	B	23.5	29.5	39.0	10.5	11.0	20.0	49.0	39.5	13.0	25.5	12.5	15.5	11.0	20.5
	C	26.0	31.5	42.5	12.0	12.5	23.0	63.0	37.0	17.0	27.0	14.0	22.5	13.0	17.5
V	A	19.5	29.5	26.5	9.5	8.0	19.0	43.5	47.5	12.0	26.5	11.5	14.5	10.0	18.5
	B	24.0	31.5	41.5	10.5	10.5	20.5	53.5	42.0	14.0	30.0	13.0	15.5	11.0	19.0
	C	25.5	32.0	50.0	12.0	13.0	26.5	64.0	47.5	17.5	29.0	14.0	23.0	12.0	18.0
VI	A	20.5	30.0	28.0	10.0	8.0	19.0	45.0	44.0	12.5	28.5	11.5	15.0	10.0	17.0
	B	23.0	34.0	45.5	10.5	10.0	21.0	49.5	39.5	15.0	33.0	13.0	15.0	12.0	18.0
	C	25.5	39.0	52.5	10.5	13.0	28.5	66.0	51.0	17.0	31.5	14.0	23.0	11.0	17.0
VII	A	20.0	29.5	28.0	9.0	7.5	18.0	43.0	37.5	11.0	25.5	11.5	13.5	10.0	15.5
	B	22.5	35.0	46.5	11.0	9.5	22.0	46.0	35.0	15.5	30.0	13.5	14.5	11.5	14.5
	C	25.0	38.5	50.0	10.5	12.0	26.0	46.0	44.0	15.5	28.5	14.5	21.5	10.0	14.5
VIII	A	18.0	27.0	25.5	8.0	6.5	14.5	41.0	32.5	8.5	21.0	11.0	13.0	8.5	14.5
	B	20.5	35.5	46.0	10.0	8.0	19.5	41.0	34.0	13.0	24.5	13.5	12.5	10.0	13.5
	C	21.5	40.0	47.5	8.0	9.0	18.0	45.0	40.0	11.5	23.5	15.0	16.0	8.0	13.5
IX	A	16.5	26.5	25.0	7.5	6.0	11.5	39.0	31.5	8.0	19.0	10.0	11.0	7.5	13.5
	B	17.0	34.5	42.5	8.5	7.0	15.0	41.5	32.0	11.0	22.0	12.0	11.0	8.0	13.0
	C	19.0	35.5	44.5	6.5	6.0	16.0	39.5	36.0	9.0	20.0	11.0	12.5	6.0	12.0
X	A	15.0	25.5	23.5	7.0	6.0	11.0	38.5	29.5	8.0	17.5	7.5	10.0	6.5	13.0
	B	15.5	32.5	38.5	7.0	7.0	13.0	38.5	33.0	10.0	19.5	9.5	10.0	6.5	12.5
	C	15.0	29.5	37.5	5.5	6.0	12.0	38.0	33.0	8.0	17.5	7.0	11.0	4.5	10.5
XI	A	14.0	23.5	24.5	6.0	5.5	11.0	36.0	29.0	7.5	16.5	7.5	9.5	6.0	12.0
	B	14.5	30.0	37.0	6.0	7.0	12.0	39.0	33.0	9.0	18.5	8.0	9.0	5.5	11.5
	C	14.0	28.5	34.5	5.5	5.5	9.0	32.0	24.0	8.5	17.0	5.5	10.0	4.5	10.5
XII	A	14.0	22.5	25.0	6.0	4.5	11.0	36.0	29.0	7.0	16.5	8.0	9.5	6.5	10.0
	B	15.0	28.5	33.0	5.5	6.5	11.5	40.0	30.5	8.0	17.0	8.0	8.5	5.5	10.5
	C	16.5	26.0	29.0	5.5	4.5	10.5	31.0	24.0	5.5	17.0	5.5	10.0	4.0	10.0
XIII	A	11.0	23.0	21.0	6.5	5.5	11.5	34.0	28.5	7.5	15.5	7.0	9.0	7.0	10.0
	B	15.0	28.0	24.0	5.0	6.5	12.5	34.5	27.5	7.0	16.5	7.0	9.5	5.5	10.5
	C	14.5	22.0	22.0	6.0	4.5	12.5	25.5	-	6.0	16.5	6.0	13.5	4.0	10.0
XIV	A		22.0					34.0	28.5		15.5		10.0		9.5
	B		26.5					32.5	26.0		15.5		10.0		11.0
	C		23.0					23.5	18.0		16.5		12.0		9.5
XV	A							31.5	26.0		14.5				(2) 9.0
	B							30.5	26.0		15.5				(2) 10.0
	C							21.5	16.5		15.5				(2) 10.0
XVI	A							30.0	23.0		14.5				(1) 8.0
	B							27.0	25.0		16.0				(1) 9.0
	C							20.0	15.0		16.0				(1) 8.0
XVII	A							30.0	-		15.0				
	B							30.0	-		16.5				
	C							19.0	-		15.0				
XVIII	A							24.0			16.0				
	B							24.0			15.5				
	C							17.5							

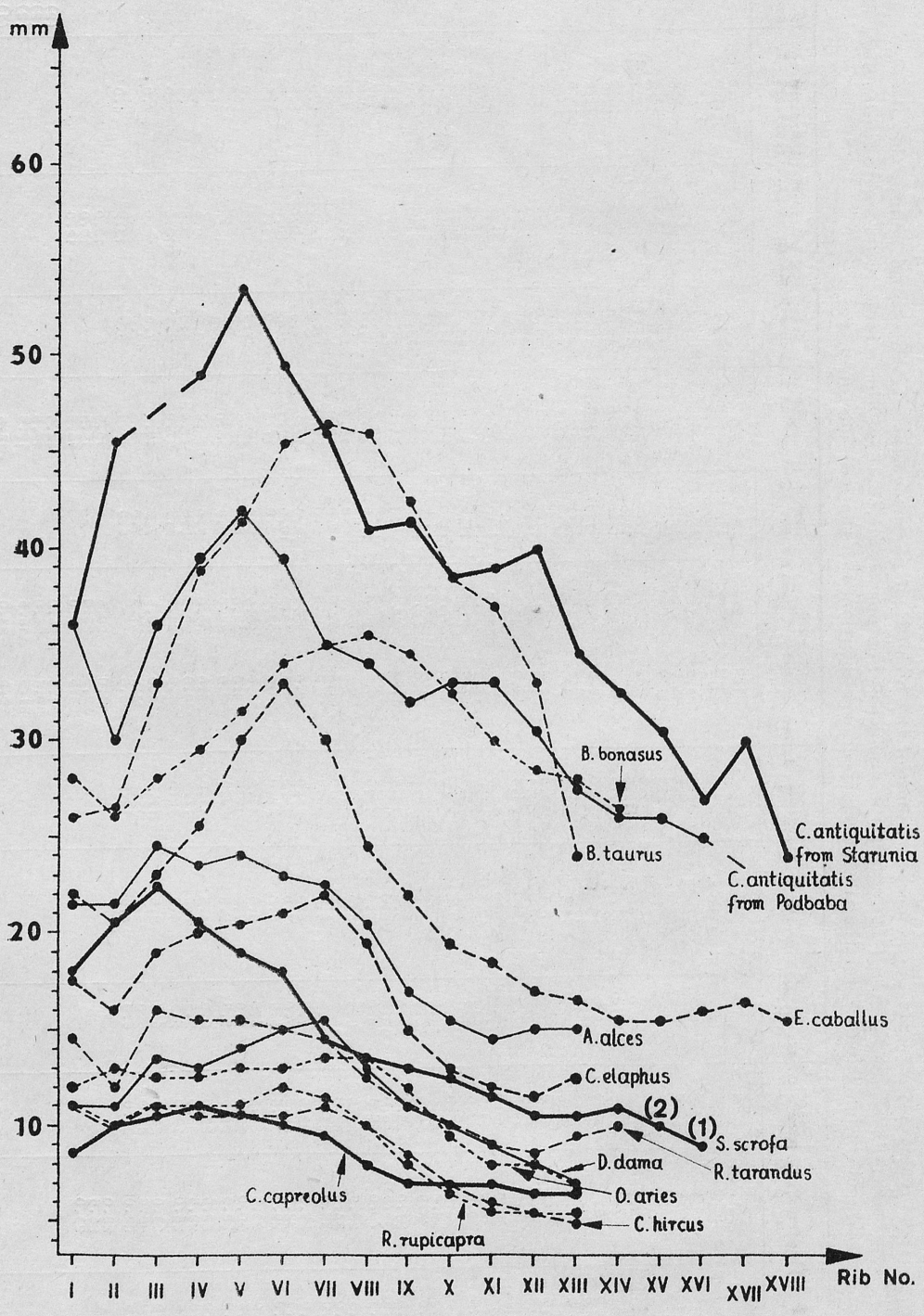

Fig. 11B. Curves representing serial variation in the breadth of corpus costae at point B (Defs. 1 and 7; see Table 8) — for details see p. 172

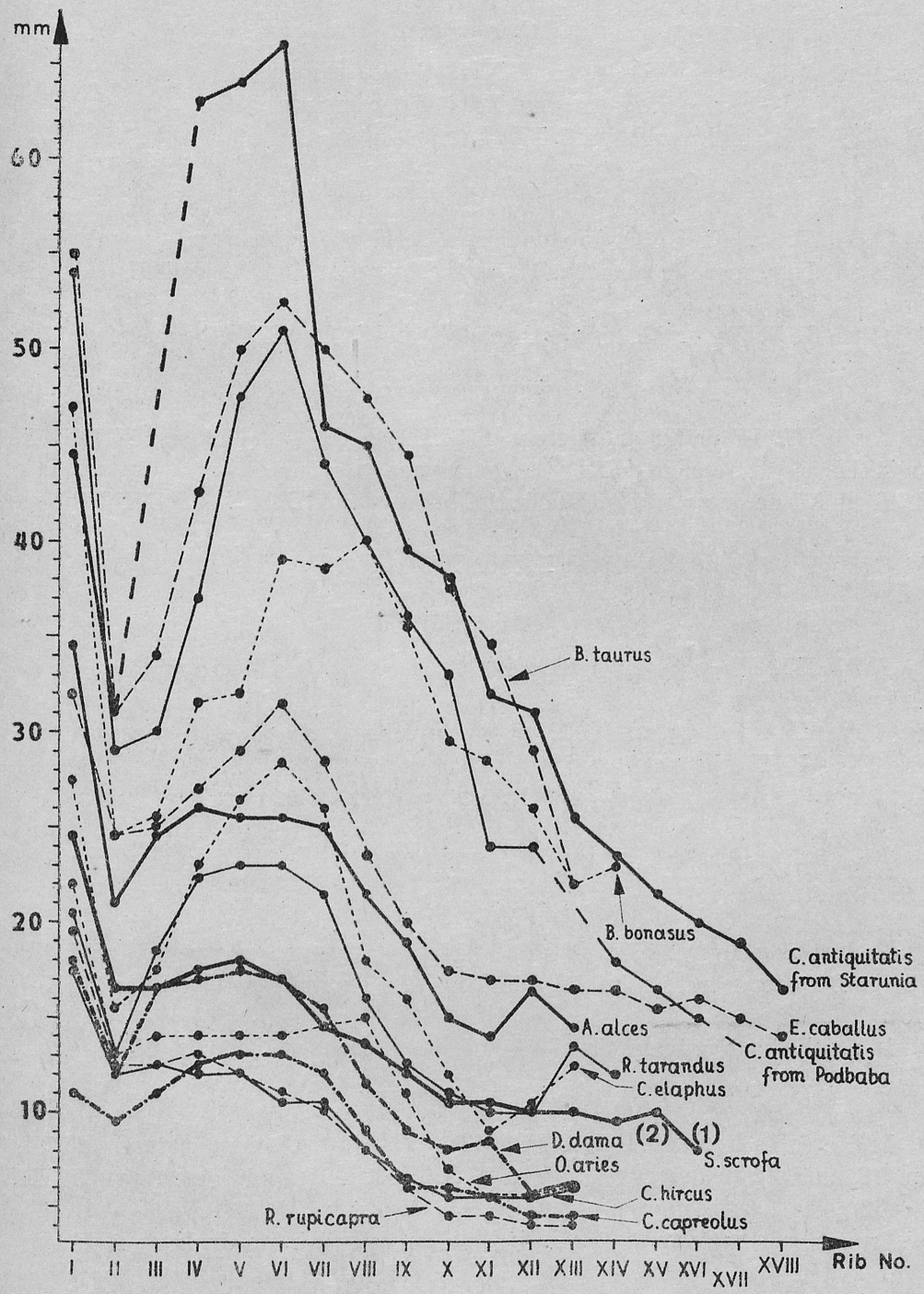

Fig. 11C. Curves representing serial variation in the breadth of corpus costae at point C (Defs. 1 and 7; see Table 8) — for details see p. 172

Ovis aries L.

At A rib VII is the broadest and XIII the narrowest.
At B rib VII is the broadest and XIII the narrowest.
At C rib I is the broadest and XI the narrowest.

Rangifer tarandus (L.)

At A rib V or VI is the broadest and XIII the narrowest.
At B rib I or, more frequently, III is the broadest and XI or XII the narrowest.
At C rib I, V, VI or VII is the broadest and XI or XII the narrowest.

Rupicapra rupicapra (L.)

At A rib III, IV or VI (most frequently III) is the broadest and X, XI, XII or XIII (most frequently XI) the narrowest.
At B rib VI or, more rarely, VII is the broadest and XI, XII or XIII the narrowest.
At C rib I is the broadest and XII or XIII the narrowest.

Sus scrofa L.

At A rib III, IV or V (most frequently III) is the broadest and the last posterior the narrowest.
At B rib III or, more rarely, IV is the broadest and one of the last posterior ribs (XI—XVI) the narrowest.
At C rib I is the broadest and the last posterior the narrowest.

3.2.2. Greatest breadth of corpus costae (Fig. 12; Table 9)

Alces alces (L.)

It decreases from rib I (in CY) to II (in CY), next increases to IV, V or VI (in BY) to decreases in the following ribs and increase again in XIII (in BC).

It reaches a maximum in rib I and a minimum in XII (in CY).

Bison bonasus (L.)

It decreases from rib I (in CY) to II or III (in CY), next increases to VIII (in BC) and again decreases to rise in XIII (in AB) and come down in XIV (in AB).

It reaches a maximum mostly in rib I and a minimum in II or XIV.

Bos taurus L.

It decreases from rib I (in CY) to II or III (in CY), next increases to VI or VII (in BC) and decreases again up to XIII (in AC).

It reaches a maximum in rib I, VI or VII and a minimum in XIII.

Capra hircus L.

It decreases from rib I (in CY) to II (in CY), incerases to IV or V (in BY), next comes down to VI (in BC) and again increases in VII (in BC) to decrease in the following ribs up to XIII (in BY).

It reaches a maximum in rib I and a minimum in XIII.

Capreolus capreolus (L.)

It decreases from rib I (in CY) to II (in BC), increases to IV or V (in BC) and decreases again to rise in XIII (in AB).

It reaches a maximum in rib I or, more frequently, IV or V and a minimum in XII (in B region).

Cervus elaphus L.

It decreases from rib I (in CY) to II (in BY), next increases to V, VI or VII (in BC) and decreases in the following ribs to X or XI (in BC) to grow again to XIII (in BC).

It reaches a maximum in rib I, V, VI or VII and a minumum in X or XI.

Coelodonta antiquitatis (Blum.)

In the Starunia specimen: it increases from rib I (in CY) to VI (in CY) and next generally decreases up to XVIII (in XA), in which it reaches a minimum.

In the Podbaba specimen: it decreases from rib I (in CY), in which it reaches a maximum, to III (in XA), next increases to VI (in CY) and again decreases up to the last rib preserved, i.e. XVI (in AB), in which it has a minimum.

Dama dama (L.)

It decreases from rib I (in CY) to II (in BC), increases in the following ribs to VI (in BC), where it reaches a maximum, and decreases up to XIII (in XA), in which it has a minimum.

Equus caballus L.

It decreases from rib I (in CY) to III (in BC), increases to VI (in BC), next decreases to XV or XVI (in BC) to grow to XVIII (in XB).

It reaches a maximum in rib I or VI and a minimum in XV or XVI.

Ovis aries L.

It decreases from rib I (in CY) to II (in BC), next increases, mostly to VII (in BC), and decreases in the following ribs to increase again in XII (in BC) and decrease in XIII (in BC).

In reaches a maximum in rib I and a minimum in XIII.

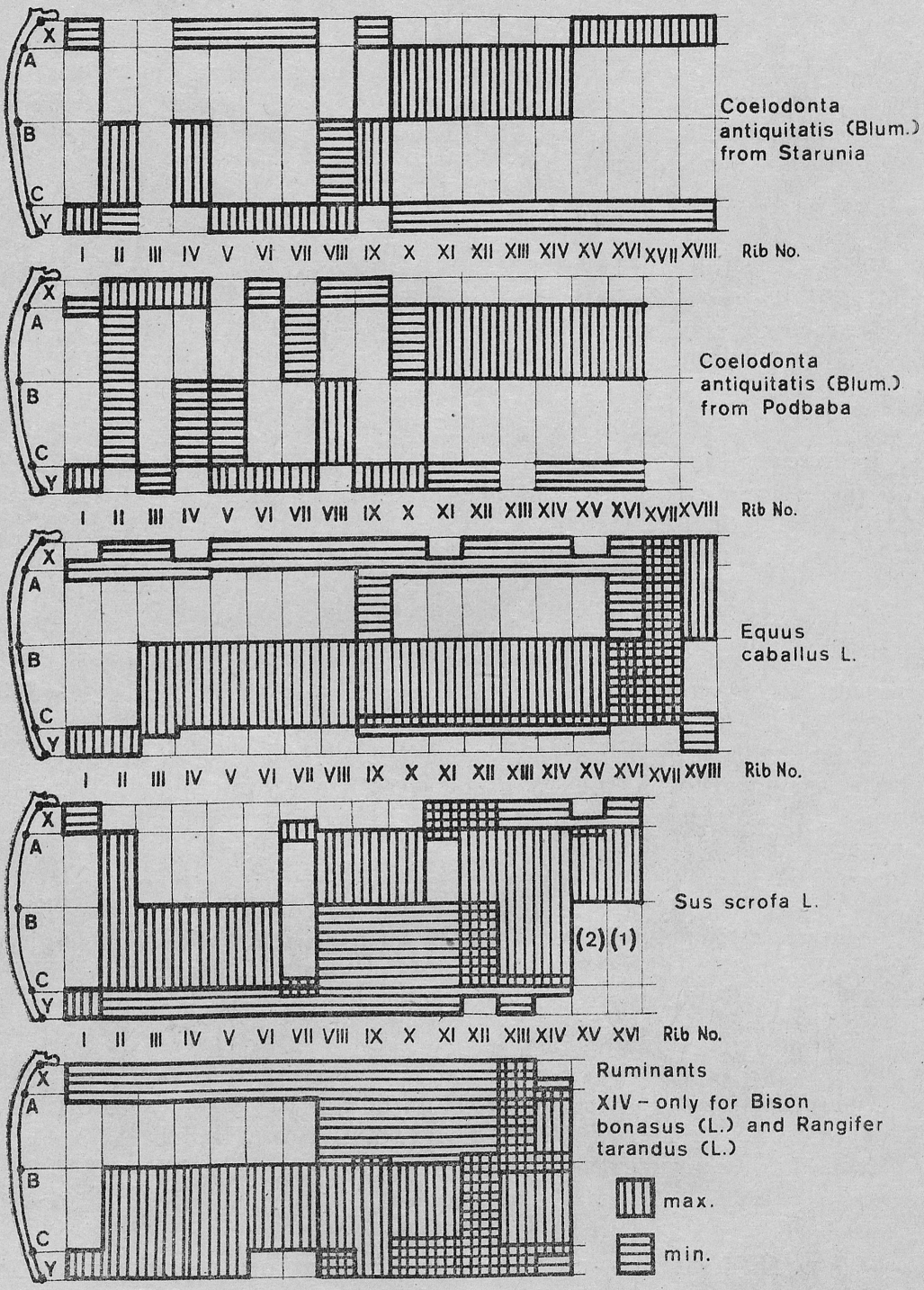

Fig. 12. Serial variation of the rib regions in which corpus costae usually reaches its greatest and smallest breadths (Def. 7; see Table 9) — for details see p. 172 and Def. 1

The greatest and the smallest breadth of corpus costae, in mm (Def. 7; see Fig. 12) — for details see p. 172.

The numerical values of the greatest and smallest breadths of corpus costae are presented also by KOCH (1932: Table 22) for chosen ribs of 20 specimens of *Bison bonasus* (L.). BOJANUS (1827) and JANICKI (1938: Table 44) give the greatest breadths of corpus costae, respectively, for ribs I and IX of the same species and for the ribs of 3 specimens of this species, too

Species / Rib	Alces alces (L.)		Bison bonasus (L.)		Bos taurus L.		Capra hircus L.		Capreolus capreolus (L.)		Cervus elaphus L.		Coelodonta antiquitatis (Blum.) Starunia		Coelodonta antiquitatis (Blum.) Podbaba		Dama dama (L.)		Equus caballus L.		Ovis aries L.		Rangifer tarandus (L.)		Rupicapra rupicapra (L.)		Sus scrofa L.	
	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.
I	42.0	18.0	56.5	24.0	59.5	22.0	20.0	9.0	14.5	6.5	32.5	14.0	48.0	27.0	56.5	25.0	19.0	8.0	35.5	17.0	22.0	7.0	24.0	12.0	22.5	8.0	24.5	12.5
II	27.5	17.5	29.0	24.0	32.5	23.5	12.0	8.0	12.5	7.5	19.0	14.5	49.0	29.0	38.0	28.0	12.5	9.5	28.0	16.5	15.0	8.5	14.5	11.5	14.0	9.0	20.5	11.5
III	28.0	18.5	30.0	24.5	36.0	27.0	12.5	8.0	13.0	7.5	21.0	16.5	-	-	36.5	28.0	17.0	10.5	26.0	21.0	16.5	9.5	20.0	13.5	14.5	10.0	23.5	11.5
IV	29.5	19.5	35.0	27.0	46.5	27.0	13.0	8.0	16.0	8.0	27.5	17.0	67.0	47.0	50.0	36.0	18.0	11.5	29.0	22.5	16.5	10.5	24.0	13.5	13.5	10.0	23.0	12.5
V	32.0	19.0	35.0	29.0	52.5	26.5	13.0	9.5	16.5	7.5	28.5	18.5	69.0	37.5	51.0	40.5	19.5	11.5	33.0	25.0	18.0	10.5	24.0	13.5	12.5	9.5	21.5	12.0
VI	33.0	18.5	43.0	30.0	56.0	27.5	12.5	9.5	14.5	7.0	30.5	18.0	72.0	40.0	55.0	37.0	20.5	11.5	35.0	25.5	18.5	11.0	24.0	14.0	13.0	9.5	19.0	14.0
VII	30.0	18.5	45.5	29.0	53.5	27.0	13.0	8.0	14.0	7.0	31.0	16.5	55.0	35.0	48.5	33.0	18.5	10.0	32.5	22.5	19.5	9.0	22.0	13.0	12.5	8.5	16.0	12.0
VIII	28.5	17.5	47.0	26.0	51.0	23.0	11.0	7.5	10.0	6.0	21.0	14.0	47.0	37.0	42.0	29.5	14.5	8.0	28.5	19.5	18.0	9.0	20.0	12.0	11.0	7.0	16.0	12.0
IX	25.0	16.0	38.0	23.5	47.5	21.5	9.0	6.5	7.5	5.0	17.5	11.5	43.0	31.0	40.0	28.5	12.0	7.5	24.5	17.5	15.0	8.0	16.0	10.0	9.0	5.5	15.0	11.0
X	21.5	14.0	34.5	22.5	44.5	21.0	8.0	5.5	7.5	5.0	14.5	9.5	41.0	34.0	35.0	28.0	10.5	7.0	22.5	15.5	13.5	7.0	13.5	9.0	7.5	4.5	14.5	9.5
XI	17.5	12.5	32.5	22.0	42.0	21.0	7.0	5.0	7.5	5.0	13.5	9.0	40.0	30.0	33.5	22.5	9.5	5.5	21.0	15.0	8.0	5.0	12.0	8.5	6.5	4.0	13.0	9.5
XII	17.0	12.5	29.0	21.0	38.0	21.0	7.0	5.0	6.5	4.0	14.5	10.0	42.0	27.0	33.5	23.0	9.0	5.5	20.0	15.0	9.5	5.5	12.0	8.0	7.0	4.0	12.0	8.5
XIII	18.5	10.5	30.5	18.5	30.0	17.0	7.0	5.0	7.5	4.0	16.0	11.0	38.5	23.0	32.0	-	8.0	5.0	18.5	14.5	7.5	4.5	14.0	8.5	7.5	3.5	12.0	8.0
XIV			28.0	13.5									36.0	20.0	30.0	16.0			17.5	14.0			12.5	9.5			12.0	8.5
XV													33.5	20.5	28.0	13.5			17.0	14.0							(2) 11.5	(2) 8.0
XVI													34.0	17.0	27.5	13.0			17.0	13.5							(1) 11.0	(1) 7.5
XVII													33.5	17.0	-	-			17.5	14.5								
XVIII													28.0	15.0					21.5	12.0								

Rangifer tarandus (L.)

It decreases from rib I (in CY) to II (in CY) and increases to IV, V or VI (in BC); it decreases in the following ribs to XI or XII (in BY), increases to XIII (in CY) to decrease again in XIV (in BC).

It reaches a maximum in rib I, IV, V or VI and a minimum in XI or XII.

Rupicapra rupicapra (L.)

It decreases from rib I (in CY) to II (in BC), next for the most part increases to III (in BC), starting from which it comes down to increase in VI (in BC); it decreases again mostly to XI (in XC) and then begins to rise to XIII (in XA).

It reaches a maximum in rib I and a minimum in XI.

Sus scrofa L.

It decreases from rib I (in CY) to II (in AC), next increases to III or IV (in BC) to decrease in the following ribs, generally, up to the last posterior one (mostly in AB).

It reaches a maximum in rib I, III or IV and a minimum in the last posterior one.

3.2.3. Smallest breadth of corpus costae (Fig. 12; Table 9)

Alces alces (L.)

It decreases from rib I (in XA) to II (in XA) and increases to IV or, more rerely, V (in XA) to decrease in the following ribs up to XIII (XA).

It reaches a minimum in rib XIII and a maximum in IV or V.

Bison bonasus (L.)

It increases from rib I (in XA) to V, VI or VII (in A region) and next decreases to reach a minimum in XIV (in CY).

Bos taurus L.

It increases from rib I (in XA) to III (in XA), next decreases to V (in A region) and increases again to VI or VII (in XA) to decrease in the following ribs, mostly, up to XIII (in XA).

It reaches a minimum mostly in rib XIII and a maximum in III, VI or, most frequently, VII.

Capra hircus L.

It decreases from rib I (in XA) mostly to II or III (in XA) and increases to V or VI (in XA) to decrease up to XIII (in B region).

It reaches a minimum in rib XIII and a maximum in VI or VI.

Capreolus capreolus (L.)

It increases from rib I (in A region) to IV or V (in A region) and next decreases, reaching a minimum mostly in XIII (in CY).

Cervus elaphus L.

It mostly increases from rib I (in XA) to IV, V or VI (in XA), decreases in the following ribs, mostly to XI (in C region) and next increases to XIII (in XB).

It reaches a minimum mostly in rib XI and a maximum in IV, V or VI.

Coelodonta antiquitatis (BLUM.)

It increases from rib I (in XA) to IV (in XA) in the Starunia specimen or V (in BC) in that from Podbaba and next it generally decreases to reach a minimum in the last posterior ribs (in CY).

Dama dama (L.)

It increases from rib I (in A region) to IV, V or VI (in XA) to decrease next up to XIII (in CY), where it has a minimum.

Equus caballus L.

It decreases from rib I (in A region) to II (in XA), next increases to V or VI (in XA) and decreases in the following ribs to increase in XVII (in XC) and decrease again in XVIII (in CY).

It reaches a minimum in rib XVIII and a maximum in V or VI.

Ovis aries L.

It increase from rib I (in XA) mostly to VI (in XA), next decreases in the following ribs and increases again in XII (in C region) to decrease in XIII (mostly in B region).

It reaches a minimum in rib XIII and a maximum mostly in VI.

Rangifer tarandus (L.)

It decreases from rib I (in XA) to II (in A region), increases to III, IV, V or, most frequently, VI (in XA), next decreases, mostly to XII (in AB), to increase again to XIV (in A or B region or in CY).

It reaches a minimum mostly in rib XII and a maximum in III, IV, V or VI.

Rupicapra rupicapra (L.)

It increases from rib I (in XA) to III or IV (in A region) and next decreases to reach a minimum in XIII (in CY).

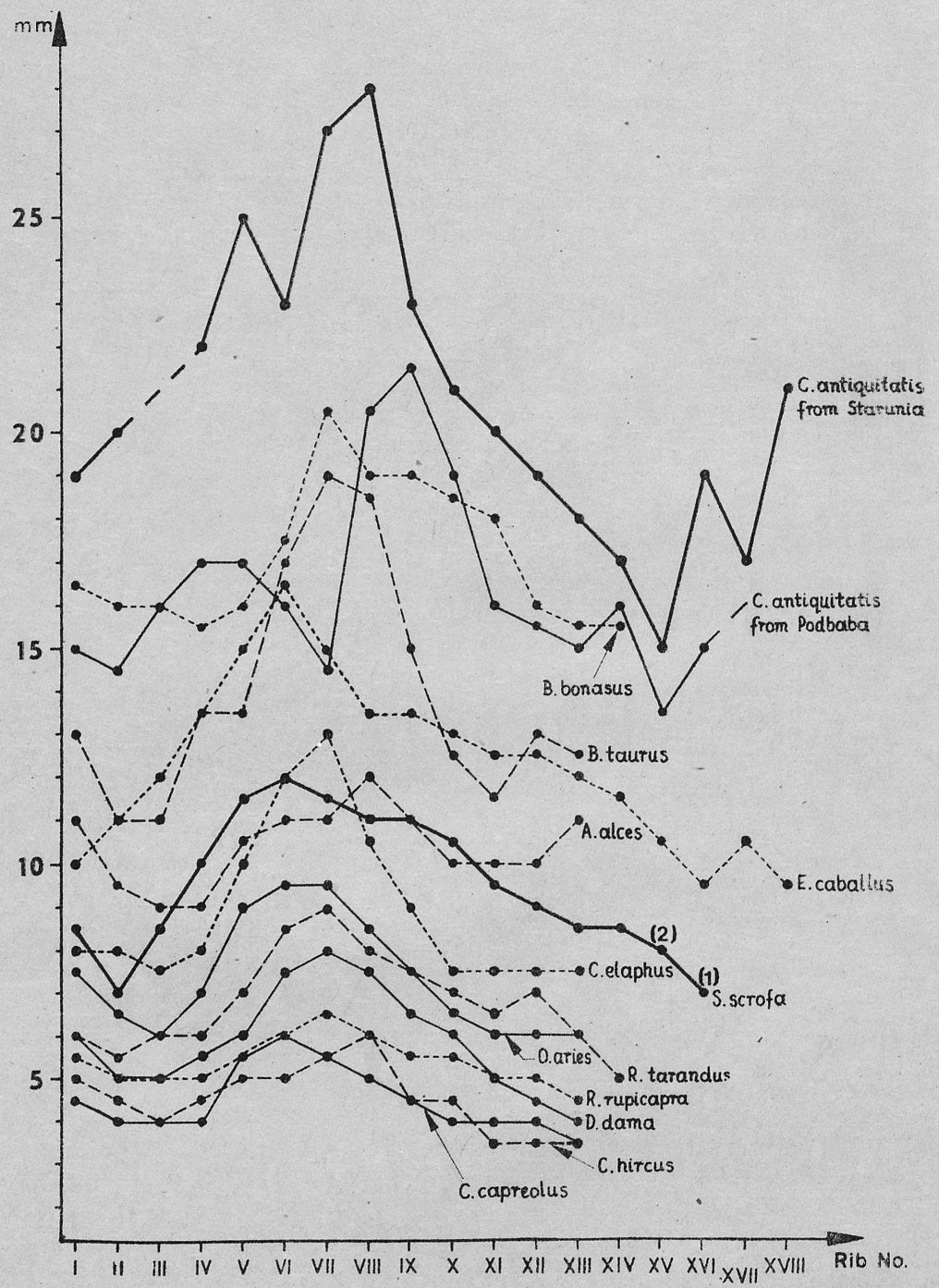

Fig. 13A. Curves representing serial variation in the thickness of corpus costae at point A (Defs. 1 and 8; see Table 10) — for details see p. 172

The thickness of corpus costae at points A, B and C, in mm (Defs. 1 and 8; see Figs. 13 A—C) — for details see p. 172. Table 10

BOJANUS (1827) and KOBRYŃ (1973: Table 7) present the numerical values of the thickness of corpus costae taken halfway along its length, for ribs I and IX of *Bison bonasus* (L.) and for the ribs of the specimens mentioned in the foot-note on p. 218, respectively, whereas JANICKI (1938: Table 44) gives the thicknesses of corpus costae, both in the middle of its length and at the ventral end, for the ribs of 3 specimens of *Bison bonasus* (L.).

Species / Rib		Alces alces (L.)	Bison bonasus (L.)	Bos taurus L.	Capra hircus L.	Capreolus capreolus (L.)	Cervus elaphus L.	Coelodonta antiquitatis (Blum.) Starunia	Coelodonta antiquitatis (Blum.) Podbaba	Dama dama (L.)	Equus caballus L.	Ovis aries L.	Rangifer tarandus (L.)	Rupicapra rupicapra (L.)	Sus scrofa L.
I	A	11.0	16.5	13.0	5.0	4.5	8.0	19.0	15.0	6.0	10.0	7.5	6.0	5.5	8.5
	B	10.0	17.5	12.0	5.0	4.5	8.5	18.0	12.5	5.5	11.0	6.0	6.0	5.0	9.0
	C	12.0	24.0	19.0	5.0	5.5	7.5	28.0	22.0	5.0	14.5	6.0	8.0	3.5	14.5
II	A	9.5	16.0	11.0	4.5	4.0	8.0	20.0	14.5	5.0	11.0	6.5	5.5	5.0	7.0
	B	7.0	15.5	10.0	3.5	3.0	6.5	23.5	14.0	4.0	9.0	4.5	4.5	3.5	5.0
	C	10.0	20.5	13.0	3.5	2.0	4.5	18.5	16.0	3.0	8.5	5.0	3.5	3.0	4.5
III	A	9.0	16.0	11.0	4.0	4.0	7.5	-	16.0	5.0	12.0	6.0	6.0	5.0	8.5
	B	7.0	14.5	9.5	3.5	2.5	7.0	-	14.0	4.5	10.0	4.5	5.0	4.0	6.0
	C	8.5	20.0	10.5	3.0	2.5	5.0	-	20.5	3.0	8.0	4.5	3.5	3.0	5.5
IV	A	9.0	15.5	13.5	4.5	4.0	8.0	22.0	17.0	5.5	13.5	7.0	6.0	5.0	10.0
	B	7.0	14.5	9.5	4.0	3.0	7.0	27.0	18.0	4.5	11.5	4.5	4.5	3.5	6.5
	C	8.0	16.0	10.0	3.0	2.5	5.5	21.0	22.0	3.5	9.0	4.0	4.0	3.0	7.0
V	A	10.5	16.0	13.5	5.0	5.5	10.0	25.0	17.0	6.0	15.0	9.0	7.0	5.5	11.5
	B	7.5	14.0	9.5	4.5	3.0	7.5	26.0	20.0	5.0	13.0	5.0	5.0	3.5	8.5
	C	9.0	16.5	10.0	3.5	2.5	5.5	23.5	23.0	4.5	9.0	5.0	4.0	3.5	9.0
VI	A	11.0	17.5	17.0	5.0	6.0	12.0	23.0	16.0	7.5	16.5	9.5	8.5	6.0	12.0
	B	8.5	14.0	10.5	4.0	3.5	8.0	29.0	20.0	5.5	12.5	5.0	5.5	3.5	10.0
	C	9.5	15.0	9.5	3.5	2.5	6.0	21.0	16.5	5.0	8.5	4.5	4.5	3.5	9.5
VII	A	11.0	20.5	19.0	5.5	5.5	13.0	27.0	14.5	8.0	15.0	9.5	9.0	6.5	11.5
	B	9.0	14.5	11.5	4.0	3.5	7.5	27.0	20.0	5.5	12.5	5.0	6.0	4.0	9.5
	C	8.5	15.5	8.5	3.0	2.5	5.0	22.0	17.0	5.0	7.5	3.5	4.0	2.5	7.5
VIII	A	12.0	19.0	18.5	6.0	5.0	10.5	28.0	20.5	7.5	13.5	8.5	8.0	6.0	11.0
	B	8.5	15.0	12.0	3.5	4.0	7.0	27.0	20.5	5.0	12.0	5.0	5.5	3.5	9.0
	C	8.0	13.5	9.5	2.5	2.0	5.5	21.5	17.0	4.5	8.0	3.5	3.5	2.0	5.5
IX	A	11.0	19.0	15.0	4.5	4.5	9.0	23.0	21.5	6.5	13.5	7.5	7.5	5.5	11.0
	B	8.5	15.5	11.0	3.5	3.5	7.0	24.0	20.5	4.5	12.0	5.0	5.0	3.5	9.0
	C	7.5	12.5	9.5	2.0	2.0	4.5	23.0	16.5	3.5	7.5	3.5	3.5	2.5	5.5
X	A	10.0	18.5	12.5	4.5	4.0	7.5	21.0	19.0	6.0	13.0	6.5	7.0	5.5	10.5
	B	8.0	15.5	10.5	3.5	3.0	6.5	22.0	19.0	4.5	11.5	5.0	5.0	3.5	9.5
	C	6.5	12.0	8.0	2.0	2.5	4.5	22.0	18.5	4.0	8.0	3.5	3.5	2.0	6.0
XI	A	10.0	18.0	11.5	3.5	4.0	7.5	20.0	16.0	5.0	12.5	6.0	6.5	5.0	9.5
	B	8.5	15.0	9.5	3.5	3.0	6.5	22.0	18.0	4.0	11.0	5.0	5.0	3.0	8.0
	C	6.0	10.5	8.0	2.0	2.5	4.5	19.0	16.0	3.0	7.5	3.5	3.0	2.0	5.0
XII	A	10.0	16.0	13.0	3.5	4.0	7.5	19.0	15.5	4.5	12.5	6.0	7.0	5.0	9.0
	B	7.5	15.0	11.0	3.5	2.5	6.5	20.0	17.0	4.0	11.0	5.5	5.5	3.0	9.0
	C	5.5	10.0	9.0	2.0	2.0	4.0	17.0	14.5	3.0	7.0	3.0	3.0	1.5	5.0
XIII	A	11.0	15.5	12.5	3.5	3.5	7.5	18.0	15.0	4.0	12.0	6.0	6.0	4.5	8.5
	B	7.5	14.5	11.0	3.5	3.0	6.0	19.0	16.5	4.5	11.0	5.0	4.5	3.5	8.5
	C	4.5	10.0	7.5	2.0	2.0	3.5	14.5	-	2.5	7.0	3.0	2.0	1.5	4.5
XIV	A		15.5					17.0	16.0		11.5		5.0		8.5
	B		14.0					18.5	17.0		11.0		3.5		7.5
	C		8.0					14.0	12.0		6.0		1.5		4.5
XV	A							15.0	13.5		10.5				(2) 8.0
	B							18.0	15.5		9.5				(2) 7.0
	C							16.0	11.5		5.5				(2) 3.5
XVI	A							19.0	15.0		9.5				(1) 7.0
	B							19.5	15.0		9.0				(1) 6.0
	C							14.0	11.0		5.0				(1) 3.0
XVII	A							17.0	-		10.5				
	B							19.5	-		8.5				
	C							13.5	-		5.0				
XVIII	A							21.0			9.5				
	B							17.0			7.0				
	C							12.5			4.5				

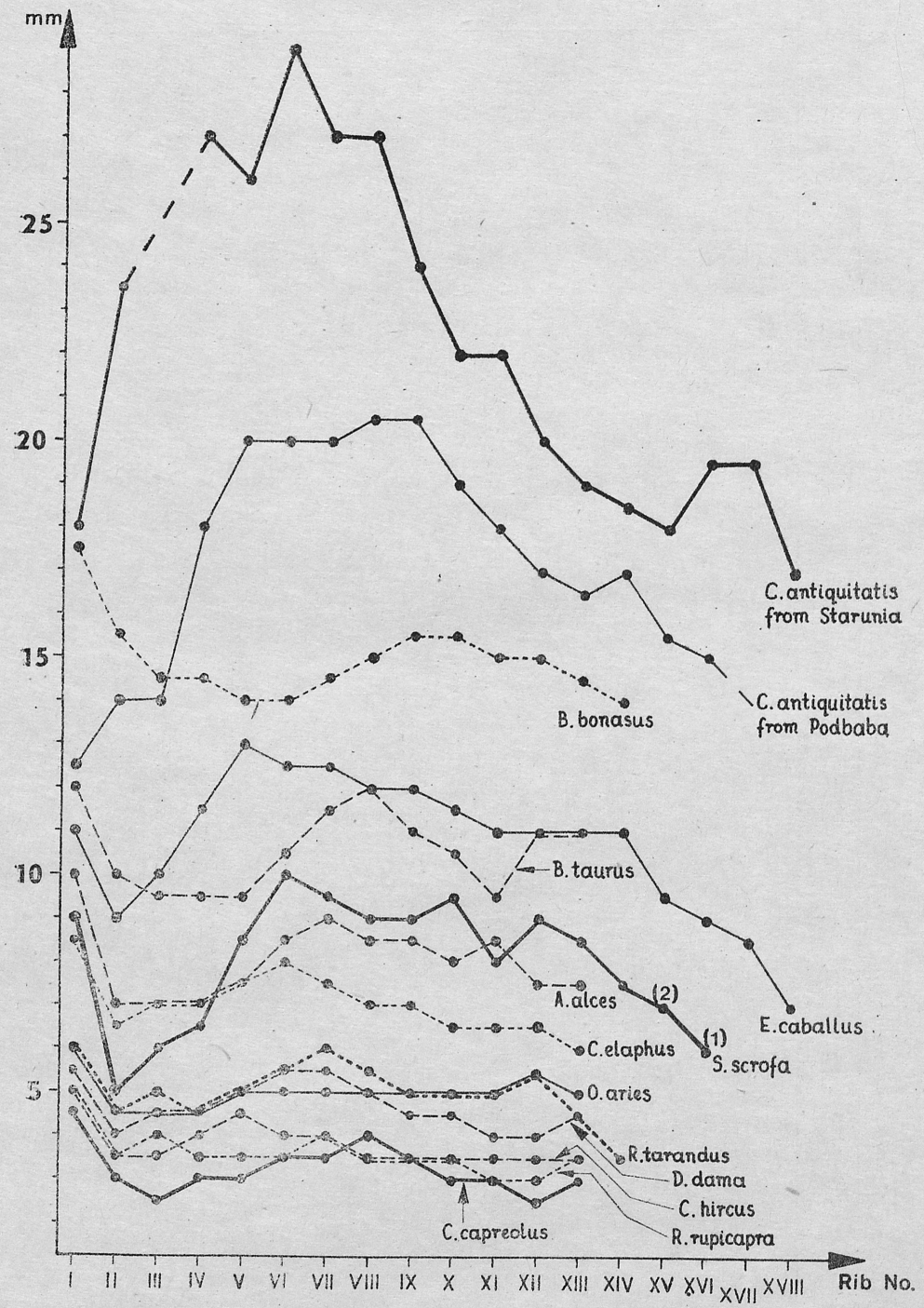

Fig. 13B. Curves representing serial variation in the thickness of corpus costae at point B (Defs. 1 and 8; see Table 10) — for details see p. 172

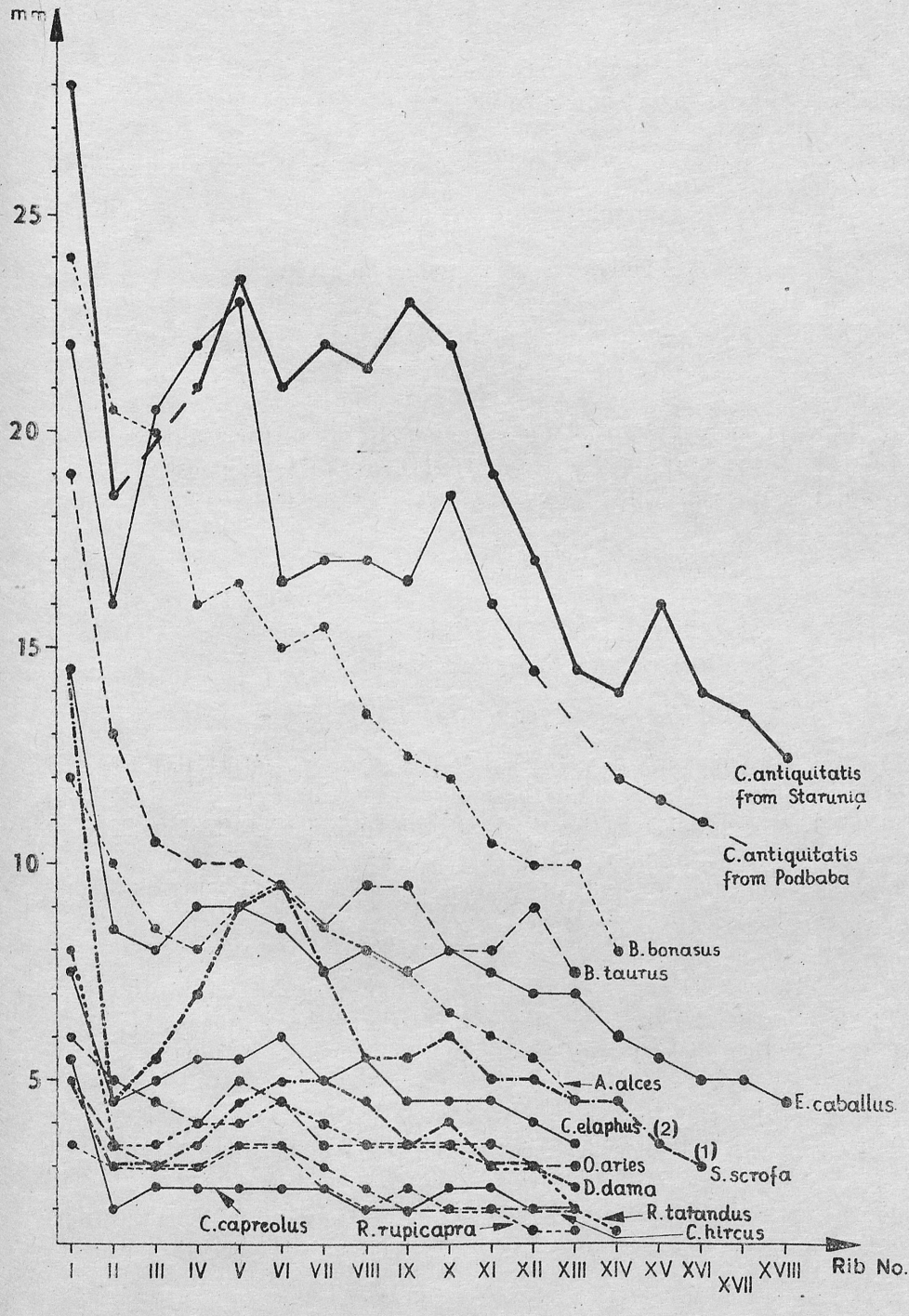

Fig. 13C. Curves representing serial variation in the thickness of corpus costae at point C (Defs. 1 and 8; see Table 10) — for details see p. 172

Sus scrofa L.

It mostly decreases from rib I (in XA) to II (in CY), increases to IV, V or VI (in CY) and next generally decreases up to the last posterior rib (in XA).

It reaches a minimum in the last posterior rib and a maximum mostly in VI.

3.3. Thickness of corpus costae (Def. 8)

3.3.1. Thickness of corpus costae at points A, B and C (Figs. 13 A—C; Table 10)

Alces alces (L.)

At A rib VIII or XIII is the thickest and III or IV the thinnest.
At B rib I or VII is the thickest and II, III or IV the thinnest.
At C rib I is the thickest and XIII the thinnest.

Bison bonasus (L.)

At A rib VII or, more rarely, VIII is the thickest and XIV the thinnest.
At B rib I is the thickest and VI or XIV the thinnest.
At C rib I is the thickest and XIV the thinnest.

Bos taurus L.

At A rib VI or, more frequently, VII is the thickest and II, III, XI, XII or XIII (most frequently II) the thinnest.
At B rib I, VII or VIII is the thickest and III, IV, XI, XII or XIII (most frequently IV) the thinnest.
At C rib I is the thickest and XI, XII or, most frequently, XIII the thinnest.

Capra hircus L.

At A rib VII or VIII is the thickest and XI, XII or XIII the thinnest.
At B rib I is the thickest and mostly X or XII the thinnest.
At C rib I is the thickest and the last posterior are the thinnest.

Capreolus capreolus (L.)

At A rib V, VI or VII (most frequently VI) is the thickest and XIII the thinnest.
At B rib I is the thickest and III, XII or, most rarely, XIII the thinnest.
At C rib I is the thickest and mostly II, XII or XIII the thinnest.

Cervus elaphus L.

At A rib VII is the thickest and mostly III the thinnest.
At B rib I is the thickest and II, III, IV or XIII the thinnest.
At C rib I is the thickest and II, III, XII or XIII the thinnest.

Coelodonta antiquitatis (BLUM.)

At A rib VIII (in the specimen from Starunia) or IX (in the one from Podbaba) is the thickest and XV the thinnest.
At B rib VI (in the specimen from Starunia) or VIII and IX (in the specimen from Podbaba) are the thickest and I (in the one from Podbaba) or XVIII (in that from Starunia) the thinnest.
At C rib I (in the specimen from Starunia) or V (in the specimen from Podbaba) is the thickest and XVI (in the one from Podbaba) or XVIII (in that from Starunia) the thinnest.

Dama dama (L.)

At A rib VII is the thickest and XIII the thinnest.
At B rib I, VI or VII is the thickest and II, XI or XII the thinnest.
At C rib I, VI or VII is the thickest and XIII the thinnest.

Equus caballus L.

At A rib V or, more frequently, VI is the thickest and I, XVI or, most frequently XVIII the thinnest.
At B rib V, VI or VII (most frequently V) is the thickest and XVIII the thinnest.
At C rib I is the thickest and XVIII the thinnest.

Ovis aries L.

At A rib VI or VII is the thickest and XI, XII or XIII the thinnest.
At B mostly rib I or XII is the thickest and mostly II or XIII the thinnest.
At C rib I is the thickest and XIII the thinnest.

Rangifer tarandus (L.)

At A rib VII or, more rarely, VIII is the thickest and II or, more frequently, XIV the thinnest.
At B rib I or, more frequently, VII is the thickest and II or more frequently, XIV the thinnest.
At C rib I is the thickest and XIV the thinnest.

Rupicapra rupicapra (L.)

At A rib VII or, more rarely, VIII is the thickest and XIII the thinnest.
At B rib I is the thickest and XI, XII or XIII (most frequently XII) the thinnest.
At C rib I, V or VI is the thickest and XII and XIII are the thinnest.

Sus scrofa L.

At A rib V, VI or IX (most frequently VI) is the thickest and II the thinnest.
At B rib VI or VII is the thickest and II or, more rarely, III the thinnest.
At C rib I is the thickest and II, penultimate or, most frequently, last posterior rib is the thinnest.

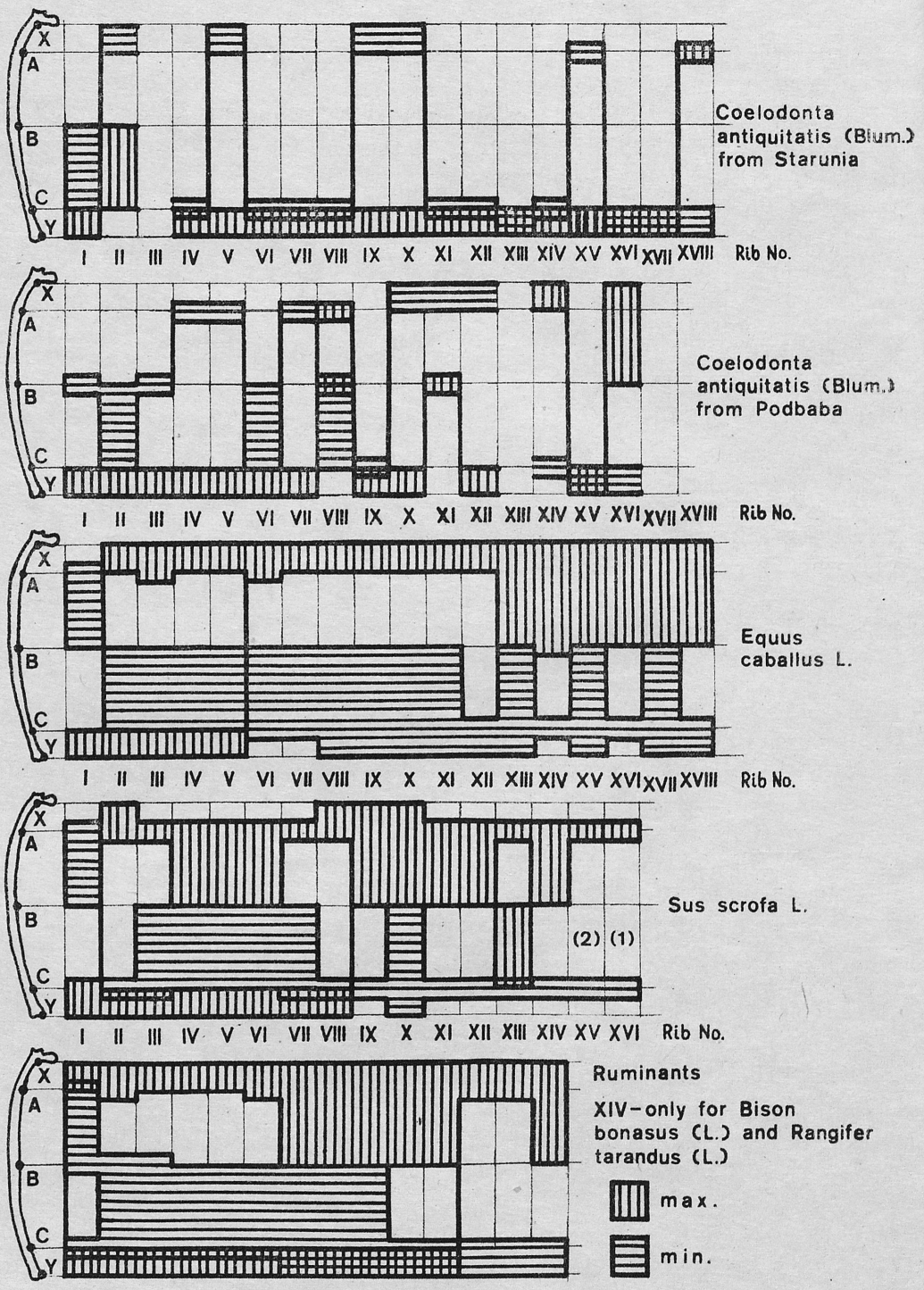

Fig. 14. Serial variation of the rib regions in which corpus costae usually reaches its greatest and smallest thicknesses (Def. 8; see Table 11) — for details see p. 172 and Def. 1

Table 11

The greatest and the smallest thickness of corpus costae, in mm (Def. 8; see Fig. 14) — for details see p. 172

Species / Rib	Alces alces (L.)		Bison bonasus (L.)		Bos taurus L.		Capra hircus L.		Capreolus capreolus (L.)		Cervus elaphus L.		Coelodonta antiquitatis (Blum.) Starunia		Coelodonta antiquitatis (Blum.) Podbaba		Dama dama (L.)		Equus caballus L.		Ovis aries L.		Rangifer tarandus (L.)		Rupicapra rupicapra (L.)		Sus scrofa L.	
	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.
I	22.0	9.5	31.0	16.0	23.0	12.0	6.0	4.5	12.0	4.0	14.0	7.0	35.0	17.0	27.0	12.5	7.0	5.0	18.5	10.0	11.5	5.5	12.5	6.0	7.0	3.5	14.5	8.0
II	17.5	6.5	26.0	15.5	17.0	9.5	5.0	3.5	5.0	2.0	10.0	4.0	24.5	18.0	20.0	12.0	6.0	3.0	14.0	7.0	7.5	4.5	6.5	3.5	5.5	3.0	7.5	4.5
III	14.5	7.0	27.0	14.0	17.0	8.0	5.5	3.0	6.0	2.5	10.5	5.0	-	-	29.0	14.0	5.5	3.0	14.0	6.5	9.0	4.0	7.5	3.5	5.5	3.0	9.5	4.5
IV	15.0	6.5	26.0	11.0	17.0	8.0	6.0	3.0	6.0	2.5	11.0	5.0	37.0	21.0	29.0	17.0	6.5	3.5	16.0	7.5	7.0	4.0	8.5	3.5	6.0	3.0	12.0	4.5
V	17.0	7.5	25.0	11.5	17.5	8.5	7.0	3.5	5.5	2.5	11.5	5.5	42.0	18.0	32.0	17.0	7.0	4.5	16.5	8.0	10.0	4.0	8.5	4.0	7.0	3.0	14.0	6.0
VI	16.0	8.0	25.0	11.5	19.5	8.0	6.0	3.0	6.5	2.5	13.5	6.0	36.0	21.0	24.0	15.5	7.5	5.0	17.0	8.0	9.5	3.5	9.0	4.0	6.5	3.5	13.5	7.5
VII	13.5	8.5	25.0	12.5	20.0	8.5	6.0	3.0	6.0	2.0	13.5	5.0	37.0	22.0	28.0	14.5	8.0	4.0	17.0	7.0	11.0	3.5	9.5	3.5	7.0	2.5	13.0	7.5
VIII	13.0	8.0	24.0	11.5	19.5	8.5	6.0	2.5	5.5	2.0	11.0	5.0	36.0	21.5	20.5	16.0	7.5	4.0	17.5	7.5	9.5	3.5	9.5	3.5	7.0	2.0	12.0	5.5
IX	12.0	7.0	20.5	11.5	18.0	8.0	5.5	2.0	5.0	2.0	10.5	4.5	32.5	22.0	27.0	16.5	6.5	3.0	17.0	7.0	8.0	3.5	8.5	3.5	6.5	2.0	11.5	5.5
X	12.0	6.5	20.0	12.0	14.5	8.0	5.0	2.0	4.5	2.0	9.0	4.0	32.5	18.5	26.0	18.0	6.0	3.0	15.5	7.5	7.0	3.5	8.0	3.5	6.0	2.0	11.5	5.5
XI	12.0	6.5	19.0	10.5	14.0	7.5	4.0	2.0	4.5	2.0	8.0	4.0	29.5	19.0	18.5	15.0	5.5	2.5	14.5	7.0	6.5	3.5	7.5	3.0	5.5	2.0	10.5	5.0
XII	10.5	5.5	19.0	10.0	15.0	8.0	4.0	2.0	4.0	2.0	8.0	3.5	24.0	17.0	20.0	14.5	5.0	2.5	14.0	7.0	7.0	3.0	7.0	2.5	5.0	1.5	10.0	5.0
XIII	11.0	4.5	17.0	10.0	14.0	7.0	4.0	2.0	4.0	2.0	8.0	3.5	24.0	14.0	-	-	5.0	1.5	12.5	6.5	6.0	3.0	6.5	2.0	4.5	1.5	9.5	4.5
XIV			16.5	8.0									24.0	14.0	18.0	12.0			12.0	6.0			5.5	1.5			9.0	4.5
XV													24.0	15.0	17.0	10.5			11.0	5.5							(2) 8.0	(2) 3.5
XVI													20.0	11.0	15.0	10.5			10.0	5.0							(1) 7.0	(1) 3.0
XVII													20.0	13.0	-	-			11.0	5.0								
XVIII													21.0	11.0					10.5	4.0								

3.3.2. Greatest thickness of corpus costae (Fig. 14; Table 11)

Alces alces (L.)

It decreases from rib I (in CY) to III (in CY), next increases to V or VI (in CY) and again decreases to increase in XIII (in A region).

It reaches inaximum in rib I and a minimum in XII (in XA).

Bison bonasus (L.)

It decreases from rib I (in CY) to II or III (in CY), next increases and decreases alternately to VI or VII (in CY) and generally decreases up to XIV (in XA).

It reaches a maximum in rib I and a minimum in XIV

Bos taurus L.

It decreases from rib I (in CY) to II, III (most rarely) or IV (in CY), next increases to VI, VII or, most rarely, VIII (in XA or CY) to decrease to X or, more frequently, XI (in XA); it mostly increases again and then comes down in XIII (in XA).

It reaches a maximum in rib I or, more rarely, VI, VII or VIII and a minimum in X, XI or XIII (most rarely in X).

Capra hircus L.

It decreases from rib I (in XA) to II (in XA), increases to V (in CY) and next either generally decreases to XIII (in XA) or to XI or XII (in XB) to increase again to XIII.

It reaches a maximum in rib V and a minimum in XI, XII or XIII.

Capreolus capreolus (L.)

It decreases from rib I (in CY) to II (in XA), next increases to III or IV (in CY) and decreases to V (in A region), starting from which it increases to VI, VII or, most rarely, VIII (in XB) and decreases again up to XIII (in A region).

It reaches a maximum in rib I and a minimum in XIII.

Cervus elaphus L.

It decreases from rib I (in CY) to II or III (in CY), next increases to VI or VII (in XA) and decreases up to XIII (in XA).

It reaches a maximum in rib I and a minimum in XIII.

Coelodonta antiquitatis (BLUM.)

It decreases from rib I (in CY) to II (in BY) and increases in the following ribs to decrease in VI (in CY) and increase in VII (in CY); next it generally decreases, in the specimen from Podbaba, to the last preserved rib, i.e. XVI

(in XB) and, in that from Starunia, to XVI and XVII (in CY) to increase in XVIII (in region).

It reaches a maximum in V (in CY) and a minimum in XVI (in the specimen from Podbaba) or XVI and XVII (in the one from Starunia).

Dama dama (L.)

It decreases from rib I (in XA) to III (in XA), increases in the following ribs to VII (in A region) and decreases again up to XII or XIII (in XA).

It reaches a maximum in rib VII and a minimum in XII or XIII.

Equus caballus L.

It decreases from rib I (in CY) to II or III (in XA or CY), increases to IV, V, VI, VII or, most frequently, VII (in XA or, in the case of IV and V, also in CY), next decreases, mostly to XV (in XB), and behaves in a various manner in the last three posterior ribs.

It reaches a maximum in rib I, IV, V, VII or VIII (most frequently in I or VIII) and a minimum in XV, XVI, XVII or XVIII (in XB) (most frequently in XVI or XVIII).

Ovis aries L.

It decreases from rib I (in XA) to II (in XA), next increases and decreases alternately to VII (in XA) and decreases in the following ribs to increase again in XII (in XA) and decrease in XIII (mostly in A region).

It reaches a maximum in rib I or VII and a minimum in XIII.

Rangifer tarandus (L.)

It decreases from rib I (in CY) to II (in XA), next increases to VII or VIII (in XA) to decrease up to XIV (in XB).

It reaches a maximum in rib I and a minimum in XIV.

Rupicapra rupicapra (L.)

It decreases from rib I (in XA or CY) to II or III (mostly in XA), increases to V, VI, VII or VIII (mostly in XA) and next decreases usually up to XIII (in XA).

It reaches a maximum in rib I, V, VI or VII and a minimum in XII or, more frequently, XIII.

Sus scrofa L.

It mostly decreases from rib I (in CY) to II (in XA or CY), increases to V or, more rarely, VI (in AB or CY), next decreases in the following rib (in AB or CY) and increases in the next one (in XA or CY) generally to decrease up to the last posterior rib (mostly in A region).

It reaches a maximum mostly in rib I and a minimum in the last posterior.

3.3.3. Smallest thickness of corpus costae (Fig. 14; Table 11)

Alces alces (L.)

It decreases from rib I (in B region) to II (in BC), next frequently increases to III (in B region) and decreases in IV (in BC) to rise again to VII (in B or C region) and decrease up to XIII (in C region).

It reaches a minimum in rib XIII and a maximum in I.

Bison bonasus (L.)

It decreases from rib I (in AB) mostly to IV (in BC), next increases to VII (in BC) and decreases and increases, generally alternately, up to XIV (in C region).

It reaches a minimum in rib XIV and a maximum in I.

Bos taurus L.

It decreases from rib I (in B region) to III or IV (in BC), next increases to V (in BC) and in the following ribs decreases and increases, generally alternately, up to XIII (in CY).

It reaches a minimum in rib XIII and a maximum in I.

Capra hircus L.

It decreases from rib I (in AB or in C region) to III or IV (in C region), next increases to V (in C region) and decreases up to the last posterior ribs (in C region).

It reaches a minimum in the last posterior ribs (X—XIII) and a maximum in I.

Capreolus capreolus (L.)

It decreases from rib I (in AB) to II (in C region), next increases mostly to V or VI (in C region) to decrease and increase, generally alternately, to IX, X or XI (in C region) and decrease to XIII (in C region).

It reaches a minimum mostly in ribs XII and XIII and a maximum in I.

Cervus elaphus L.

It decreases from rib I (in AB or in C region) to II (in C region), next increases to V or, more frequently, VI (in C region), decreases to VII (in CY), again increases in VIII (in CY) generally to decrease in the following ribs up to XIII (in CY).

It reaches a minimum in rib II or, more frequently, XIII and a maximum in I.

Coelodonta antiquitatis (Blum.)

In the Starunia specimen: it increases from rib I (in BC) to IV (in C region), next decreases and increases, generally alternately, up to XVIII (in CY).

It reaches a minimum in ribs XVI and XVIII and a maximum in VII (in C region) and IX (in XA).

In the Podbaba specimen: it decreases from rib I (in B region) to II (in BC), next increases to IV and V (in A region) and decreases again to VII (in A region); starting from this rib, it increases to X (in XA) to decrease next up to the last posterior ribs (in CY). It reaches a minimum in ribs XV and XVI and a maximum in X.

Dama dama (L.)

It decreases from rib I (in C region) to II or III (in C region), next increases to VI (in C region) and comes down up to XIII (in CY).

It reaches a minimum in XIII nad a maximum in I or VI.

Equus caballus L.

It decreases from rib I (in AB) to II or, more frequently, III (in BC), increases to V or VI (in BC) and further decreases and increases, generally alternately, mostly to XIV (in C region) and usually decreases to XVIII (in CY).

It reaches a minimum in rib XVIII and a maximum mostly in I.

Ovis aries L.

It generally decreases from rib I (in C region) to XII or XIII (in C region).

Rangifer tarandus (L.)

It decreases from rib I (in AB) to II, III or IV (most frequently II) (in BC), next increases to V or VI (in BC) and generally decreases up to XIV (in C region).

It reaches a minimum in rib XIV and a maximum in I.

Rupicapra rupicapra (L.)

It decreases from rib I (in C region) to II or III (in C region), next increases, mostly to VI (in C region), to decrease up to XIII (in CY).

It reaches a minimum in rib XIII and a maximum in I or VI.

Sus scrofa L.

It decreases from rib I (in AB) to II, III or IV (in BC), increases to VI or VII (in BC) and next generally decreases up to the last posterior ribs (in C region).

It reaches a minimum in the last but one or, more frequently, last posterior rib and a maximum in I, VI or VII (most frequently in I).

IV. DISCUSSION

1. Os costale

1.1. Number of pairs of ribs

Alces alces (L.)

It has typically 13 pairs of ribs, which is indicated by the author's own observations and those presented by GESSNER (1922), PILARSKI & ROSKOSZ (1959) and KOBRYŃ (1973). Occasionally these are 14 pairs (PILARSKI & ROSKOSZ, 1959).

Bison bonasus (L.)

It has typically 14 pairs of ribs, which is indicated by the author's own observations and those presented by BOJANUS (1827), FLOWER (1885), MERTENS (1906), KOCH (1932), JANICKI (1938), ALLEN (cited by MOHR, 1952), MOHR (1952), JUŚKO (1953), ROSKOSZ (1962) and KOBRYŃ (1973). Occasionally there are 13 pairs (BOJANUS, 1827; JANICKI, 1938; ROSKOSZ, 1962; KOBRYŃ, 1973).

Bos primigenius BOJ.

It has typically 13 pairs of ribs (BOJANUS, 1827; FLOWER, 1885; MERTENS, 1906).

Bos taurus L.

It has typically 13 pairs of ribs, which is indicated by the author's own observations and those presented by BOJANUS (1827), FLOWER (1885), CHAUVEAU (1890), LEISERING et al. (1890), SUSSDORF (1895), NUSBAUM (1903), MERTENS (1906), HOYER (1927), ELLENBERGER & BAUM (1932), SISSON (1945), KLIMOV (1950), NICKEL et al. (1954), KOBRYŃ (1973), KRYSIAK (1975), BARONE (1976), LUTNICKI (1977) and others. Occasionally there are 14 pairs of ribs (SISSON, 1945). In this case the 14th pair is represented by a rib on one side of body or one rib on either side (BARONE, 1976).

Capra hircus L.

It has typically 13 pairs of ribs, which is indicated by the author's own observations and those presented by FLOWER (1885), CHAUVEAU (1890), LEISERING et al. (1890), SUSSDORF (1895), HOYER (1927), ELLENBERGER & BAUM (1932), NICKEL et al. (1954), KOBRYŃ (1973), KRYSIAK (1975) and others.

Capreolus capreolus (L.)

It has typically 13 pairs of ribs, which is indicated by the author's own observations and those presented by PILARSKI & ROSKOSZ (1959) and KOBRYŃ (1973).

Cervus elaphus L.

It has typically 13 pairs of ribs, which is indicated by the author's own observations and those presented by FLOWER (1885), PILARSKI & ROSKOSZ (1959), ROSKOSZ & PYTEL (1966), SZANIAWSKI (1966) and KOBRYŃ (1973). Occasionally, a rib of the 14th pair occurs on one or both sides of body (ROSKOSZ & PYTEL, 1966).

Coelodonta antiquitatis (BLUM.)

The specimen found at Starunia in 1929 had 18 pairs of ribs and that from Podbaba probably 17. BRANDT (1877) writes that there are 18 pairs of ribs in the skeleton from Munich and the data included in GORDEEV & ŽERNAKOV's (1957) work show that the specimen from Fuljaèrdi has 19.

Thus, this species most probably had typically 18 pairs of ribs.

Dama dama (L.)

It has typically 13 pairs of ribs, which is indicated by the author's own observations and those presented by FLOWER (1885), PILARSKI & ROSKOSZ (1959) and KOBRYŃ (1973).

Equus caballus L.

It has typically 18 pairs of ribs, which is indicated by the author's own observations and those presented by NUHN (1878), FLOWER (1885), CHAUVEAU (1890), LEISERING et al. (1890), SUSSDORF (1895), NUSBAUM (1903), HOYER (1927), ELLENBERGER & BAUM (1932), SISSON (1945), AVTOKRATOV (1949), KLIMOV (1950), NICKEL et al. (1954), GILL et al. (1957), KRYSIAK (1975), BARONE (1976), LUTNICKI (1977) and others. Occasionally there are 19 pairs of ribs (FLOWER, 1885; LEISERING et al., 1890; NUSBAUM, 1903; HOYER, 1927; AVTOKRATOV, 1949; GILL et al., 1957; according to SISSON, 1945, the 19th pair may have a rib on either side of body or only one on one side or 17 pairs (LEISERING et al., 1890; AVTOKRATOV, 1949; GILL et al., 1957).

Mammuthus primigenius (BLUM.)

The specimen found at the mouth of the River Lena in 1799, called Adams's mammoth, had 19 pairs of ribs (FELIX, 1912; PFIZENMAYER, 1926). As can be seen from the data contained in the works of the below-mentioned writers, the specimen from Borna (FELIX, 1912), the specimen found at Starunia in 1907 (LUBICZ-NIEZABITOWSKI, 1911, 1914a), the one from "Pfännerhall" (TOEPFER, 1957) and that found at the sources of the River Atrikanova (COPPENS, 1958) had 19 pairs of ribs originally, too. PFIZENMAYER (1926) writes that the specimen found on the River Berezovka had 18 pairs, but FELIX (1912) claims that there were also two fragments, most probably derived from the 19th pair. According to FELIX (1912), the skeleton from Brussels contained 20 pairs of ribs.

The foregoing suggests that this species had typically 19 pairs of ribs.

Ovis aries L.

It has typically 13 pairs of ribs, which is indicated by the author's own observations and those presented by FLOWER (1885), CHAUVEAU (1890), LEISERING et al. (1890), SUSSDORF (1895), HOYER (1927), ELLENBERGER & BAUM (1932), SISSON (1945), NICKEL et al. 1954, KOBRYŃ (1973), KRYSIAK (1975), BARONE (1976) and others. Occasionally there are 14 pairs (KOBRYŃ, 1973), with the 14th pair having ribs on both sides of body or only one rib on one side (SISSON, 1945).

Rangifer tarandus (L.)

It has typically 14 pairs of ribs, which is indicated by the author's own observations and those presented by FLOWER (1885) and KOBRYŃ (1973).

Rupicapra rupicapra (L.)

It has typically 13 pairs of ribs, which is indicated by the author's own observations.

Sus scrofa L.

In the skeletons examined by the author there were 14—16 pairs of ribs (most frequently 14). It seems to have typically 14 pairs, which number is also given by FLOWER (1885), CHAUVEAU (1890), LEISERING et al. (1890), SUSSDORF (1895), STÖCKLI (1922), HOYER (1927), ELLENBERGER & BAUM (1932), SISSON (1945), AVTOKRATOV (1949), KLIMOV (1950), NICKEL et al. (1954), KRYSIAK (1975), BARONE (1976), LUTNICKI (1977) and others, although the occurrence of 15 pairs is frequent (LEISERING et al., 1890; SUSSDORF, 1895; STÖCKLI, 1922; HOYER, 1927; ELLENBERGER & BAUM, 1932; SISSON, 1945; AVTOKRATOV, 1949; KLIMOV, 1950; NICKEL et al., 1954; KRYSIAK, 1975; BARONE, 1976). Considerably more rarely there are 13 (ELLENBERGER & BAUM, 1932; AVTOKRATOV, 1949; KLIMOV, 1950), 16 (LEISERING et al., 1890; SUSSDORF, 1895; STÖCKLI, 1922; HOYER, 1927; ELLENBERGER & BAUM, 1932; AVTOKRATOV, 1949; KLIMOV, 1950) or 17 pairs (LEISERING et al., 1890; SUSSDORF, 1895; HOYER, 1927; KLIMOV, 1950). In SHAW'S opinion (cited by ELLENBERGER & BAUM, 1932), higher numbers of ribs occur in the biggest, heavy-boned strains and the smaller ones in the smaller, medium- and small-boned strains and types.

1.2. Length of os costale

This length was determined by earlier investigators on the basis of various measurements. In the present study it has been obtained from the measurement taken along margo anterior (Def. 1).

Alces alces (L.)

The results of the present study indicate that the ribs of pair VIII or, more frequently, IX are the longest. KOBRYŃ (1973) writes that rib VIII is

the longest, although Table 3 of his work suggests rather IX. The ribs of pair XIV, observed by PILARSKI & ROSKOSZ (1959), reach hardly a half of the length of pair XIII.

The ribs of pair I are the shortest. This is indicated by the author's own observations and those of KOBRYŃ (1973).

Bison bonasus (L.)

The author's own observations and those published by KOBRYŃ (1973) indicate that the ribs of pair IX or, more frequently, X are the longest. KOCH (1932), too, mentions pair IX or X. JUŚKO (1953) writes that IX, although, as can be seen from Table IX in her work, it is also X. JANICKI (1938) claims that rib VIII (in a young male) or IX (in two adults of either sex) is the longest and BOJANUS (1827) names rib IX.

The observations presented in this paper and those of JANICKI (1938), ALLEN (cited by MOHR, 1952), JUŚKO (1953) and KOBRYŃ (1973) indicate that the ribs of pair I are the shortest. Only in the case of a young male JANICKI (1938) mentions pair XIV.

Bos primigenius BOJ.

BOJANUS (1827) writes that its rib XIII reaches a length of 1.5 f. or 432 mm (BOJANUS, 1965).

As can be seen from the drawing of the skeleton of the specimen in the Jena Museum, published by BOJANUS (1827: Pl. XXIV), the ribs of pair I are the shortest.

Bos taurus L.

The results of the present study indicate that the ribs of pair IX or, more rarely, X are the longest. KOBRYŃ (1973) writes that rib VIII is the longest, although Table 3 of his work suggests rather IX. Other authors specify the following ribs as the longest: BARONE (1976) — VIII or IX, SUSSDORF (1895) and HOYER (1927) — IX, LEISERING et al. (1890), ELLENBERGER & BAUM (1932) and KLIMOV (1950) — VII—IX, and NICKEL et al. (1954) and KRYSIAK (1975) — VII—X.

The ribs of pair I are the shortest. This is indicated by the author's own observations and those of LEISERING et al. (1890), ELLENBERGER & BAUM (1932), KOBRYŃ (1973) and BARONE (1976).

Capra hircus L.

The results of the present study indicate that the ribs of pair VII, VIII or IX (most frequently VIII) are the longest. KOBRYŃ (1973) mentions rib VIII, SUSSDORF (1895) — IX, and NICKEL et al. (1954) and KRYSIAK (1975) ribs VII—X as the longest.

The ribs of pair I are the shortest. This is indicated by the author's own observations and those of KOBRYŃ (1973).

Capreolus capreolus (L.)

The results of the present study indicate that the ribs of pair VIII or, more frequently, IX are the longest. KOBRYŃ (1973) writes that rib VIII is the longest, although Table 3 of his work shows that it is more frequently rib IX.

The ribs of pair I are the shortest. This is indicated by the author's own observations and those of KOBRYŃ (1973).

Cervus elaphus L.

The results of the present study indicate that the ribs of pair IX are the longest. According to SZANIAWSKI (1966), it is rib VIII or IX. KOBRYŃ (1973) writes that rib VIII is the longest, although Table 3 of his work suggests rather IX.

The ribs of pair I are the shortest. This is indicated by the author's own observations and those of SZANIAWSKI (1966) and KOBRYŃ (1973).

Coelodonta antiquitatis (BLUM.)

Both in the Starunia specimen found in 1929 and in the skeleton from Podbaba the ribs of pair X are the longest and I the shortest.

According to LUBICZ-NIEZABITOWSKI (1914b), the length of rib I of the specimen found at Starunia in 1907 is 380 mm (for comparison: it is 315 mm in the specimen from Starunia from 1929 and 305 mm in the skeleton from Podbaba). This measurement for the rib (one of the last posterior ribs) found in the River Prosna, taken on the convex side, is 530 mm (LUBICZ-NIEZABITOWSKI, 1926).

Dama dama (L.)

The results of the present study indicate that the ribs of pair IX are the longest. KOBRYŃ (1973) writes that rib VIII is the longest, although Table 3 of his work suggests rather IX.

The ribs of pair I are the shortest. This is indicated by the author's own observations and those of KOBRYŃ (1973).

Equus caballus L.

The results of the present study indicate that the ribs of pair IX or, more frequently, X are the longest. BARONE (1976) gives rib IX, HOYER (1927) — X, LEISERING et al. (1890), ELLENBERGER & BAUM (1932), SISSON (1945) and KLIMOV (1950) — X or XI, and SUSSDORF (1895), NICKEL et al. (1954) and KRYSIAK (1975) — XI.

The ribs of pair I are the shortest. This is indicated by the author's own observations and those of LEISERING et al. (1890), HOYER ((1927), ELLENBERG & BAUM (1932), KLIMOV (1950) and BARONE (1976).

Mammuthus primigenius (BLUM.)

According to SALENSKY (sited by FELIX, 1912), the length of rib I of the specimen found on the River Berezovka is 50.2 cm and in the specimen from

Borna 55.5 cm (FELIX, 1912). This measurement for rib II of the specimen from the River Berezovka is 54.4 cm (SALENSKY, cited by FELIX, 1912) and in the specimen from Borna about 58 cm (FELIX, 1912). TOEPFER (1957) gives 44 cm for a juvenile. As regards the specimen from Borna, FELIX (1912) gives the following values of the lengths of the ribs: IV, measured along the external curvature — 81 cm, measured along the internal curvature — 69 cm, V — about 82 cm, VI, measured along margo anterior — 91 cm, VII — 101 cm, VIII — 112 cm, IX — 107 cm, X — 105 cm, presumably XIV — 71 cm, XV — above 65 cm, XVI, measured along the internal curvature — above 60 cm, XVIII — above 40 cm and XIX — 35.5 cm.

Thus, in the specimen from Borna the ribs of pair VIII are the longest and XIX the shortest.

Ovis aries L.

The results of the present study indicate that the ribs of pair VIII or, more frequently, IX are the longest. SUSSDORF (1895) gives rib IX, KOBRYŃ (1973) — IX or X, and NICKEL et al. (1954) and KRYSIAK (1975) ribs VII—X.

The ribs of pair I are the shortest. This is indicated by the author's own observations and those of KOBRYŃ (1973).

Rangifer tarandus (L.)

The results of the present study indicate that the ribs of pair VIII, IX or X (most frequently IX) are the longest. KOBRYŃ (1973) writes that rib VIII is the longest, although Table 3 of his work suggests rather IX or X.

The ribs of pair I are the shortest. This is indicated by the author's own observations and those of KOBRYŃ (1973).

Rupicapra rupicapra (L.)

The results of the present study indicate that the ribs of pair VIII or, more frequently, IX are the longest and I the shortest.

Sus scrofa L.

The results of the present study indicate that the ribs of pair VII or, more frequently, VIII are the longest. According to SUSSDORF (1895), it is rib VII and, to NICKEL et al. (1954), VI or VIII. SISSON (1945) and BARONE (1976) claim that ribs VI—VII reach the greatest length and, according to LEISERING et al. (1890), ELLENBERGER & BAUM (1932) and KLIMOV (1950), VI—VIII.

The ribs of pair I are the shortest. This is indicated by the author's own observations.

1.3. Curvature of os costale

The course of variation in the degree of bend in corpus costae observed in the present investigation agrees with the data given, among other authors, by SUSSDORF (1895), ELLENBERGER & BAUM (1932), SISSON (1945), NICKEL et.

al. (1954) and KRYSIAK (1975) for *Equus caballus* L., ELLENBERGER & BAUM (1932) and BARONE (1976) for *Sus scrofa* L., and KOBRYŃ (1973) * for the ruminants under the study except *Rupicapra rupicapra* (L.). From data of FELIX (1912) and TOEPFER (1957) it results that the curvature of corpus costae changes in a similar manner in *Mammuthus primigenius* (BLUM.). On the basis of the drawing of the skeleton of the specimen of *Bos primigenius* BOJ. presented by BOJANUS (1827: Pl. XXIV) it may be stated that the same variation occurred also in that species.

The serial variation of the angle between collum costae and corpus costae, described in the third part (Results), corresponds, as regards *Bos taurus* L., to the data given by BARONE (1976). The statement that this angle is less obtuse in the artiodactyls examined than in the perissodactyls agrees with the observations published by SISSON (1945) on *Bos taurus* L. and *Equus caballus* L.

According to the author, the ribs are more strongly bent in the perissodactyls examined than in the artiodactyls. This agrees with the data presented by HOYER (1927), ELLENBERGER & BAUM (1932) and SISSON (1945) for *Equus caballus* L. and *Bos taurus* L. The relationship found between the angle of curvature and the body mass of the animal in the artiodactyls is decribed by KOBRYŃ (1973) for the sternal ribs of the ruminants under the present study except *Rupicapra rupicapra* (L.). LEISERING et al. (1890), ELLENBERGER & BAUM (1932), NICKEL et al. (1954) and KRYSIAK (1975) write that the bend in the ribs is greater in *Capra hircus* L. and *Ovis aries* L than in *Bos taurus* L. SISSON (1945) confirms that for *Ovis aries* L. and *Bos taurus* L. SISSON (1945) and BARONE (1976) paid attention to the particularly marked bend in the region of angulus costae in the anterior ribs of *Sus scrofa* L. observed also by the author of the present study.

2. Dorsal end of rib

2.1. Caput costae

The author's own observations and those of NICKEL et al. (1954) and KRYSIAK (1975) indicate that crista capitis costae separates facies articularis capitis costae anterior from facies articularis capitis costae posterior on all the ribs of *Sus scrofa* L. The above-mentioned investigators think that facies articularis capitis costae anterior is lacking on the last three posterior ribs, which situation the author found only on the ribs of pair XVI of one specimen. The

* This author gives the numerical values of the angle of the rib curvature (in Table 8), the length of the curvature radius (in Table 9) and the coefficient of the rib curvature (in Table 10) for the ribs of 10 specimens of *Alces alces* (L.), 93 specimens of *Bison bonasus* (L.), 14 specimens of *Bos taurus* L., 3 specimens of *Capra hircus* L., 22 specimens of *Capreolus capreolus* (L.), 24 specimens of *Cervus elaphus* L., 5 specimens of *Dama dama* (L.), 17 specimens of *Ovis aries* L. and 7 specimens of *Rangifer tarandus* (L.).

existence of two detached articular surfaces on caput costae was also observed in *Mammuthus primigenius* (BLUM.) (LUBICZ-NIEZABITOWSKI, 1914a; TOEPFER, 1957). According to the author, the junction of these surfaces is very frequent in the ruminants (it is most frequent in *Bos taurus* L.). SZANIAWSKI (1966) observed it on the ribs of pair I in *Cervus elaphus* L. and JANICKI'S (1938) paper shows that this phenomenon occurs also on the first anterior ribs of *Bison bonasus* (L.), in which, according to KOBRYŃ (1973), crista capitis costae is indistinct in the first three anterior ribs. Only NICKEL et al. (1954) write that in *Bos taurus* L., *Capra hircus* L. and *Ovis aries* L. caput costae has a distinct crista capitis costae in all ribs.

The diameter of caput costae of rib I in the Starunia specimen of *Coelodonta antiquitatis* (BLUM.) from 1907 is 3 cm (LUBICZ-NIEZABITOWSKI, 1914b). In the specimen of *Mammuthus primigenius* (BLUM.) from "Pfännerhall" this measurement is 6 cm for rib I and 5.5 cm for II (TOEPFER, 1957), and in the specimen from Starunia 7 cm for presumable XI or XII and 6 cm for ribs XIV—XIX (LUBICZ-NIEZABITOWSKI, 1914a).

2.2. Tuberculum costae

The serial variation of the prominence of tuberculum costae described in the part on the results obtained was also observed by KOBRYŃ (1973) in *Bison bonasus* (L.). BARONE (1976) turns an attention on to a particularly considerable height of tuberculum costae in the anterior ribs of *Sus scrofa* L., the fact which has been observed by the present author.

According to LUBICZ-NIEZABITOWSKI (1914b), the greatest diameter of facies articularis tuberculi costae for rib I of the specimen of *Coelodonta antiquitatis* (BLUM.) found at Starunia in 1907 is 30 mm and the smallest 20 mm (for comparison: in the Podbaba specimen 30.5 mm and 23 mm, respectively). These values for rib I of the specimen of *Mammuthus primigenius* (BLUM.) from "Pfännerhall" are 57 mm and 43 mm, respectively (TOEPFER, 1957).

The lack of facies articularis tuberculi costae, often observed by the author in the last posterior ribs of the ruminants, was also found by PILARSKI & ROSKOSZ (1959) on ribs XII and XIII of *Alces alces* (L.); KOBRYŃ (1973) observed it on rib XIV of *Bison bonasus* (L.) (the specimens of this species examined by JANICKI, 1938, had facies articularis tuberculi costae even on the last posterior rib), SISSON (1945) and BARONE (1976) on the last posterior ribs an NICKEL et al. (1954) on rib XIII of *Bos taurus* L., SZANIAWSKI (1966) on rib XIII of *Cervus elaphus* L., and LEISERING et al. (1890) and ELLENBERGER & BAUM (1932) on rib XIII of *Capra hircus* L. and *Ovis aries* L.

The ellipticity of facies articularis tuberculi costae found in most ribs of the ruminants under study was also observed by KOBRYŃ (1973) in *Bison bonasus* (L.).

The course of variation observed in the concavity of facies articularis tu-

berculi costae in the ruminants examined was also described by KOBRYŃ (1973) for *Bison bonasus* (L.) and by SISSON (1945) and BARONE (1976) for *Bos taurus* L.

2.3. Collum costae

The union of facies articularis capitis costae posterior with facies articularis tuberculi costae occurred on ribs XV—XVIII in the examined specimens of *Equus caballus* L. (most frequently on XVIII and XVIII). It was observed by LEISERING et al. (1890), SUSSDORF (1895), KLIMOV (1950) and BARONE (1976) on the last two posterior ribs, by HOYER (1927) and SISSON (1945) on the last two or three, and by ELLENBERGER & BAUM (1932), NICKEL et al. (1954) and KRYSIAK (1975) on the last three posterior ribs of the this species. As regards *Sus scrofa* L., the author observed the union of these articular surfaces on ribs XI—XVI. NICKEL et al. (1954) and KRYSIAK (1975) claim that it takes place on the last three posterior ribs, LEISERING et al. (1890) recorded it from the last three or four posterior ribs, BARONE (1976) from four or five and SISSON (1945) from five or six. LUBICZ-NIEZABITOWSKI (1926) writes that on one of the last posterior ribs of *Coelodonta antiquitatis* (BLUM.) from the River Prosna facies articularis capitis costae posterior is joined with facies articularis tuberculi costae (the greatest diameter of these surfaces is 43 mm, the shortest 26 mm). No such junctions were observed in the examined specimens of this species (the ribs of pair XVIII of the Starunia specimen have no facies articularis capitis costae posterior and the last pair of ribs of the Podbaba specimen has been lost). Collum costae is particularly conspicuous in the ribs of the ruminants under study and it never comes to the union of the above-mentioned surfaces. The same was indicated by the observations published by JANICKI (1938) and KOBRYŃ (1973) for *Bison bonasus* (L.), LEISERING et al. (1890), ELLENBERGER & BAUM (1932), NICKEL et al. (1954), KRYSIAK (1975) and BARONE (1976) for *Bos taurus* L., SZANIAWSKI (1966) for *Cervus elaphus* L., and NICKEL et al. (1954) and KRYSIAK (1975) for *Capra hircus* L. and *Ovis aries* L. HOYER (1927) and SISSON (1945) think that collum costae is more distinct in *Bos taurus* L. than in *Equus caballus* L.

According to LUBICZ-NIEZABITOWSKI (1914b), the spread of the dorsal end of rib I in the specimen of *Coelodonta antiquitatis* (BLUM.) from Starunia from 1907 is 110 mm and the length of collum costae 30 mm (for comparison: in the skeleton from Podbaba 61 mm and 10 mm, respectively). The spread of the dorsal end of rib I in the specimen of *Mammuthus primigenius* (BLUM.) from Borna is 10.8 cm (FELIX, 1912), whereas in the one from "Pfännerhall" it is 12.6 cm and in rib II 10 cm (TOEPFER, 1957).

According to LUBICZ-NIEZABITOWSKI (1914b), the breadth of collum costae for rib I of the Starunia specimen of *Coelodonta antiquitatis* (BLUM) found in 1907 is 17 mm (for comparison: in the skeleton from Podbaba it is 17.5 mm). This measurement for ribs XIV—XIX in the specimen of *Mammuthus primigenius* (BLUM.) from Starunia is 40 mm (LUBICZ-NIEZABITOWSKI, 1914a).

3. Corpus costae

3.1. Transverse section through corpus costae

Most of the authors quoted describe the morphology of corpus costae in various species, but they do that in a very general manner, insufficient for determining the species. POPLEWSKI (1948), FRECHKOP (1958) and LUTNICKI (1977) emphasize the role of transverse sections in discrimination of the species.

MERTENS (1906) states that the ribs of *Bos primigenius* BOJ. are broad and flat in transverse sections and, according to BOJANUS (1827), they are broader than those of *Bos taurus* L. LUBICZ-NIEZABITOWSKI (1914a) writes that in shape the transverse section through the dorsal part of corpus costae in *Mammuthus primigenius* (BLUM.) more or less resembles a rhomboid with a long outer side. FELIX (1912) reports that facies externa of rib I of the specimen from Borna is lightly convex and its facies interna is nearly flat (only in the ventral part it is somewhat concave).

3.2. Breadth of corpus costae

Alces alces (L.)

According to the author, the broadest ribs are those of pair I (at B — III or V). KOBRYŃ'S (1973: Tables 4 and 5) observations show that rib I is the broadest but, basing himself only on the measurements taken halfway along corpus costae, he writes that it is rib V, although his Table 4 suggests also rib III.

Bison bonasus (L.)

According to the author, the broadest ribs are those of pair I (at B — VII or VIII). KOCH (1932) writes that rib VII is the broadest (although Table 22 presented in his work indicates also rib I) and JANICKI (1938) — VII or VIII, although the data given in his Table 44 suggest rib I. KOBRYŃ'S (1973: Tables 4 and 5) observations show that it is rib I but, basing himself only on the measurements taken halfway along corpus costae, he writes that VII or VIII

Bos taurus L.

According to the author, the broadest ribs are those of pair I, VI or VII (at B — VII or VIII). KOBRYŃ'S (1973: Tables 4 and 5) observations show that rib I is the broadest but, basing himself only on the measurements taken halfway along corpus costae, he writes that it is rib VII or VIII. LEISERING et al. (1890), HOYER (1927) and ELLENBERGER & BAUM (1932) mention rib VI and BARONE (1976) — VIII or IX. NICKEL et al. (1954) claim that ribs VI—VIII reach the greatest breadth.

Capra hircus L.

According to the author, the broadest ribs are those of pair I (at B — I, III, IV or, most frequently, VII). KOBRYŃ'S (1973: Tables 4 and 5) observations show that rib I is the broadest but, basing himself only on the measurements taken halfway along corpus costae, he writes that it is rib VII or VIII, although his Table 4 suggests rather III. NICKEL et al. (1954) think that ribs VI—VIII reach the greatest breadth.

Capreolus capreolus (L.)

According to the author, the broadest ribs are those of pair I or, more frequently, IV or V (at B — III, IV or V). KOBRYŃ'S (1973: Tables 4 and 5) observations show that rib I, IV or V is the broadest but, basing himself only on the measurements taken halfway along corpus costae, he writes that it is rib VII, although his Table 4 suggests rather II or IV.

Cervus elaphus L.

According to the author, the broadest ribs are those of pair I, V, VI or VII (at B — IV, VI or VII). KOBRYŃ'S (1973: Tables 4 and 5) observations show that rib I is the broadest but, basing himself only on the measurements taken halfway along corpus costae, he writes that it is rib VII, although his Table 4 suggests also VI. SZANIAWSKI (1966) writes that ribs VII—VII reach the greatest breadth.

Coelodonta antiquitatis (BLUM.)

In the Starunia specimen from 1929 the ribs of pair VI are the broadest and in the skeleton from Podbaba — I (at B — V in both cases).

LUBICZ-NIEZABITOWSKI (1914b) writes that in the Starunia specimen from 1907 the breadth of rib I measured halfway along the rib is 40 mm and close to the ventral end 65 mm (for comparison: as regards the specimen found at the same locality in 1929, these measurements, are respectively, 36 mm and 44.5 mm, and in the skeleton from Podbaba, 36 and 54 mm. The breadth of one of the last posterior ribs (found in the River Prosna) measured in the middle of its length is 46 mm (LUBICZ-NIEZABITOWSKI, 1926).

Dama dama (L.)

According to the author, the broadest ribs are those of pair VI (at B — VII). KOBRYŃ'S (1973: Tables 4 and 5) observations show that rib I is the broadest but, basing himself only on the measurements taken halfway along corpus costae, he writes that it is rib VII.

Equus caballus L.

The author's own observations show that the ribs of pair I or VI are the broadest (at B — VI). LEISERING et al. (1890), HOYER (1927), ELLENBERGER &

BAUM (1932), SISSON (1945), KLIMOV (1950) and NICKEL et al. (1954) give rib VI as the broadest and SUSSDORF (1895) — VI or VII.

Mammuthus primigenius (BLUM.)

Corpus costae of rib I in the specimen from Borna reaches its greatest breadth, which is 9.9 cm, at a distance of about 8 cm from the ventral end (FELIX, 1912), in the skeleton from "Pfännerhall" the greatest breadth is 14.2 cm at the ventral end (TOEPFER, 1957) and in the specimen found on the River Berezovka 8.5 cm (SALENSKY, cited by FELIX, 1912). As regards rib II, the greatest breadth is 6.2 cm in the dorsal part of corpus costae in the specimen from Borna (FELIX, 1912), 7.6 cm at the ventral end the skeleton from "Pfännerhall" (5.5 cm in a juvenile) (TOEPFER, 1957) and 8.7 cm in the specimen found on the River Berezovka (SALENSKY, cited by FELIX, 1912). For the specimen from Borna FELIX (1912) gives the following values of the breadth of corpus costae: rib IV (the greatest breadth) — 6 cm, V (in the dorsal part, where it is particularly broad) — 8.3 cm, VI (in the dorsal part) — 7.7. cm and (close to the ventral end) — 5.4 cm, VII (in the dorsal part) — 6.8 cm and (at the ventral end) — 4.6 cm, VIII (in the dorsal part) — 4.8 cm and (at the ventral end) — 3.5 cm, X (in the dorsal part) — 5.2 cm and (at the ventral end) — 3.6 cm, XV — 5.3 cm, XVI (in the dorsal part) — 4.8 cm and (in the ventral part) — 4.1 cm and XVIII (halfway along the rib) — 3.7 cm.

Thus, the ribs of pair I are the broadest in the specimen from Borna.

Ovis aries L.

According to the author, the broadest ribs are those of pair I (at B — VII). KOBRYŃ'S (1973: Tables 4 and 5) observations show that rib I is the broadest (measured halfway along corpus costae — VI or VIII). NICKEL et al. (1954) think that ribs VI—VIII reach the greatest breadth.

Rangifer tarandus (L.)

According to the author, the broadest ribs are those of pair I, IV, V or VI (at B — I or, more frequently, III). KOBRYŃ'S (1973: Tables 4 and 5) observations show that rib I is the broadest but, basing himself only on the measurements taken halfway along corpus costae, he writes that it is rib IV, although his Table 4 suggests also III or V.

Rupicapra rupicapra (L.)

The author's own observations show that the ribs of pair I are the broadest (at B — VI or, more rarely, VII).

Sus scrofa L.

The author's own observations show that the ribs of pair I, III or IV are the broadest (at B — III or, more rarely, IV). NICKEL et al. (1954) and KRYSIAK (1975) ascribe the greatest breadth to ribs II—IV and LEISERING et al. (1890), ELLENBERGER & BAUM (1932) and SISSON (1945) to III—IV.

3.3. Thickness of corpus costae

Alces alces (L.)

According to the author, the thickest ribs are those of pair I (at B — I or VII). On the basis of the measurements taken halfway along corpus costae KOBRYŃ (1973) mentions rib I.

Bison bonasus (L.)

According to the author, the thickest ribs are those of pair I (at B — also I). This agrees with JANICKI'S (1938: Table 44) observations. Basing himself on the measurements taken halfway along corpus costae, KOBRYŃ (1973) writes that rib I is the thickest, although Table 7 of his work shows that also X (more rarely).

Bos taurus L.

According to the author, the thickest ribs are those of pair I or, more rarely, VI, VII or VIII (at B — I, VII or VIII). Basing himself on the measurements taken halfway along corpus costae, KOBRYŃ (1973) writes that rib I is the thickest, although Table 7 of his work shows that rather XII or XIII.

Capra hircus L.

According to the author, the thickest ribs are those of pair V (at B — I). On the basis of the measurements taken halfway along corpus costae KOBRYŃ (1973) mentions rib I.

Capreolus capreolus (L.)

According to the author, the thickest ribs are those of pair I (at B — also I). The same ribs are mentioned by KOBRYŃ (1973) on the basis of the measurements taken halfway along corpus costae.

Cervus elaphus L.

According to the author, the thickest ribs are those of pair I (at B — also I). Basing himself on the measurements taken halfway along corpus costae, KOBRYŃ (1973) writes that rib I is the thickest, although Table 7 of his work shows that also VI.

Coelodonta antiquitatis (BLUM.)

In the specimens examined the ribs of pair V are the thickest (at B — VI in the Starunia specimen or VIII and IX in the Podbaba skeleton).

LUBICZ-NIEZABITOWSKI (1914b) writes that in the Starunia specimen from 1907 the thickness of rib I in the middle of its length and close to the ventral end is 20 mm in both cases (for comparison: as regards the specimen found at the same locality in 1929, these measurements are, respectively, 18 mm and 28 mm, and in the skeleton from Podbaba, 12.5 mm and 22 mm). The thickness of one of the last posterior ribs from the River Prosna, measured halfway along the rib, is 15 mm (LUBICZ-NIEZABITOWSKI, 1926).

Dama dama (L.)

According to the author, the thickest ribs are those of pair VII (at B — I, VI or VII). Basing himself on the measurements taken halfway along corpus costae, KOBRYŃ (1973) writes that rib I is the thickest, although Table 7 of his work shows that also VII.

Equus caballus L.

The author's own observations indicate that the ribs of pair I, IV, V, VI, VII or VIII (most frequently I or VIII) are the thickest (at B — V or, more rarely, VI or VII). HOYER (1927) and BARONE (1976) emphasize the considerable thickness of rib I.

Mammuthus primigenius (BLUM.)

In the specimen from "Pfännerhall" the thickness of rib II at the ventral end of corpus costae is 33 mm (TOEPFER, 1957). FELIX (1912) writes that in the specimen from Borna this measurement for rib XV, taken in the middle of its length, is 32 mm and at the ventral end 34.5 mm. The greatest thickness of rib XIX of this specimen is 24 mm in the dorsal part (FELIX, 1912).

Ovis aries L.

According to the author, the thickest ribs are those of pair I or VII (at B — I or XII). Basing himself on the measurements taken halfway along corpus costae, KOBRYŃ (1973) writes that rib I is the thickest, although Table 7 of his work shows also XIII.

Rangifer tarandus (L.)

According to the author, the thickest ribs are those of pair I (at B — I or, more frequently, VII). Basing himself on the measurements taken halfway along corpus costae, KOBRYŃ (1973) writes that rib I is the thickest, although Table 7 of his work shows also XII.

Rupicapra rupicapra (L.)

The author's own observations indicate that the ribs of pair I, V, VI, or VII are the thickest (at B — I).

Sus scrofa L.

The author's own observations indicate that mostly the ribs of pair I are the thickest (at B — VI or VII). NICKEL et al. (1954), KRYSIAK (1975) and BARONE (1976) emphasize the marked thickness of rib I.

Translated into English
by Jerzy Zawadzki

Institute of Systematic and Experimental Zoology
Polish Academy of Sciences
Sławkowska 17
31-016 Kraków, Poland

REFERENCES

Avtokratov D. M. 1949. Anatomija domašnich životnych. Moskva, 348 pp., 118 figs.

Barone R. 1976. Anatomie comparée des mammifères domestiques. T. 1. Osteologie. Fasc. 1, 2. Paris, 296+428 pp., 401 pls.

Bieda F. 1969. Paleozoologia. T. 2. Warszawa, 582 pp., 378 figs.

Bojanus L. H. 1827. De uro nostrate eiusque sceleto commentatio. Nova Acta physico-medica Academiae Caesareae Leopoldino-Carolinae, Naturae Curiosum, Bonnae, 13 (2): 413—478, pls. XX—XXIV.

Bojanus L. H. 1965. De uro nostrate eiusque sceleto commentatio. Rozważania nad żubrem i jego kośćcem. Memorab. zool., Wrocław—Warszawa—Kraków, (14): 1—186, 23 figs., pls. XX—XXIV.

Borsuk-Białynicka M. 1973. Studies on the Pleistocene rhinoceros *Coelodonta antiquitatis* (Blumenbach). Palaeont. pol., Warszawa—Kraków, 29: 1—96, 13 figs., pls. I—XXIII.

Brandt J. F. 1877. Versuch einer Monographie der Tichorhinen Nashörner nebst bemerkungen über *Rhinoceros leptorhinus* Cuv. U. S. W. Mém. Acad. Impér. Sci. St.—Pétersbourg, série VII, 24 (4): II+1—135, pls. I—XI.

Chauveau A. 1890. Traité d'anatomie comparée des animaux domestiques. Paris, VIII+1064 pp., 455 figs.

Coppens Y. 1958. Le Mammouth de l'Atrikanova (Sibérie). Bull. Mus. Nat. Hist. natur., Paris, série 2, 30 (4): 402—406.

Dobberstein J., Hoffmann G. 1961. Lehrbuch der vergleichenden Anatomie der Haustiere. Bd. 1. Leipzig, VIII+191 pp., 249 figs., pl. I.

Duerst J. U. 1930. Vergleichende Untersuchungsmethoden am Skelett bei Säugern. In: E. Abderhalden (ed.) — Handbuch der biologischen Arbeitsmethoden. Berlin-Wien, Abt. VII (1): 125—530, figs. 23—249.

Ellenberger W., Baum H. 1932. Handbuch der vergleichenden Anatomie der Haustiere. Berlin, XVIII+1102 pp., 1393 figs.

Felix J. 1912. Das Mammuth von Borna. Veröffentlichungen des Städtischen Museums für Völkerkunde zu Leipzig, Leipzig, (4): IV+1—53, 9 figs., pls. I—VIII.

Flower W. H. 1885. An introduction to the osteology of the *Mammalia*. London, XI+383 pp., 134 figs.

Frechkop S. 1958. Notes sur les Mammifères. XLV. — Les côtes des Ongulés; leur intérêt systématique et physiologique. Bull. Inst. r. Sci. nat. Belg., Bruxelles, 34 (21): 1—7, 2 figs.

Gessner I. 1922. Die Gliederung der Rippen bei den Säugetieren. Gegenbaurs morph. Jahrb., Leipzig, 52 (2): 197—220, 4 figs., pl. IV.

Gill J., Jaczewski Z., Wilkus E. 1957. Zarys anatomii i fizjologii zwierząt gospodarskich. Warszawa, 817 pp., 376 figs.

Gordeev T. P., Žernakov V. N. 1957. Skelet iskopaemogo nosoroga najdennyj v okrestnostjach st. Fuljaèrdi Chèjlunczjanskoj provincii. Vert. palasiat., Peking, 1 (3): 233—246, 5 figs., pls. I—IV.

Hoyer H. 1927. Anatomia porównawcza zwierząt domowych. Kraków, IV+323 pp., 206 figs.

Janicki S. 1938. Badania nad szkieletem żubra (*Bison bonasus* L.). Prace roln.-leśne P.A.U., Kraków, (27): 1—55, pls. I—IV.

Juśko J. 1953. Dimorfizm płciowy szkieletu żubra (*Bison bonasus*). Folia morph., Warszawa, 4 (1): 1—30, 13 figs.

Klimov A. F. 1950. Anatomija domašnich životnych. T. 1. Moskva, 560 pp., 365 figs.

Kobryń H. 1973. The thorax in European bison and other ruminants. Acta theriol., Białowieża, 18 (17): 313—341, 6 figs.

Koch W. 1932. Über Wachstums- und Altersveränderungen am Skelett des Wisents. Beitr. zur Natur- und Kulturgesch. Lithauens und angrenzender Gebiete. Abhandl. d. math.-

naturw. Abt. d. Bayer. Akad. d. Wiss., München., Suppl.-Band. Abhandl. **15**: 553—678, 44 figs., pls. I—III.

KRYSIAK K. 1975. Anatomia zwierząt. T. **1**. Warszawa, 639 pp., 283 figs.

LEISERING A. G. T., MUELLER C., ELLENBERGER W. 1890. Handbuch der vergleichenden Anatomie der Haus-säugetiere. Berlin, VI+948 pp., 248 figs.

LUBICZ-NIEZABITOWSKI E. 1911. Die Haut- und Knochenüberreste des in Starunia in einer Erdwachsgrube gefundenen Mammut-Kadavers (*Elephas primigenius*). Bull. int. Acad. Sci. Cracov., Cl. d. Sci. Math. et Nat., série B, Cracovie, 229—239, pl. VII.

LUBICZ-NIEZABITOWSKI E. 1914 a. Słoń mamut (*Elephas primigenius* BLUM.). In: J. A. BAYGER et al. — Wykopaliska Staruńskie. Słoń mamut (*Elephas primigenius* BLUM.) i nosorożec włochaty (*Rhinoceros antiquitatis* BLUM. s. *tichorhinus* FISCH.) wraz z współczesną florą i fauną. Kraków, 95—180, pls. I—XXV.

LUBICZ-NIEZABITOWSKI E. 1914 b. Nosorożec włochaty (*Rhinoceros antiquitatis* BLUM. s. *tichorhinus* FISCH.). In: J. A. BAYGER et al. — Wykopaliska Staruńskie. Słoń mamut (*Elephas primigenius* BLUM.) i nosorożec włochaty (*Rhinoceros antiquitatis* BLUM. s. *tichorhinus* FISCH.) wraz z współczesną florą i fauną. Kraków, 181—268, pls. XXVI—LVI.

LUBICZ-NIEZABITOWSKI E. 1926. Szczątki nosorożca włochatego (*Rhinoceros antiquitatis* BLUM.) znalezione na ziemi wielkopolskiej. Rocz. Muz. wielkop., Poznań, (2): 1—52, pls. I—IV.

LUTNICKI W. 1977. Zarys osteologii zwierząt domowych. Warszawa—Kraków, 214 pp., pls. I—L.

MERTENS A. 1906. Der Ur, *Bos primigenius* BOJANUS. Abhandl. Bericht. Mus. Nat.- u. Heimatkunde zu Magdeburg, Magdeburg, **1** (2): 45—119, 9 figs.

MOHR E. 1952. Der Wisent. Neue Brehm-Büch., Leipzig, No. 74: 1—75, 42 figs.

NICKEL R., SCHUMMER A., SEIFERLE E. 1954. Lehrbuch der Anatomie der Haustiere. Bd. **1**. Berlin—Hamburg, XVI+502 pp., 517 figs., pls. I—XI.

NUHN A. 1878. Lehrbuch der vergleichenden Anatomie. T. **2**. Heidelberg, pp. 291—674, figs. 302—636.

NUSBAUM J. 1903. Zasady anatomii porównawczej. T. **2**. Anatomia porównawcza zwierząt kręgowych. Warszawa, X+553 pp., 134 figs.

PFIZENMAYER E. W. 1926. Mammutleichen und Urwaldmenschen in Nordost-Sibirien. Leipzig, 341 pp., 118 figs.

PILARSKI W., ROSKOSZ T. 1959. Beobachtungen über den Rumpfabschnitt der Wirbelsäule des Elches — *Alces alces* L. Acta theriol., Białowieża, **3** (1): 1—16, pls. I—III.

POPLEWSKI R. 1948. Anatomia ssaków. T. **2**. Stockholm, 690 pp., 492 figs.

ROSKOSZ T. 1962. Morphologie der Wirbelsäule des Wisents, *Bison bonasus* (LINNAEUS, 1758). Acta theriol., Białowieża, **6** (5): 113—164, pls. XIX—XXIX.

ROSKOSZ T., PYTEL S. 1966. Wirbel- und Rippenvariationen beim Rothirsch. Acta theriol., Białowieża, **11** (9): 289—296, pls. XIII—XIV.

SISSON S. 1945. The anatomy of the domestic animals. Philadelphia—London, 972 pp., 770 figs.

STACH J. 1930. The second woolly Rhinoceros from the diluvial strata of Starunia. In: The second woolly Rhinoceros (*Coelodonta antiquitatis* BLUM.) from Starunia, Poland. (Geology, mineralogy, flora and fauna). Bull. int. Acad. pol. Sci. et Let., Cl. d. Sci. Math. et Nat., série B, Cracovie, No suppl.: 21—47, pls. 2—10.

STELMASIAK M. 1979. Mianownictwo anatomiczne. Warszawa, 330 pp.

STÖCKLI A. 1922. Beobachtungen über die Entwicklungsvorgänge am Rumpfskelett des Schweines. Gegenbaurs morph. Jahrb., Leipzig, **52** (2): 153—195, 9 figs.

SUSSDORF M. 1895. Lehrbuch der vergleichenden Anatomie der Haustiere. Bd. **1**. Stuttgart, VI+711 pp., 229 figs.

SZANIAWSKI A. 1966. Osteologische Untersuchungen über den Rothirsch in Polen. Acta theriol., Białowieża, **10** (6): 195—267, 33 figs.

TOEPFER V. 1957. Die Mammutfunde von Pfännerhall im Geiseltal. Veröffentl. Landesmus. Vorgesch. in Halle, Halle, (16): VI+1—58, 11 figs., pls. I—XXIV.

STRESZCZENIE

Porównano morfologię żeber 15 gatunków ssaków kopytnych (*Ungulata*), spośród których trzynaście opracowano na podstawie własnych obserwacji a dwa — na podstawie danych z literatury. Scharakteryzowano również zmienność serialną tych kości w obrębie gatunku. Badane gatunki należą do tych spośród ssaków kopytnych, których szczątki spotykane są w europejskich wykopaliskach archeologicznych. Celem pracy było umożliwienie rozpoznawania tych gatunków na podstawie morfologii żeber i ich fragmentów.

Obserwacje i część dyskusyjna pracy uporządkowane zostały według okolic anatomicznych żebra. W pierwszej części (1. Os costale) autor omówił zmienność liczby par żeber (1.1.), oraz długość (1.2.) i krzywiznę (1.3.) żebra kostnego. Część druga (2. Koniec dorsalny żebra) zawiera porównania główki (2.1.), guzka (2.2.) i szyjki żebra (2.3.). W części trzeciej (3. Corpus costae) scharakteryzowano przekroje poprzeczne trzonu żebra (3.1.), oraz jego szerokość (3.2.) i grubość (3.3.).

Cechy dorsalnej okolicy żebra (ryc. 5 i 6) pozwalają rozróżnić podrzędy ssaków kopytnych, natomiast na podstawie trzonu żebra (przekroje poprzeczne, ryc. 10) można rozpoznawać gatunki.

Redaktor pracy: doc. dr L. Sych