presence causes an extension of the caudal border. These are anterior attachments of the multifidus dorsi. On thoracic vertebra I, these crests are observed over the ventral four cm of the height of spinous process. The rest of the border is sharp. The range of the multifidus dorsi on the caudal borders of the spinous processes extends more and more dorsally while passing towards the posterior part of the thoracic region. On vertebra V, it occupies about three-quarters of the height of spinous process and, beginning with vertebra IX, the entire caudal border of this process. Consequently, this border is provided over its entire length with two posterolateral crests separated by a sagittal groove with a crest for the interspinal ligament running inside it. On vertebra XIV and posteriorly of it, the crests converge and fuse with each other approximately halfway the height of the crest, ventrally diverging towards the articular processes. The spinous processes of lumbar vertebrae have sharp border bifurcating ventrally and provided with paired tuberosities dorsally. The distribution of the attachments of the multifidus dorsi is in this region somewhat less clear. The posterior scars of this muscle occur on the mammillary processes. (A higher position of these processes on thoracic vertebrae (see above) may be connected with, among other things, a larger dorsal range of the anterior scars of this muscle in the thoracic sector and it would be an expression of the tendency of muscle bundles to an as horizontal position as possible and thus to increase the component of the pressing force of the muscle).

Cranial attachments of the spinalis dorsi, situated on the borders of the spinous processes of thoracic vertebrae over the attachments of the multifidus are poorly developed. They are most distinctly visible on thoracic vertebrae II and III, where they form posterolateral crests running as a continuation of the crests which serve for the multifidus dorsi. Posteriorly, the attachments of the spinalis dorsi reach thoracic vertebra VIII. The situation of caudal attachments has not been determined.

The vertebrae also lack distinct traces of the longissimus dorsi. According to SLIJPER (1946), this muscle attaches in the rhinos only to the spinous processes and has no accessory attachments on transverse, articular and mammillary processes. The arrangement of spinous processes in the lumbar region is indicative of the attachments of this muscle on these processes. A caudal inclination or vertical position of the processes of lumbar region and a lack of a distinct anticline in the diaphragmatic region is, according to SLIJPER *(l. c.)* connected with shifting the attachments of the longissimus dorsi from the lumbar region onto the sacral bone (by a decrease in muscle bundles attaching themselves in the lumbar region in favour of those attaching themselves onto the sacral bone), which in turn is connected with the limitation of the flexibility of the lumbar region. According to this author *(l. c.)*, the lack of anticline is also a feature of several other heavy representatives of the Ungulata, including *D. bicornis* and *Rh. sondaicus*, but the spinous processes of these rhinos are markedly inclined caudally. The vertical position of the spinous processes in the lumbar region of the vertebral column in the woolly rhino indicates that the process of shifting the attachments of the longissimus dorsi was not very advanced in this species and that this sector preserved a certain sagittal flexibility as also shown by the development of articular processes (see above) and the adaptation to the horse-gallop (SLIJPER, 1946) is manifested only by the development of a short lumbar sector.

In the lumbar and thoracic vertebrae, beginning with vertebra VIII, a depression occurs on each side of the spinous process laterally of its base. These depressions are most strongly developed on thoracic vertebrae XIII and XIV. Their assignment is not clear, but they might be connected with part of the fibers of the multifidus dorsi.

On the ventral side of the vertebral column, noteworthy are bony swellings on the last thoracic vertebra, as well as in lumbar, cranial and caudal parts of the ventral spine. The situation of these swellings at the end of the thoracic sector and in the lumbar sector on the ventral side of the vertebral bodies leads one to suppose that they are connected with the psoas minor, but it is not unlikely that they served for attaching the ventral longitudinal ligament.

A bony prominence running over the entire width of the transverse process of lumbar vertebra I, was probably connected at its base with the psoas major running from the trochanter minor of the femur to the ventral surface of the vertebral column externally of the psoas minor.

Sacrum. — The sacrum (Pl. XIX, Figs. 2*a*, *b*) consists of four vertebrae.

The transverse processes of sacral vertebrae II, III and IV are reduced to a small extent and fused with strongly developed transverse processes of sacral vertebra I. Since the posterior border of the last transverse process is situated at an angle smaller than 180° to the lateral border of the sacrum, the latter is subpentagonal in shape.

The auricular surface stretches over the entire length of the lateral border and, consequently, the pelvis closely adheres three sacral vertebrae and also contacts the fourth.

The auricular surface is oval, 144 mm long and 75 mm wide. The ventral, most medial part of this surface is concave, uneven, but not as rough as the external part, from which it is separated by a crest. Medially, the auricular surface is also bounded by a prominent crest, related with the attachment of a ligament (ligamentum sacroilicum suspensorium).

Table 38

Dimensions of the sacrum (in mm) in *Coelodonta antiquitatis* (Blum.)

Dimensions \ Cat. No.	ZAPUJ No. 683	ZIN No. 4118		ZIN No. 24729		ZIN No. 673	
Length of body	152	155		182		206	
Width of the wings of sacrum	208	222		203		201	
Width (height) of the anterior articular surface	62/38	78/42		60/29		54/34	
Height of the first spinous process	83	—		87		96	
Height of the last spinous process	68	46		37		41	
Angle of the inclination of spinous processes	about 60	—		—		—	
Dimensions of auricular surface — length, maximum width	144 75	158 78	161 82	185 76	185 72	183 70	185 75

The cranial borders of wings are slightly oblique diverging anteriorly and consequently the base of the sacrum is concave anteriorly. The anterior articular surface of the body is oval (38 mm high, 62 mm wide), the same as the surfaces for articulation with the transverse processes of the last lumbar vertebra which are 22 mm high and 27 mm (right) or 32 mm (left) wide.

The dorsal and ventral sacral foramina are the largest between sacral vertebra I and II (the dorsal 10 mm and the ventral 18 mm in diameter), diminishing and becoming slitlike posteriorly. The body of vertebra I is not as strongly fused with the whole of the sacrum as those of the remaining vertebrae, between which only transverse lines are visible, while a fissure occurs between the bodies of vertebrae I and II. The body of the sacrum is separated from its wings by two notches situated on the sides of the cranial articular surface of the body and on the ventral side by oblique crests (lineae terminales).

The spinous processes of the sacrum are similar in shape to those of the lumbar region, but more strongly extended anteroposteriorly and laterally in their dorsal parts. The spinous process of sacral vertebra I is not fused with the remaining ones, the same as the arch of this vertebra, which is separate from the next arch by an interarcual space. The spinous processes of the remaining sacral vertebrae are fused together to form a crest provided dorsally with a very strong tuberosity. Boundaries between successive processes are visible in the form of groovelike depressions.

The articular surfaces of cranial articular processes are oval, horizontal and bounded by mammillary processes of the same type as those of the lumbar region. Further articular processes, occurring in a vestigial form, are distinctly outlined only over the dorsal sacral foramen between vertebra I and II, where convexities are also visible undoubtedly corresponding to mammillary processes. The traces of articular processes disappear posteriorly.

The vertebral canal is triangular in transverse section.

The sacrum is an attachment place of many important ligaments related with the sacro--iliac articulation and those forming a dorsolateral limit of the pelvis.

Strongly widened tubers on the spinous processes of the sacrum make up an attachment of the dorsal sacro-iliac ligament, running from the sacral tuber, of the supraspinous ligament, probably very strongly developed in the woolly rhino and, in addition, of the gluteal fascia and, through its mediation, of the fibers of the gluteus medius and superficialis, the biceps femoris and the semitendinosus. Moreover, these tubers might serve, much the same as in the horse (the tubers of the last three spinous processes of the sacrum) for the attachment of the sacro coccygeus dorsalis medialis, while the sacro coccygeus dorsalis lateralis was presumabely inserted on the lateral surfaces of the spinous processes. The traces of the latter are, however, lacking.

The lateral sacro-iliac ligament, usually attaching on an extensive area of the lateral border of the sacrum, in the woolly rhino was attached — due to the length of the auricular surface (see above) — much more posteriorly on the caudal border of the wing (= of the last transverse process). Directly below, the sacro-sciatic ligament was attached along the caudal border of the sacrum. This border is, however, sharp and does not display any traces of attachments.

The posterior inclination of the spinous processes of the sacrum is caused by the gluteal muscles, biceps femoris and semitendinosus, whose caudal action is much stronger than the cranial one of the longissimus dorsi, irrespective of the strength of its fibers attached to the sacrum.

The following remarks result from the observation of the axial skeleton of the woolly rhino:

The position of the spinous processes of the cervical region, vertical in vertebrae V and VI and a caudal bend of the process of vertebra VII, is probably connected with a low position of the head and inclination of the neck. These processes are influenced by the spinalis cervicis, spinalis dorsi (the last two vertebrae), multifidus cervicis and the lamellar part of the ligamentum nuchae which is attached to the tips of spinous processes. However, the position of these processes, depends almost entirely on the spinalis cervicis (SLIJPER, 1946). The most advantageous from the viewpoint of the action of this muscle is on the whole the cranial inclination of the spinous processes of cervical vertebrae, observed in most mammals (all domestic mammals, *l. c.*). The inclination of the head and neck causes a decrease in an angle of insertion and, consequently, a decrease in a component force suspending the cervical vertebrae to the thoracic part of the vertebral column. The caudal turn of the spinous processes of cervical vertebrae in the woolly rhino would serve for a compensative increase in the value of this angle. Here may be also involved a relative decrease in the role of the spinalis cervicis and increase in that of the multifidus cervicis, which, however, cannot be ascertained.

A similar sense (the compensation of the angle of insertion) may be ascribed to the deflection of the spinous process of thoracic vertebra I from the direction of the remaining thoracic vertebrae (Pl. I). Here would be involved the muscles spinalis cervicis and splenius, as well as the nuchal ligament, whose posterior attachments are situated on this process. In addition, a certain influence on the position of this process is exerted by the spinalis dorsi and multifidus dorsi, which, however, act in opposite direction.

The woolly rhino, as a hoofed animal with a large body weight, could certainly trot or gallop as a horse (horse gallop, SLIJPER, 1946). In these types of movement, only the limbs make up a driving organ, while the vertebral column remains stiffened, except for the lumbo-sacral articulation, which preserves a small degree of flexibility playing a certain role in one of the phases of horse gallop. The stiffening of the vertebral column in its thoracic sector is caused by high spinous processes and their ligaments (SLIJPER, *l. c.*) and in the lumbar region mostly by its shortness and by the articular surfaces occurring between the transverse processes. A certain degree of flexibility before the diaphragmatic vertebra was also found in herbivorous Ungulata, which is connected with the lack of ventral flexibility (concave ventrally) in the cervical sector (found by SLIJPER, *l. c.*) which is replaced, by lowering of the entire vertebral column beginning with the diaphragmatic vertebra. This is accompanied of course by a bend of the atlanto--occipital articulation.

In the woolly rhino, an increased flexibility of probably the same type is observed in the region from thoracic vertebra XVI to lumbar vertebra III, which is expressed by a vertical position of articular surfaces of articular processes parallel to the articular surfaces of the bodies and theoretically enabling a slight shift of the vertebrae in vertical plane. An incomplete shift of the bundles of the longissimus dorsi from the lumbar region may probably be also referred to the preservation of a certain flexibility in this region.

BONES OF THE THORACIC LIMB

Scapula. — Scapula (Pl. VIII, Figs. 1*a-c*) of the mediportal type, with its vertebral and anterior borders slightly convex and posterior somewhat concave. The posterior angle extended posteriorly. Maximum width of the scapula, recorded near the vertebral border, amounts to -about a half of the physiological length [4].

The spine of the scapula is shaped like an isosceles triangle with its base stretching from the region of the neck of scapula to the vertebral border and an obtuse (about 130°) apical angle. The spine is bent posteriorly towards the infraspinous fossa. The supra- and infraspinous fossae are developed to an approximately equal degree. At the level of the spinal tuber, slightly wider is the supra- and near the spinal border the infraspinous fossa.

The neck of scapula is elongate but not very strongly contracted. The spinal tuber is robust, the glenoid cavity oval and anteroposteriorly elongate. The glenoid notch vestigial.

[4] The proportions of the scapula were undoubtedly subject to a certain variability which, however, due to the scarcity of material, could not be accurately studied. In the specimen from Podbaba, the width-length ratio, amounting to 1 : 2 is in conformity with BRANDT's (1877) data. The scapula of the rhino from Starunia I is relatively wider (about 3 : 5 according to NIEZABITOWSKI, 1914), which may be caused by its young individual age.

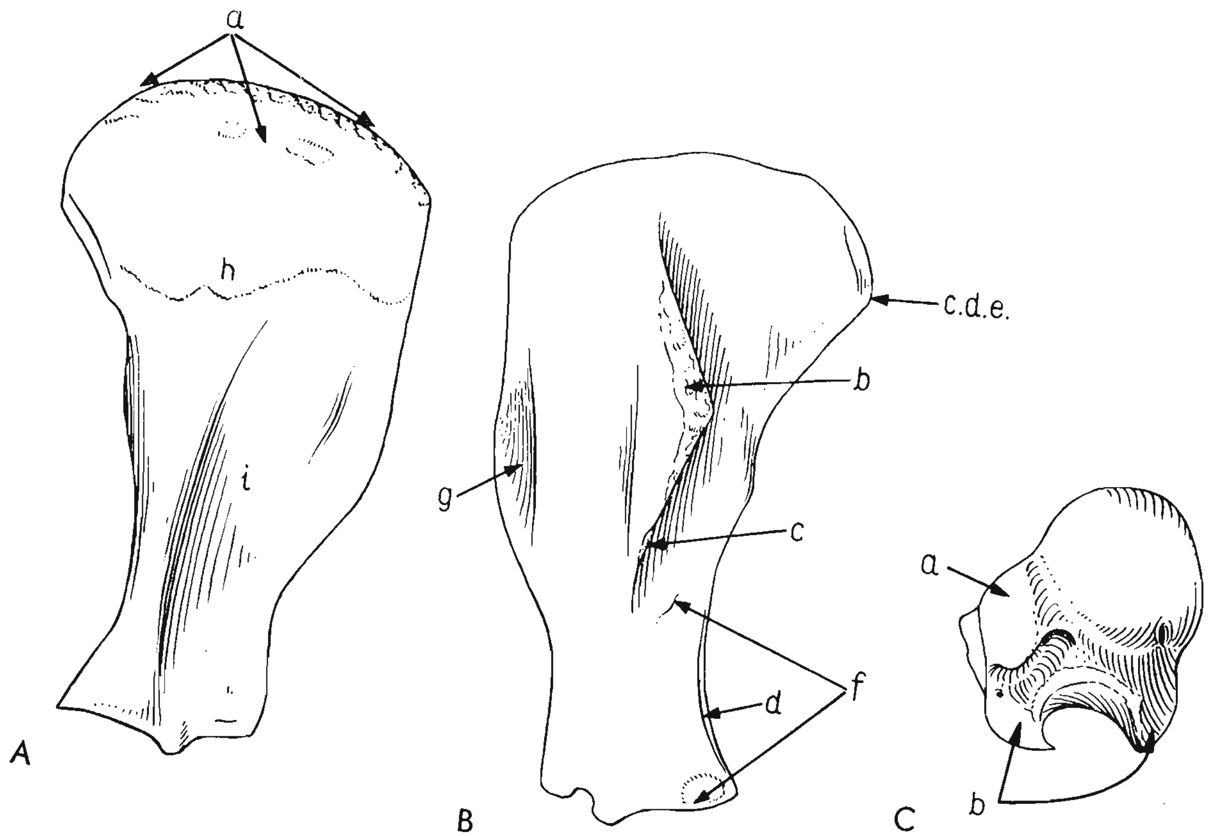

Fig. 6

A Scapula, medial view;
B Scapula, lateral view; *a* m. rhomboideus, *b* m. trapezius, *c* m. deltoideus, *d* caput longum m. tricipitis, *e* m. teres major, *f* m. teres minor, *g* m. pectoralis profundus, *h* m. serratus ventralis, *i* m. subscapularis, *k* m. biceps brachii.
C Humerus, proximal view; *a* m. infraspinatus, *b* m. supraspinatus

The following traces of muscle attachments are observed on the surface of scapula (Text-fig. 6*A*, *B*).

The trace of the rhomboideus occurs in the form of tubers situated on the vertebral border of scapula and on its medial surface about 2 cm from the vertebral border (Text-fig. 6*A*, *a*).

The serrate line, a trace of the attachment of the serratus ventralis, runs at a distance equalling about two-thirds of the length of scapula from the glenoid cavity. It is indented by wide, shallow bends.

The subscapular fossa, an attachment place of the subscapularis muscle is wide and shallow. Its surface is smooth, except for the lowest part. A longitudinal convexity, taking about one-third of the width of scapular neck, separates it from the posterior border of scapula.

The posterior border of scapula is the region in which the caput longum musculi tricipitis is attached. At the lower one-third of its length, it is thickened to about 30 mm and, above this place, bent externally. The trace of the attachment of the long head of the triceps is shaped like a crest beginning with a tubercle above the glenoid cavity and running dorsally along the outer margin of the posterior border (Text-fig. 6*B*,*d*). The crest disappears dorsally.

Table 39

Dimensions (in mm) of the scapula of *Coelodonta antiquitatis* (BLUM.) as compared with those of *Diceros bicornis* L. and *Rhinoceros sondaicus* DESM.

Dimension \ Cat. No.	*C. antiquitatis* ZAPUJ No. 683	*Diceros bicornis* ZIN No. 615 left	*Diceros bicornis* ZIN No. 615 right	*Diceros bicornis* ZIN No. 24729 left	*Diceros bicornis* ZIN No. 24729 right	*Diceros bicornis* MIZ	*Rh. sondaicus* MIZ
Physiological length	457	431	431	400	395	408	344
Length measured along the anterior border	480	421	421	394	390	395	347
Length of the base of spine	350	335	342	325	302	352	252
Width of supraspinous fossa *	123	74	80	74	79	83	47
Width of infraspinous fossa *	147	120	110	110	113	87	132
Maximum anteio-posterior dimension of the neck	113	89	91	103	101	82	84
Maximum antero-posterior dimension of the glenoid part	142	137	135	133	134	120	139
Anteroposterior diameter of the glenoid fossa	88	84	84	78	83	73	72
Height of spine, together with thickness of scapula	95	113	114	99	82	82	95
Thickness of scapula in the region of the acromion	47	33	39	35	36	36	34

* The largest near the vertebral border, perpendicular to the spine.

The posterior projection of the posterior angle of scapula is caused by the activity of the dorsal part of the caput longum musculi tricipitis, the teres major and the dorsal part of the deltoideus, but the scars of these muscles are indistinct.

The coracoid process is very poorly developed in the form of a slight roughness.

The spinal tuber extends on both borders of the scapular spine. Its apex and the dorsal border of the scapular spine serve as attachment places for the trapezius. The lower extension of the spinal tuber was an attachment place of the deltoideus. A longitudinal tubercle situated in the ventral part of the scapular spine (Text-fig. 6*c*) is most likely to be related with the last-named muscle.

The areas of the infra- and supraspinatus, having smooth or almost completely smooth surfaces, are approximately identical in extent. The area of the supraspinatus is limited anteriorly by a muscle scar of the pectoralis profundus (or, higher up by the levator scapulae), developed in the form of a longitudinal depression, 25 mm wide and running along the anterior border of scapula. The area of the infraspinatus is limited in the dorsal part by attachments traces of the teres major, deltoideus and of the long head of the triceps.

A crest running posterodorsally of the acromial end of the scapular spine (Text-fig. 6*B, f*) is a trace of the teres minor. Part of this muscle is attached to a flat tubercle situated just over the posteroexternal border of the glenoid cavity.

The strongly developed scar of the biceps brachii on the external surface of the scapular tuber projects ventrally and externally.

Humerus. — The humerus (Pl. X, Fig. 2; Pl. XI, Figs. 1, 4*a, b*; Pl. XII, Fig. 3) is characterized by a strong, external extension of its extremities and upper part of shaft, with a simultaneous external shift of the medial muscular part of the upper extremity and a reduction of the medial epicondyle.

The head of humerus, slightly separated from the muscular part, round, slightly convex, is inclined posteriorly, at an angle of about 44°, to the axis of shaft and somewhat to the medial surface of the humerus (about 107° to the axis of shaft).

The lateral tuberosity is bifid. It projects above the level of head anteriorly for about 25 mm and posteriorly for about 15 mm. The notch of the lateral tuberosity is situated anteriorly and ventrally of the anterior border of head.

The medial tuberosity is also bifid. Its anterior part is shifted before the head and exceeds it in height by about 35 mm. The posterior part is situated on the medial side directly below the head. The bicipital groove, with a smooth, concave surface, is about 65 mm wide.

A strong development of the muscular part, limited by the crest of the lateral tuberosity, the curved line and the deltoid tuberosity, results in an extension of the proximal part of the shaft of the order of about 0.6 of the physiological length of the bone and about twice as wide as the minimum width of shaft, as well as in its anteromedial and posterolateral flattening.

A turn of the distal extremity of humerus in relation to the proximal one amounts to about 30°.

The oleocranon fossa is deep, with its borders running obliquely, ventrally and medially.

The medial condyle is larger and extends towards the medial surface of the humerus and the lateral smaller, becomes rounded towards its epicondyle. The distal extremity of humerus is inclined posteriorly and externally forming, together with the axis of shaft, an angle of about 120°.

The lateral epicondyle (Pl. XI, Fig. 1; Text-fig. 7*B*) has the form of a bony protuberance with a round (90×90 mm) strongly tuberculate lateral wall. In the anterior part, it does not project externally outside the level of condyle; in the posterior part, its thickness reaches about 50 mm and the dorsal border projects about 60 mm outside of the border of condyle. Ventrally, the lateral epicondyle is oviform and narrowing anteriorly (Text-fig. 9*E*).

The medial epicondyle (Pl. XII, Fig. 3; Text-fig. 7*C*) is shaped like an oval bony protuberance (90×60 mm), not very strongly projecting over the surface of condyle and reaching posteriorly about 45 mm in thickness. Its posterior part overlaps the oleocranon fossa contracting its inlet.

The traces of the following muscles may be recognized on the humerus (Text-fig. 7*A-D*).

Two flat oval areas (about 65×40 mm), making up attachments of the infraspinatus occur on the lateral surface of the lateral tuberosity. One of them, situated about 20 mm below the notch of the lateral tuberosity, is arranged with its longer diameter parallel to the axis of the shaft, the other occurring on the posterior part of the lateral tuberosity, has its longer diameter approximately perpendicular to the bone axis.

The anterior parts of the lateral and medial tuberosities, separated by a wide bicipital groove are attachment places of the supraspinatus. The lateral scar of this muscle is probably formed by an oval area (50 mm long and 26 mm wide), situated before the notch

Table 40

Dimensions (in mm) of the humeri of *Coelodonta antiquitatis* (BLUM.) as compared with those in *Diceros bicornis* L., *Rhinoceros sondaicus* DESM. and *Ceratotherium simum* BURCH.

Cat. No. / Dimensions	*Coelodonta antiquitatis*					*Diceros bicornis*					*C. simum*	*Rh. sondaicus*
	MG-1	PS-2	PS-3	ZAPUJ No. 683		ZIN No. 24729		ZIN No. 615		MIZ	ZIN exhibition	MIZ
Physiological length *	356	376	380	350	344	340	339	350	364	—	—	—
Maximum length	394	415	424	433	429	400	400	410	422	—	478	—
Width of shaft at the level of the deltoid tuberosity	150	167	—	161	161	158	165	193	173	147	197	170
Minimum width of shaft	73	74	77	70	70	60	58	60	59	59	79	58
Minimum diameter of shaft	72	84	88	70	71	61	67	68	65	50	75	66
Maximum width of distal end **	155	159	156	143	143	145	152	149	146	143	170	141
Width of the trochela humeri (measured from below)	97	106	104	100	101	93	95	93	86	89	114	102
Transverse diameter of the caput humeri	103	—	108	105	107	101	95	100	82	89	110	101
Longitudinal diameter of the caput humeri	106	—	99	98	103	89	81	95	85	77	115	96
Medial diameter of the distal end	112	130	126	119	118	102	105	103	103	98	106	118
Lateral diameter of the distal end	115	120	112	100	113	99	108	110	108	93	109	109

* According to DÜRST (1926).
** Parallel to the axis of the distal extremity of humerus.

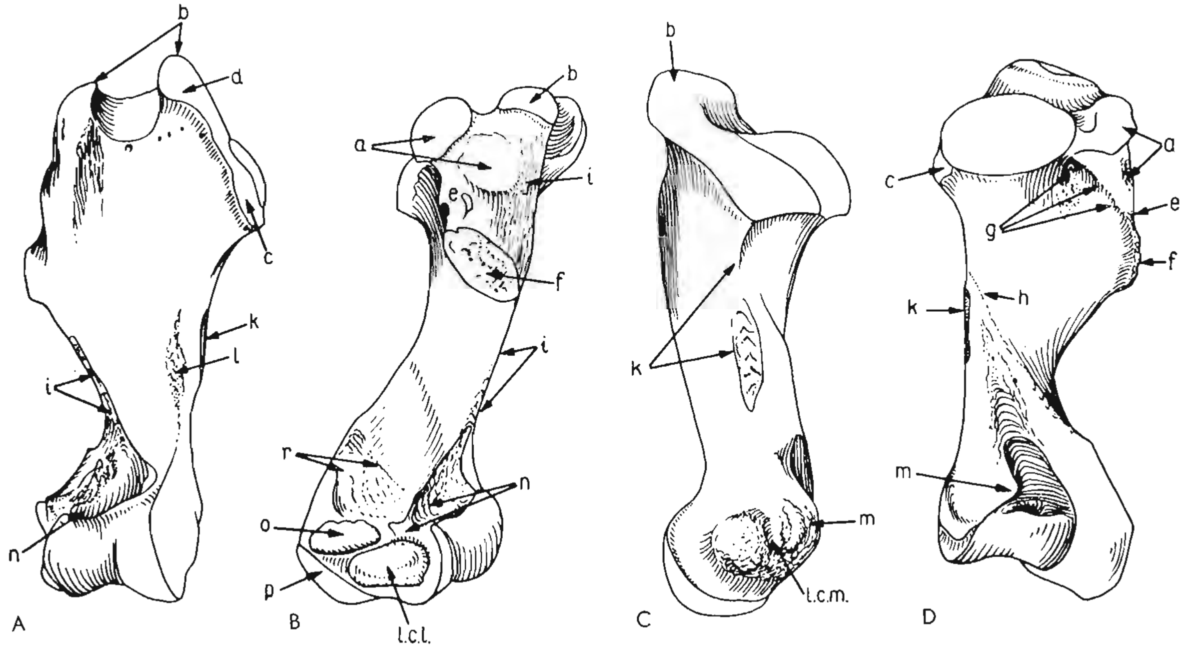

Fig. 7

The right humerus of *Coelodonta antiquitatis* (BLUM). with muscle and ligament attachment areas marked; × ca 1/6, *A* anterior view, *B* lateral view, *C* medial view, *D* posterior view, *a* m. infraspinatus, *b* m. supraspinatus, *c* m. subscapularis, *d* m. pectoralis profundus, *e* m. teres minor, *f* m. deltoideus, *g* caput laterale m. tricipitis, *h* caput mediale m. tricipitis, *i* m. brachiocephalicus, *k* m. latissimus dorsi and m. teres major, *l* m. coracobrachalis, *m* m. flexor digitalis superficialis, *n* m. extensor digitalis communis, *o* m. extensor digitalis lateralis, *p* m. extensor carpi ulnaris, *r* m. extensor carpi radialis, l. c. m. lig. collaterale mediale, l. c. l., lig. collaterale laterale

of the lateral tuberosity (Text-fig. 7*B*, *b*) and does not reach its most anterior part. The attachment place of the medial part of this muscle was probably the apex of the anterior part of the medial tuberosity, while the lateral surface of this part of the tuberosity might be connected with part of the fibers of the pectoralis profundus (Text-fig. 7*A*, *d*). Posteriorly of these muscles, the subscapularis was undoubtedly attached to the posterior part of the medial tuberosity. Its scar, turning without a distinct boundary, into those of the pectoralis profundus and the supraspinatus, is shaped like a smooth area, 83 mm long and 34 mm wide, under the head of humerus.

A depression (impressio teretica), limited by a tubercle near the curved line and provided with a small bony protuberance on its surface (Text-fig. 7*B*, *e*), that is, a trace of the teres minor (poorly developed in young individuals) occurs on the lateral side of the bone directly posteriorly and distally of the anterior attachment of the infraspinatus. The deltoid tuberosity, connected with the attachment of m. deltoideus, has the form of an elongate bony protuberance (68 × about 28 mm) with its longer axis slightly ascending posteriorly. Frequently, it projects posteriorly and externally of the muscle area.

The curved line and a rough area adhering to it posteriorly make up an attachment of the lateral head of the triceps brachii.

The wide, flat crest of humerus, running parallel to the axis of shaft, is cut by longitudinal grooves on both its external (anteriorly of the anterior attachment of the infraspinatus) and anteromedial surface. The brachiocephalicus and probably part of the fibers of the pectoralis superficialis were attached in this region. Both these muscles were probably attached also below the deltoid tuberosity on the above mentioned crest running towards the medial condyle. Their traces, starting about 30 mm below the deltoid tuberosity, discontinue directly above the coronoid fossa. They border a wide groove of the brachial muscle (sulcus m. brachialis). The trace of the brachial muscle, which on the whole starts posteriorly of the head of humerus, has not been identified in this place. On the other hand, quite distinct is the distal attachment of this muscle to the anteromedial surface of the radius (see below).

A sharp, short (about 30 mm) crest runs from the medial tuberosity over the anteromedial surface of humerus. A convex, teres tuberosity about 20 mm wide and varying in length (about 30 to about 70 mm) is situated, in continuation of this crest, more or less halfway the length of humerus. The crest and the tuberosity form an attachment area of the latissimus dorsi and the teres major. Another small, longitudinal tuberosity occurs (Text-fig. 7 *D*, *h*) above the teres tuberosity, posteriorly of it and, at the same time, in continuation of the crest of lateral epicondyle. It makes up an attachment place for the medial head of the triceps brachii. Near the teres tuberosity, a not very distinctly separated attachment of the coraco-brachialis (Text-fig. 7 *A*, *l*) is formed by the anterior surface of humerus above the medial condyle.

The epicondyles of humerus make up places of origin of numerous muscles moving the distal part of the limb and attachment places of ligaments.

An attachment, probably related with the flexor digitalis profundus, is situated in the posterior part of the medial epicondyle on its distal surface slightly inclined medially. It is difficult to interpret the remaining attachments of this epicondyle (Text-fig. 7 *C*). A smooth area in its central part is limited anteriorly by a rough convexity, resembling in development an attachment place of the medial ligament in the ruminants and the horse, but situated considerably more posteriorly than in these mammals. With such a position of the ligament, it is difficult to imagine the situation of the attachments of the flexor capri radialis and the flexor carpi ulnaris (or, of a common tendon of these muscles which, according to BEDDARD & TREVES, 1889, occurs in *D. sumatrensis*), since they are on the whole situated posteriorly of the ligament. Perhaps, they were situated anteromedially of the attachment of the flexor digitalis superficialis, on the posterior surface of the epicondyle, which is, however, marked by relatively small dimensions for a supposed attachment area of the three important muscles.

An oval, smooth area (50×37 mm), situated in the anterior part of the lateral epicondyle and whose longer axis is arranged perpendicularly to the axis of shaft, is a trace of the lateral ligament of the elbow joint. Dorsally of it, a tuberculate attachment scar of the extensor digitalis communis (Text-fig. 7 *B*, *n*) occurs in the lateral part of the coronoid fossa and on the surface of the epicondyle adhering to this fossa. A rhomboidal, tuberculate area (Text-fig. 7 *B*, *o*) is situated posteriorly of the last-named scar and posteiodorsally of the trace of the ligament. This area probably belonged to the humeral part of the lateral digital extensor, whose venter is situated in the limb directly behind the common digital extensor. The humeral part of the lateral digital extensor occurs in the Sumatran rhino (BEDDARD & TREVES, 1889) in contrast to the horse in which this muscle begins on the forearm bones.

A ventrally facing ovate surface and part of laterodistal surface of the epicondyle formed attachment areas of the ulnaris lateralis, a strong flexor of the forearm.

A longitudinal sharp about 85 mm long crest runs along the lateral condyloid crest, changing in its upper part into a longitudinal tuberosity directed towards the coronoid fossa. The crest and the tuberosity are attachment places of two muscles: the extensor carpi radialis and the supinator longus. However, it is impossible to separate accurately the traces of the two muscles. Judging from its position in *D. sumatrensis* (cf. BEDDARD & TREVES, 1889) the origin of the supinator longus was probably situated more proximally.

The humeral head of the extensor carpi obliquus [5], whose occurrence in *C. antiquitatis* may be expected by analogy to *D. sumatrensis*, was certainly also attached in this region. In the horse, this muscle begins on the external side of the radius.

Radius (Pl. XII, Figs. 1, 2*a-c*; Pl. XIII, Figs. 1*a*, *b*). — A massive bone. The strongest contraction of the shaft, amounting to about 16 to 19% of the physiological length, occurs just above a point halfway of this length. The width of the distal extremity is twice as large and that of the proximal one slightly less than twice as large as the minimum width of the shaft.

The proximal articular surface is bifid. Its medial part (about 70 mm long and about 60 mm wide) strongly projects anteriorly. The external part is about 40 mm long and about 45 mm wide. A distinct, sharp protuberance occurs on the posterior border of the articular surface of the head.

The tuberosites for the attachment of ligaments are prominent, oval, about 25 mm high and about 40 mm (the external one) and about 52 mm (the medial one) long. The external tuberosity overlaps the anterior surface of the radius (Text-fig. 8*A*, *c*, *l*).

The radial tuberosity oval (about 49 mm high and 32 mm wide) and covered with crests parallel to its longer axis. It is situated more or less in the middle of the anterior surface of radius and frequently fuses, by a barely perceptible crest (Pl. XII, Fig. 2*c*), with the external ligamental tuberosity which gives it the shape of a triangle with an obtuse apex turned distally. Posteriorly of the external ligamental tuberosity, there occurs a tubercular crest, running down from the border of the humeral articular surface and making up a lateral limit of the surface for articulating with the ulna.

The surface for articulating with the ulna is situated on the posterior proximal side at one-third of the radius and on the posterolateral side at distal two-thirds of the bone. It has the form of two triangles whose bases rest on the articular surfaces of the bone. These triangles are covered with robust tuberosities serving as attachments areas for the interosseous ligaments and provided at their bases with articular surfaces for the ulna. At the proximal extremity, these are two surfaces: the medial one in the form of a narrow strip (about 5 to 8 mm high and 30 to 40 mm long) and the external, triangular one, slightly concave, 30 to 35 mm high and with its base about 60 mm long. The articular surface for the distal extremity of ulna is semilunar and resting with its distal, concave border on the postero-external border of the articular surface of the distal extremity.

The shaft of radius, oval in transverse section in the proximal half of the bone, becomes trapezoidal distally, which is caused by the occurrence — on the anterior surface of the bone — of two longitudinal, blunt crests which limit the tendon groove (for the tendon of the extensor carpi radialis) situated between them and by the sharpening of the posterolateral borders of the bone.

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[5] This muscle is described by BEDDARD & TREVES (1889) as the extensor obliquus metacarpi and designated in their illustration as the extensor carpi radialis, whereas the proper extensor carpi radialis is described as the extensor metacarpi and illustrated as the extensor carpi radialis brevior. It follows from the same illustration that the humeral head of the extensor carpi obliquus was situated between the extensor digitalis communis and the extensor carpi radialis, attaching itself anteriorly below the latter, that is, on the tuberculate surface separating the attachment area of the extensor carpi radialis from the dorsal border of the epicondyle.

Table 41

Dimensions (in mm) of the radius in *Coelodonta antiquitatis* (BLUM.), *Diceros bicornis* L. and *Rhinoceros sondaicus* DESM

Species	*Coelodonta antiquitatis*				*Diceros bicornis*				*Rhinoceros sondaicus*
Cat. No.	ZAPUJ No. 683		ZIN No. 17220	ZIN No. 5087	MIZ	ZIN No. 24729		ZIN No. 615	MIZ
Dimensions	left	right				left	right		
Physiological length	308	312	361	300	—	329	330	336	—
Maximum length	347	348	385	343	361	353	358	367	348
Maximum length on the external side	290	295	342	295	333	310	310	312	about 291
Maximum length on the medial side	319	317	351	318	348	325	326	332	309
Width of the head of radius	102	103	117	105	96	99	101	106	107
Width of the proximal articular surface	102	103	114	104	89	92	98	100	106
Minimum width of shaft	54	53	70	53	47	48	49	51	46
Width of the distal extremity	110	110	—	110	93	62	65	74	about 102
Width of the carpal surface	84	78	106	93	75	81	76	77	89
Diameter of shaft *	39	38	47	35	31	35	34	37	34

* At the same level as the smallest width of shaft.

The distal end is irregularly hexagonal due to the presence of the medial tuberosity for the attachment of ligaments and to the occurrence of a posterolaterally facing surface (which makes up the lowermost part of the articular surface for the ulna, see above). This surface is also slightly turned distally thus causing a contraction in this direction.

The articular surface of the distal extremity consists of a medial part, destined for the scaphoideum, anteriorly concave and posteriorly limited by a roller-like concavity, overlapping the posterior surface of the bone, and of a concave external surface for the lunare.

The anterior and posterior walls of the head of radius, as well as the walls of the distal end are covered with many nutrient foramina. A nutrient foramen also as a rule occurs on the radius on the side of the interosseous space. A distant vascular groove runs ventrally of this region along the posteroexternal border of the bone.

The traces of the following muscular and ligamental attachments are visible on the radius:

The radial tuberosity — an attachment place of the biceps brachii.

The medial ligamental tuberosity — an attachment place of the medial ligament corresponding to the ligamentum collaterale mediale breve in the horse and the ruminants [6].

[6] The other part of the medial ligament of the elbow joint in the horse and the ruminants, that is the long medial ligaments is an equivalent of the vestigial, tendinous muscle called the pronator radii teres (NICKEL, SCHUMMER & SEIFERLE,

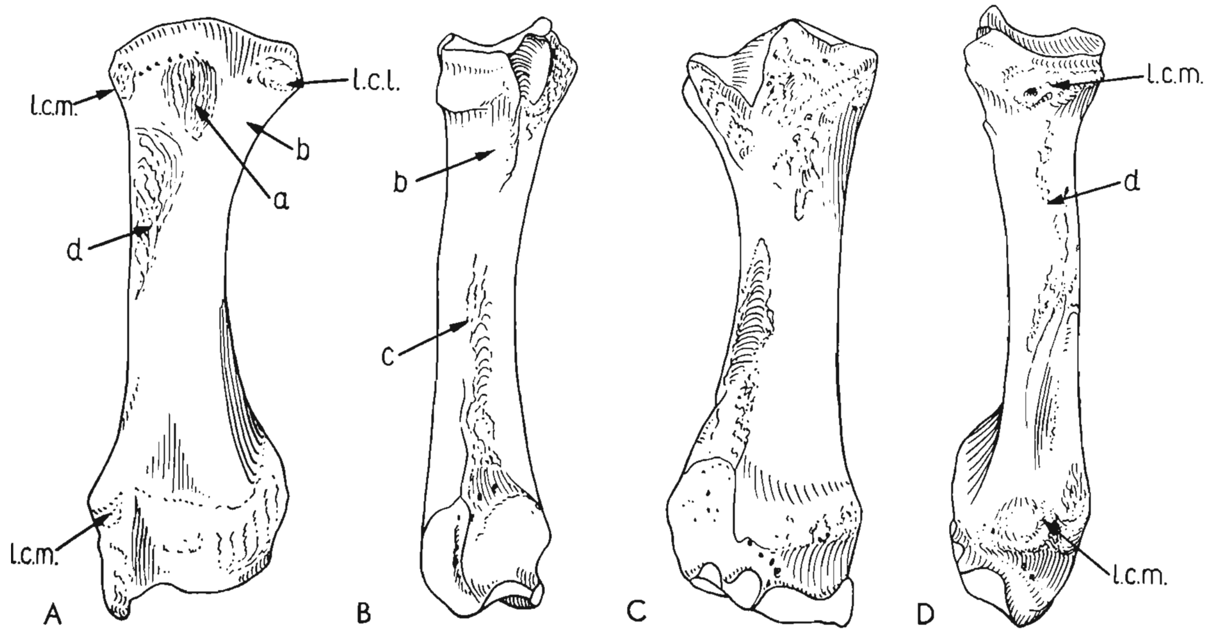

Fig. 8

The left radius of *Coelodonta antiquitatis* (Blum.) with muscle and ligament attachment areas marked; × ca 1/6. *A* anterior view, *B* lateral view, *C* posterior view, *D* medial view, *a* m. biceps brachii, *b* m. extensor digitalis communis, *c* m. extensor ossis metacarpi pollicis, *d* m. brachialis, l. c. m., ligamentum collaterale mediale, l. c. l., ligamentum collaterale laterale.

A triangular, rough area, narrowing distally and reaching about halfway the length of shaft, is situated below the attachment of the medial ligament of the elbow joint. This area makes up an insertion of the brachial muscle.

The lateral ligamental tuberosity, as a rule much strongly developed than the medial one, makes up an attachment area of the lateral ligament and a proximal limit of the attachment area of the radial common digital extensor. An oblique crest, which sometimes connects the lateral ligamental tuberosity with the latero-distal border of the radial tuberosity, makes up an anterior limitation and a strong crest parallel to the axis of shaft, running along the external border of the attachment surface for the interosseous ligament, a posterior limitation of the radial attachment area of the common digital extensor. Since the surface of shaft is in this region completely smooth, it is not clear how far the attachment of this muscle reaches down the shaft of the radius (according to Beddard & Treves, 1889, in *D. sumatrensis* this attachment reaches halfway the length of shaft).

In the horse, the tendon of the common digital extensor runs in a lateral tendon groove, limited externally by the styloid process of ulna. In *C. antiquitatis*, in which this groove is poorly developed and limited distally by a strong ligamental tuberosity, connected with the attachment of one of the ligaments of the carpal joints. It seems, therefore, that the tendon of the common

1968). The degree of reduction in this muscle, which rotates the forearm inwards, is connected with the disappearance of the mobility between the forearm bones. The development of the forearm bones in the rhino is most similar, in the mutual ratio of the size of radius and ulna and in their mobility, to the forearm of the pig. Hence, we may expect by analogy that the pronator radii teres in *C. antiquitatis* functioned as a muscle and that the medial ligament was signle as in the pig. Beddard & Treves (1889) do not, however, find the presence of this muscle in *D. sumatrensis*. Likewise, no information in this respect may be obtained from the medial surface of the radius in *C. antiquitatis*.

digital extensor runs over the distal end of ulna externally of the ligamental tuberosity mentioned above.

The longitudinal crest, running along the posterolateral border of radius (Text-fig. 8*B c*) separated by the vascular groove from the surface for ulna, might make up an attachment of the radial head of the extensor ossis metacarpi pollicis, corresponding to a single head occurring in the horse and other domestic animals. In *D. sumatrensis*, this muscle also had a radio-humeral head, attached to extensor epicondyle of humerus and to the shaft of radius. It is impossible to ascertain whether or not such a head occurred in *C. antiquitatis* and in which place of the radius it was attached.

The tuberosities occurring on the medial side of radius on the boundary of the shaft and the distal end make up attachments of the medial ligament of the carpal joints. Likewise, the insertion of the supinator longus was probably situated in this region.

The borders of the rough surface for articulating with the ulna serve as attachments of the interosseous ligaments.

The superficial and deep digital flexors, running, in the horse, from the flexor epicondyle of the humerus to the digit, are, in addition, attached to the posterior surface of radius and the deep digital flexor also on the medial side of the olecranon. Such accessory attachments have not been found in *D. sumatrensis* (BEDDARD & TREVES, 1889) which enables the supposition that they did not occur in *C. antiquitatis* either. However, irregularities occurring sometimes in the distal half of the medial border of radius and corresponding in position to the radial attachment of the superficial digital flexor in the horse might indicate the presence of such an attachment in *C. antiquitatis.*

Ulna. — The ulna (Pl. XIII, Figs. 1*a*, *b*, 2*a*, *b*) is about 1.5 times as long as the radius and, consequently, in the life-time position, about one-third of the ulna projects above the level of the proximal articular surface of the radius. The posterior border of ulna is strongly bent with its concavity facing posteriorly. The triangular transverse section of its shaft changes in the region of the olecranon into irregularly quadrangular, which results from a protrusion of the external surface of olecranon. Subsequenty, as a result of a concavity of its anterior and medial walls, it takes an irregularly polygonal shape.

The relatively low tuber olecranii is provided with a thick crest running sagitally through the middle of its anterior part (Text-fig. 9*D*, *a*) and then postero-obliquely towards the medial wall of the olecranon.

The narrow anterior wall of the olecranon slightly extends upwards in particular in the medial direction, where a sharp crest (Text-fig. 9*D*, *c*), that is, the attachment of the medial head of triceps, runs along it and downwards where it turns into a flattened, dorsal surface of the anconaeus process.

The anterior surface of the shaft, in particular its proximal part, is strongly developed medially. The surface of the semilunar notch is bifid in its lower part, its medial part being oblique and strongly projecting medially, while the external part runs parallel to the sagittal plane of the shaft. The distal borders of the semilunar notch contact each other at an angle which contains a sharp process of the posterior border of the proximal articular surface of radius.

The surfaces for the articulation with the radius closely fit corresponding surfaces on the latter.

A saddle-shaped surface for the cuneiform, with its concavity arranged in the sagittal plane of the bone and with its convexity perpendicular to it, occurs on the distal surface of the distal end of ulna. The articular surface for the accessory carpal bone forms a medial wall

Table 42

Dimensions (in mm) of ulna in *Coelodonta antiquitatis* (BLUM.), *Diceros bicornis* L. and *Rhinoceros sondaicus* DESM.

Species	*Coelodonta antiquitatis*			*Diceros bicornis*			*Rhinoceros sondaicus*
Cat. No.	ZAPUJ No. 683		ZIN No. 4063	MIZ	ZIN No. 24729	ZIN No. 615	MIZ
Dimensions	right	left					
Maximum length measured parallel to the axis of shaft	451	451	460	464	444	434	433
Distance from anconaeus process to the distal end *	366	365	362	—	—	372	—
Length of shaft	366	355	about 383	—	—	398	—
Length of the anterior border of olecranon	140	123	160	123	129	112	150
Width of the tuber olecranii	82	68	—	68	72	58	64
Width of olecranon at the base (minimum)	25	25	30	32	32	35	23
Minimum anteroposterior dimension of olecranon	86	85	90	80	82	100	83
Anteroposterior dimension in the region of processus anconaeus **	112	110	121	100	102	115	109
Minimum width of the anterior wall of shaft	52	52	53	32	36	42	37
Anteroposterior dimension of shaft (at the same level as the minimum width)	43	42	48	43	40	41	40
Maximum width of semilunar notch ***	93	95	91	—	89	97	—
Maximum anteroposterior dimension of the distal end	58	58	75	—	—	61	—

* In projection on a tangent to the curvature of shaft.
** Perpendicularly to the axis of olecranon.
*** In projection on a straight line perpendicular to the longitudinal axis of shaft.

of the styloid process of ulna, which is shaped like a pyramid with a triangular base and an apex directed distally.

The most important muscle attachments of the ulna are located on the olecranon which makes up a main hypomochlion of the ulnar articulation. It comprises insertions of particular heads of the triceps brachii, origins of the ulnar head of the flexor carpi ulnaris and, perhaps, of the ulnar head of the deep digital flexor and the palmaris longus, or of one of them only.

The medial head of the triceps is attached in the anteromedial part of the tuber olecranii. This attachment is limited posterolaterally by a robust, blunt crest (Text-fig. 9 *C a, d*) and extends turning itself into the anteromedial border of the olecranon which, in this connection, takes the shape of a sharp, strongly projecting crest.

The lateral part of the tuber olecranii makes up a bony attachment of the long head of triceps. Extensive and irregularly oval, this attachment turns posteriorly into a rough, oval

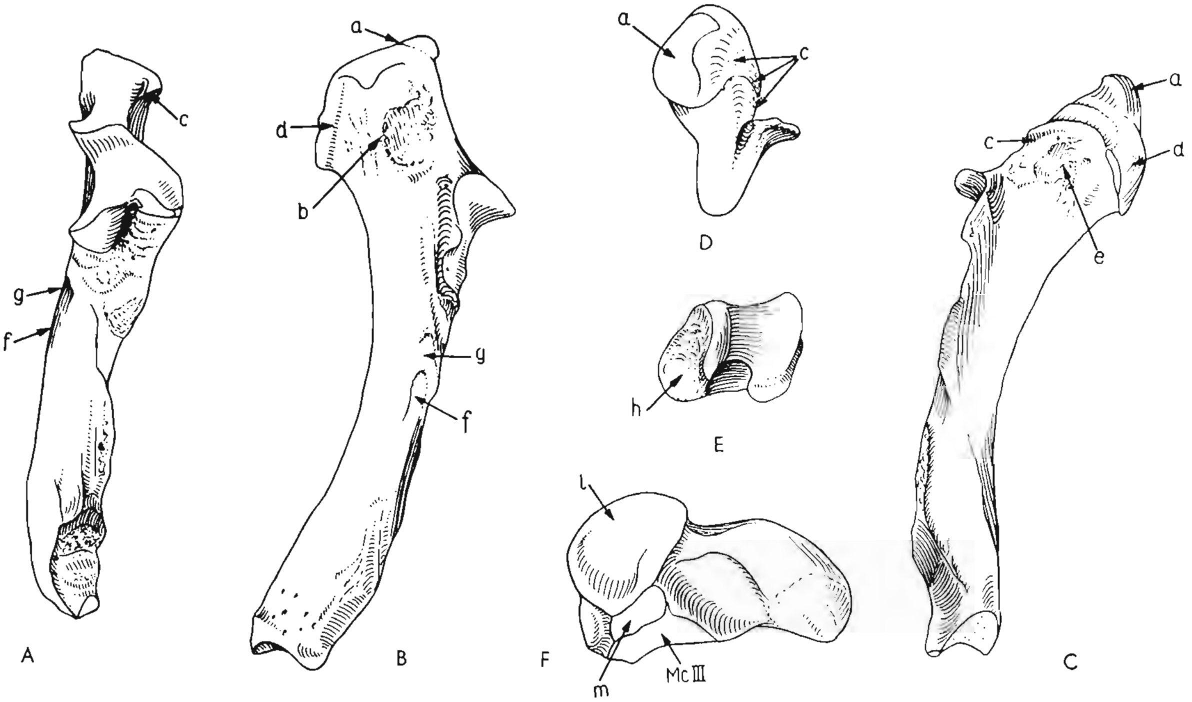

Fig. 9

Bones of *Coelodonta antiquitatis* (BLUM.) with muscle attachment areas and joint surfaces marked; × ca 1/6. *A* the right ulna, anterior view; *B* same bone, lateral view; *C* same bone, medial view; *D* olecranon of the right ulna, proximal view; *E* the right humerus, distal view, right unciforme, medial view; *a* caput longum m. tricipitis, *b* caput laterale m. tricipitis, *c* caput mediale m. tricipitis, *d* m. flexor carpi ulnaris, *e* m. flexor digitalis profundus, *f* m. extensor digitalis lateralis, *g* mextensor digitalis communis, *h* m. extensor carpi ulnaris, *l* articular surface for lunar, *m* articular surface for magnum, Mc III, articular surface for metacarpale III.

attachment of the ulnar head of the flexor carpi ulnaris with a subvertical longitudinal axis. It is bent medially.

Two tuberosities (Text-fig. 9 *B, b*), which make up an attachment of the lateral head of triceps, usually occur on the lateral side of the olecranon.

The medial side of the olecranon is covered in its proximal half with strong, irregular roughnesses in the form of crests and tubercles intersecting each other. In domestic animals, this region is an attachment place of the ulnar head of the deep digital flexor. According to BEDDARD & TREVES (1889) such head does not occur in *D. sumatrensis*. However, the supposed palmaris longus they mention is excellently matched in regard to its attachments (olecranon — tendon of the deep digital flexor) with the description of the uln ar head of the deep digital flexor. Besides, the occurrence, in the rhino, of the palmaris longus, a muscle typical of the Primates (it starts on the medial epicondyle), is less probable. In this connection, the attachments visible on the medial surface of the olecranon (Text-fig. 9*C*, *e*) are interpreted in the present paper as those belonging to the ulnar head of the deep digital flexor.

A strand of muscle scars (Text-fig. 9*B*, *g*) of the ulnar heads of the common digital flexor (situated higher) and the lateral digital extensor (situated lower) occurs on the lateral border of ulna in the medial one-third of its length. This strand is limited proximally by an oblique vascular groove running from the lateral to the anterior surface of the bone and continuing along the surface connecting forearm bones.

An elongate bony protuberance, running from the end of shaft distally and terminating in a smooth, oval area (20×17 mm) occurs as a continuation of the lateral border of ulna. It probably makes up an attachment of the external ligament of the carpal articulation. The form of this ligament, is however, indeterminable.

Carpal bones (Pls. XV—XVII, Figs. 1*a-d*). — The following traces of muscle and ligament attachments are visible on the carpal bones.

On the dorsal walls of the scaphoideum, lunare and cuneiforme, as well as of the bones of the distal row of carpus, there occur attachments of the dorsal ligaments connecting them. On the scaphoideum this attachment occurs in the form of a convexity running obliquely along the process of this bone formed by os carpi centrale.

Table 43

Dimensions (in mm) of the carpal bones in *Coelodonta antiquitatis* (Blum.)

Cat. ZAPUJ No. 683

Bone \ Dimension	Maximum anterior width	Maximum anterior height	Total thickness
Scaphoideum	86	60	69
Lunare	52	46	68
Cuneiforme	38	46	46
Pisiforme	27	31	58
Trapezoideum	28	32	43
Magnum	49	25	89
Unciforme	66	48	75

On the lunare, this is a tuberosity limited by two crests slightly convergent distally and running from the proximal to the distal border of the bone (Text-fig. 10B_1) and on the cuneiform — a vertical crest forming the medial border of the bone. A ligamental tuberosity, situated in the distal and medial corner and markedly corresponding to that situated in the distal lateral part of the dorsal surface of the magnum, occurs on the dorsal surface of the cuneiform. Two tuberosities, facing each other and similarly corresponding to each other (as two attachments of the same ligament), occur near the medial border of the magnum (a tuberosity in the form of a crest) and in the lateral and distal part of the trapezoideum (Text-fig. 10E_1, *F*).

The medial surface of the scaphoideum makes up an attachment place of deep part of the ligamentum collaterale mediale. Bony proturbances (Text-fig. 10C_2), occurring on the medial surface of this bone anteriorly of its posteromedial tuber, are probably related with this ligament. The anterolateral borders of the cuneiform and unciform (Text-fig. 10*A*, *D*) may in turn be related (judging by analogy to the carpal bones of the horse) with deep part of the ligamentum collaterale ulnare of the carpal joints.

The posterior process of the unciforme (Text-fig. 9*F*) projecting posteriorly for about 80 mm (measuring from the dorsal surface of the bone) and 34 mm in maximum width is marked by the largest dimensions on the volar surface of the carpus. A robust, oval ligamental tuberosity occurs at the end of this process, which is curved laterally and downward (Pl. XV, Fig. 2*c*). The magnum has a more delicate (27 mm in width and more strongly contracted at the base) but somewhat longer (90 mm) process, also provided with a tuberosity situated on its proximal, lateral and posterior surfaces (Pl. XV, Figs. 3*b-d*; Text-fig. 10E_{2-5}). In the case of the lunare and magnum, these processes form attachments for radiate ligaments connecting particular carpal bones and running to the distal extremity of the radius and to the metacarpal bone. The same concerns the posteromedial tuberosity of the scaphoideum (Text-fig. 10C_2). Judging by analogy to the horse, only few carpal ligaments were attached to the palmar surface of the unciforme and the purpose of this process was therefore, certainly different. Presumably, together with the posterior process of the magnum and proximal ends of metacarpal bones, it formed an attachment of the interosseus medius. This muscle plays a fundamental role in keeping the metacarpo-digital angle and thus preventing the limb from taking a superextended position typical of the plantigrades. (In connection with this function, this muscle in the horse completely turns into a tendon, forming what is known as the tendo interosseus).

The os carpi accessorium (os pisiforme) (Pl. XVII, Figs. 1*a-d*) is connected with the adjoining bones by special ligaments (according to SISSON, 1938, ligaments of the accessory carpal bone). The distal ligament connecting this bone with metacarpale IV (Text-fig. 5*H*, *lg*) is attached to its swollen distal border in the distal part of the vertical groove for the extensor carpi ulnaris (Text-fig. 5*H ex*). A robust tuberosity for the ligament connecting the two bones is situated on the medial side of the articular surface for the cuneiforme. The proximal ligament of the accessory bone is attached to its proximal border near the flexor carpi ulnaris, with whose attachment the tuberosities of the posterior surface of this bone (Text-fig. 5*H*, *fl*) are probably related.

In regard to the mutual arrangement of its particular bones, the carpus of the woolly rhino displays an alternating type of structure, connected with the cursorial type of the limb and representing a primitive structure, which (according to OSBORN, 1929) is initial in the order Perissodactyla. This structure is marked by a lack of contact or a strongly limited contact between the lunare and the magnum. In the woolly rhino's carpus, this contact is very slight on the dorsal side of limb (limited only to the mediodistal angle of the lunare, Pl. XIV, Fig. 1*a*) and its area gradually extends posteriorly (Text-fig. 10E_5). The proximal articular surface of the magnum, articulates, near the dorsal surface of this bone, almost exclusively with the lateral (central) process of the scaphoideum (Text-fig. 10E_5, *s*). Due to the presence of this process, the interosseous space between the scaphoideum and the lunare has the shape of an oblique slit directed distally and laterally and extending directly to form a slit between the magnum and the cuneiforme (Pl. XIV, Fig. 1*a*). This slit seems to divide the carpus into two blocks. Such an oblique division of the carpus is also a primitive character of the carpi in the Perissodactyla, directly connected with the position of the lunare and the magnum.

Some of the features of carpus in the woolly rhino are graviportal in character, which properly corresponds to a considerable body weight of the animal. Here belongs the shape of the magnum (Text-fig. 10E_1) which grows in width (its height/width ratio amounting to 1 : 2)

Table 44

Dimensions (in mm) of the metacarpal bones in *Coelodonta antiquitatis* (BLUM.)

Cat. ZAPUJ No. 683

Dimension \ Bone	Metacarpale II	Metacarpale III	Metacarpale IV
Anterior length in sagittal plane	139	155 (maximum 161)	130
Width of proximal end	46	46	44
Maximum width of proximal end	51	60	44
Width of distal end	36	49	35
Maximum width of distal end	48	57	43

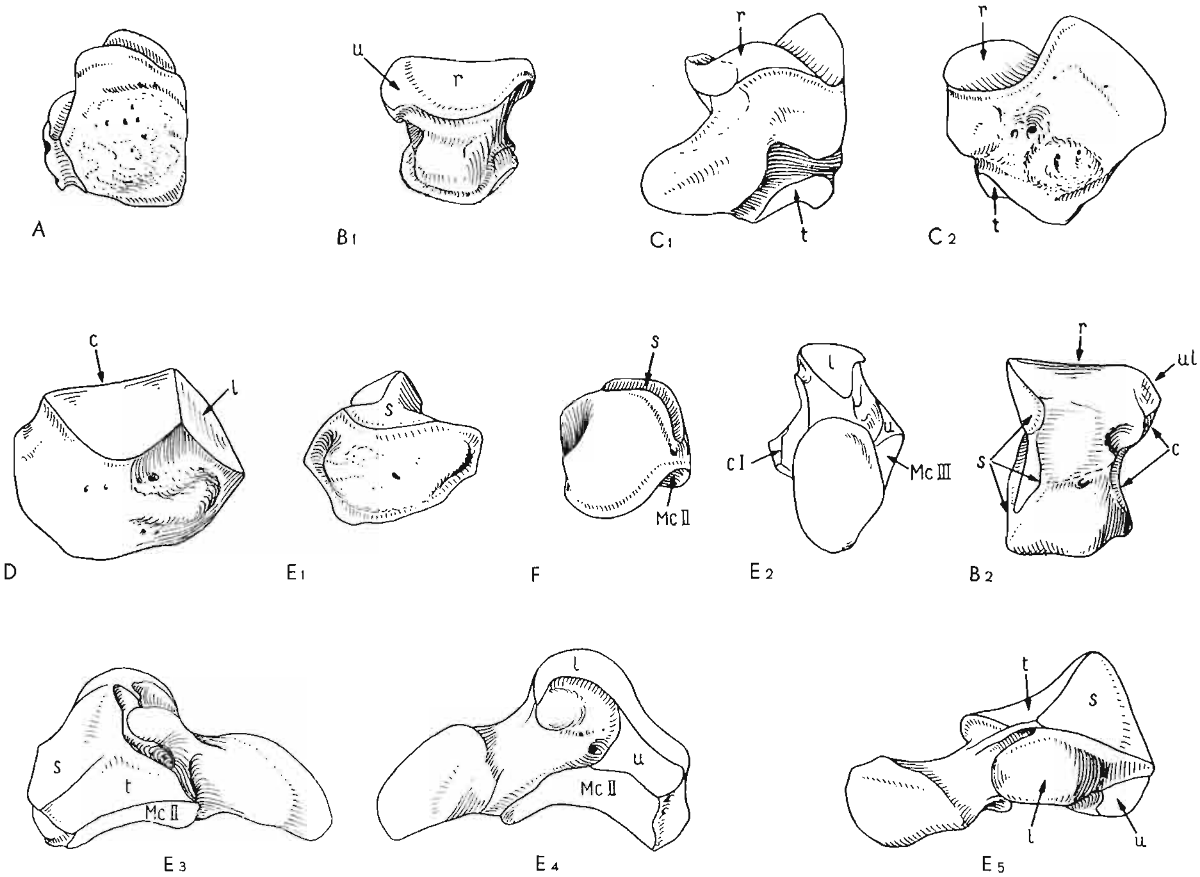

Fig. 10
The right carpals of *Coelodonta antiquitatis* (BLUM.) with articular surfaces designated by letters; × ca 1/6. *A* cuneiform, B_1 B_2 lunar, C_1 C_2 scaphoid, *D* uniciform, E_{1-5} magnum, *F*, trapezoideum. *A* B_1 C_1 D_1 E_1 *F* anterior views, B_2 E_2 posterior views, C_2 E_3 medial views, E_4 lateral view, E_5 proximal view, articular surfaces for: c cuneiform, l, lunar, m. magnum, r, radius, s, scaphoid, t, trapezoideum, u, unciform, ul, ulna, Mc II and Mc III, metacarpals II, III.

and, in the present writer's opinion, a strong development of the posterior processes of the distal row of carpus (the unciforme and the magnum). The development of these processes makes up an adaptation to fast running (RADINSKY, 1965, p. 245), since it is connected with the development of here attached palmar flexors. In view of the loss of digits V and I, the interosseus medius only may come into consideration in the rhino. As mentioned above, this muscle is of importance for maintaining the metacarpo-digital angle, which becomes more and more difficult with an increase in body weight. The development of the attachments of muscles which are responsible for this function, is correlated with the development of the muscles themselves and the shift of the muscle attachments from the joint served by them, raises the efficiency of these muscles. The development of the posterior processes of the unciforme and the magnum would be, therefore, a graviportal adaptation, connected, however, with the high degree of the animal's mobility only indirectly, that is, by keeping the limb in an unguligrade position.

BONES OF THE PELVIC LIMB

Pelvic girdle. — Pelvis (Pl. XIX, Fig. 1; Pl. XX, Fig. 1*a-c*) of the subgraviportal type, with a very wide wing, but a relatively elongate shaft of the ilium.

Tuber coxae occupies about a half of the length of the anterior border of the wing of ilium and thus contributes to its swelling. With its convexity it faces anterolaterally. In the posterolateral, thickest part (reaching about 48 mm), the tuber is limited by a triangular surface facing posterolaterally and which makes up the anterior part of the lateral border of wing.

A robust, subtriangular, sacral tuber ascends medially thus causing in this region a deeper concavity of the gluteal surface of ilium, whose more outer part is nearly completely flat.

The crest of ilium slightly concave. The medial, articular part of the pelvic surface of ilium convex. The auricular surface elongate, subhorizontal (in the physiological position of the pelvis), with its longitudinal axis parallel to the sagittal plane. The external part of the pelvic surface of ilium, or iliac part, is developed as a concavity which deepens anteriorly.

The ilio-pectineal line forms a boundary between both parts of the pelvic surface of ilium and, posteriorly, a ventromedial border of the shaft of ilium. It is variously, sometimes fairly strongly, developed. Two vascular grooves [7] run externally of the ilio-pectineal line and transversally to the shaft in the place in which the wing turns into the shaft (Pl. XX, Fig. 1*c*). They are as a rule accompanied by an nutrient foramen.

A distinct, oval, rough psoas tubercle is situated on the shaft of ilium as a continuation of the ilio-pectineal line. Posteriorly of the psoas tubercle, the ilio-pectineal line extends, here and there almost invisible, up to the place somewhat below the level of acetabulum where it terminates in a small swelling.

The dorsal border of ilium is sharp at the level of the auricular surface and in the region of ischiatic spine and blunt in the region of the lesser sciatic notch.

The ventral, external border of ilium begins in the external part of wing with a triangular muscle area facing with its apex posteriorly and occupying slightly more than one-quarter of its length. Further on, it turns into a sharp edge, usually extending up to the anterior border of acetabulum. A triangular muscle area, resting with its base on the margin of acetabulum and overlapping the dorsoexternal surface of ilium, adheres to this border in the region of the shaft of ilium. Sometimes, the border of shaft dwindles away in this region and the muscle area mentioned above overlaps the gluteal surface of the bone.

[7] In the pelvis of the horse such grooves are located in two places: near the anterior border of the wing (grooves for the iliaco-femoral vessels). A nutrient foramen occurs in the neighborhood of the last-named grooves.

Table 45

Dimensions (in mm) of the pelvis in *Coelodonta antiquitatis* (Blum.), ZAPUJ No. 683 as compared with those in *Diceros bicornis* L., MIZ, and *Rhinoceris sondaicus* Desm., MIZ.

Dimensions \ Species	*Coelodonta antiquitatis*	*Diceros bicornis*	*Rhinoceros sondaicus*
Maximum length of pelvis	549	491	494
Maximum spacing of the tuber coxae	772	684	700
Minimum spacing of sacral tubers	about 62	78	62
Distance between most ventrally situated points of auricular surfaces	202	160	156
Distance between the middle of acetabula	238	about 228	about 247
Distance between psoas tubercles	about 265	252	about 267
Distance between ischiatic spines	245	210	232
Maximum spacing of the tubera ischii	245	258	296
Distance between the external angle of the wing and the middle of acetabulum *	about 242	about 204	246
Length of the ischium (from the middle of acetabulum) *	175	about 193	177
Length of symphysis	about 155	157	165
The smallest anteroposterior dimension of the acetabular branch of the pubis	36	37	33
Minimum distance of the anterior border of acetabulum from the auricular surface	233	207	210
Maximum width of the wing of ilium	390	400	430
Minimum width of the shaft of ilium	56 left 59 right	79	65

* In projection on the axis of the shaft of ilium or on the axis of the shaft of the ischium.

The pubis is very robust. Its acetabular branch is shaped like a stout beam about 40 mm high and about 35 mm in anteroposterior diameter. Its symphyseal branch has the form of a coarse lamella concave ventrally and convex dorsally. As a result of a strong increase in the thickness of the pubis, it turns anteriorly with its anterior wall which has two borders: dorsal and ventral and not one as is the case in the horse. The ilio-pectineal line terminates, slightly below the level of the dorsal border, in an ilio-pectineal eminence. The pubic tubercle is situated on the ventral side.

The acetabular part of the ischium is shaped like a beam triangular in transverse section. The tuber ischii is triangular, with a nodular ventral surface. The lesser sciatic notch is not very deep and has a blunt border.

A not very high, blunt ischiatic spine is separated from the lesser sciatic notch by a transversally situated groove and strongly ornamented by oblique crests. The surface of bone, situated externally of it and above the acetabulum, is very rough and deeply concave in its posterior part.

The acetabulum is deep, round, about 102 mm in diameter and provided, on the side of the obturator foramen, with a distinct acetabular notch.

The obturator foramen round (105 mm in diameter). A shallow, wide notch for the obturator nerve and accompanying vessels is marked on the posterior border of the pubis which limits it anteriorly. This notch is directed dorsally, anteriorly and laterally.

The ischial arch strongly wedged in the symphysis.

The traces of the following muscle attachments are visible on the surface of pelvis:

A thickened anterior border of the wing, including the tuber sacrale, the crest of ilium and the tuber coxae, except for its external part turned posteriorly, was occupied by the longissimus dorsi and, directly below it, the ilio-lumbar ligament. The external part of the tuber coxae in the form of an isosceles, rough triangle, disposed with its largest height (about 80 mm) along the external border of wing (Text-fig. 11*Ab*, *Cb*; Pl. XX, Fig. 1*b*), served as an attachment for the tensor fasciae latae. The oblique muscles of abdomen, that is, the obliquus abdominis externus and the obliquus abdominis internus, are on the whole also attached to the shaft of ilium on the tuber coxae and in its region, but their attachment places in *C. antiquitatis* cannot be accurately determined.

The gluteal surface of ilium is smooth and does not allow one to determine precisely the situation of the gluteus medius, which was attached in this region. The attachment of the gluteus medius is only posteriorly limited by semicircular lines with their convexities facing anteriorly (Text-fig. 11*Ac*). These lines make up an anterior limitation of the trace of the gluteus profundus extending posteriorly as far as the region between the ischiatic spine and the acetabulum inclusively. This region is slightly convex and covered with irregular elevations, while the anterior part of the attachment area, which makes up an almost entire dorsolateral surface of the shaft, is fairly smooth and slightly concave. A crest, which at the same time forms the dorsal border of a triangular preacetabular area [8], (Pl. XX, Fig. 1*b*), makes up a lateral limitation of the gluteus profundus.

This poorly developed crest, sometimes almost invisible at all, probably limited dorsally the attachment of the capsularis (Text-fig. 11*C*, *e*), while both tendons of the rectus femoris were attached in the ventral corner of the preacetabular area in which there are two muscle scars adjoining each other or a single, bifid scar (Text-fig. 11*C*,*f*).

A very extensive iliac part of the pelvic surface of ilium was an attachment area of the iliacus, which is limited posteriorly by two vascular grooves running across the shaft approximately on the boundary between the shaft and wing (see above). These grooves represent impressions of iliaco-femoral vessels (the arteria circumflexa and two other accompanying veins). A nutrient foramen for the nutrient artery of ilium occurs in the neighbourhood of the grooves.

The psoas tubercle, in the form of an oval (25×15 mm), flat and rough area makes up an attachment of the psoas minor.

[8] An analogous crest is formed in the horse by an attachment of the dorsal tendon of the rectus femoris and of the tendon of the capsularis. These muscles form a distinct depression anteroventrally of this crest.

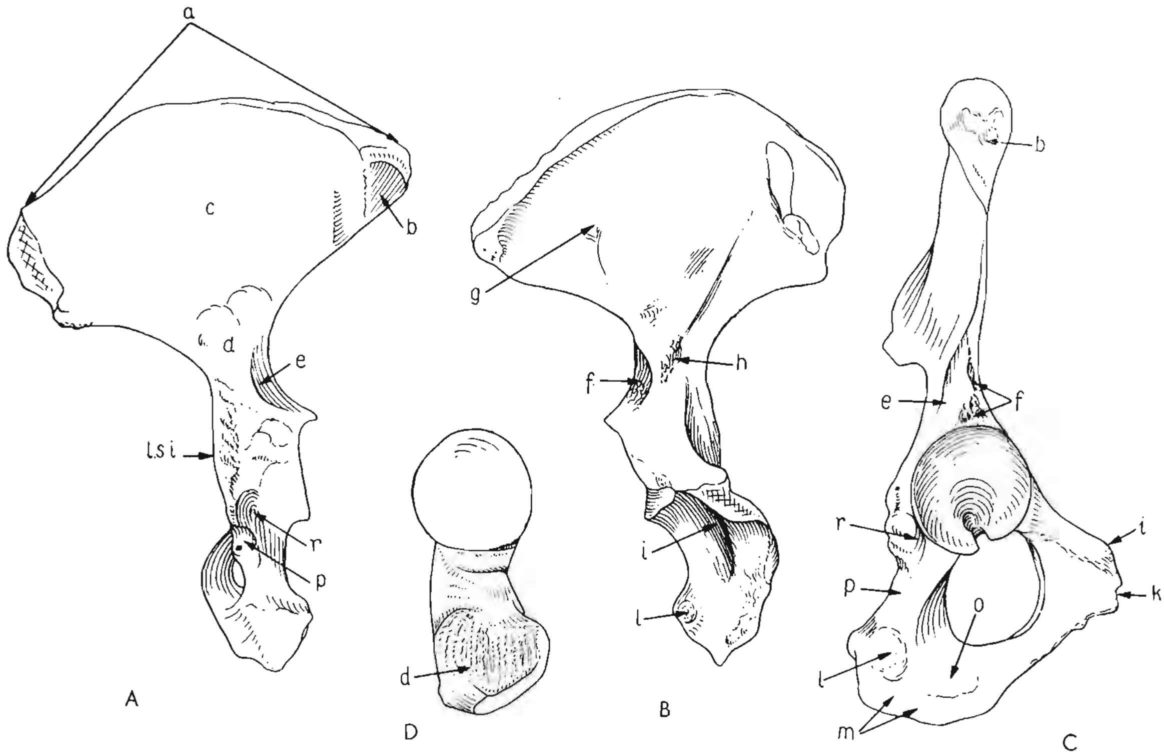

Fig. 11

The right innominate bone; *A* dorsal view, *B* ventral view, *C* lateral view. The left femur; *D* proximal view, with muscle and ligament attachment areas marked, × ca 1/6; *a* m. longissimus dorsi, *b* m. tensor fasciae latae, *c* m. gluteus medius, *d* m. gluteus profundus, *e* m. capsularis, *f* m. rectus femoris, *g* m. iliacus, *h* m. psoas minor, *i* tendo prepubicus, *k* m. pectineus, *l* m. biceps femoris, *m* m. semimembranaceus and m. semitendineus, *o* m. obturator externus, *p* groove for the fascicules of m. obturator internus, *r* m. gemelli, lsi, ligamentum sacroischiadicum

The ilio-pectineal eminence serves as an attachment for the prepubic tendon belonging to the rectus abdominis and, in addition, for the obliquus abdominis externus and internus, the gracilis and the pectineus. The pectineus is also attached to the pecten ossis pubis between the left and right pubic tubercle. The ventıal surface of the pubis is rough. The gracilis and the adductor femoris were attached along the pelvic symphysis and on a concave ventral surface posteriorly of the pecten ossis pubis.

The obturator externus, whose attachment area is relatively smooth and depressed posteriorly, was attached on the ventral side of pelvis around the obturator foramen. Several semicircular lines, whose concavities is facing the obturator foramen, separate this attachment area from the posteromedial part of the ventral surface of the ischium, which is somewhat convex and nodular.

A nodular area projecting with its blunt spine ventrolaterally is formed by the ventral surface of the tuber ischii in its external part. It makes up a trace of the attachment of the short head of the biceps femoris. Shorter heads of the semimembranaceous and the semitendineus are also attached to the ventral surface of the tuber ischii posteriorly of the attachment of the biceps femoris. According to BEDDARD & TREVES, 1889, in *D. sumatrensis* these muscles are grown together to form a single muscle unit, but it is not certain if this phenomenon occurs over their entire length. The quadratus femoris was attached anteriorly of the semimembranaceus.

An attachment of the sacro-sciatic ligament is situated on the pelvic surface of the tuber ischii. This ligament is also attached to the medial surface of the spina ischiadica.

The obturator internus was attached around the obturate foramen on the pelvic surface of the ischium and the ilium. Its traces are visible in particular on the pelvic surface of the os coxae in the region of acetabulum. These are shallow and smooth depressions and more or less distinct bony elevations, situated posteriorly of the ilio-pectineal eminence in continuation of the anterior border of the obturate foramen.

The traces of the obturator internus are also visible on the pelvic surface of the branch of ischium situated posteriorly of symphysis. This muscle was getting out from the inside of pelvis through the lesser sciatic notch (or through the lesser sciatic foramen), whose thick, smooth border is provided in this connection with several shallow, groovelike transverse depressions (Pl. XX, Fig. 1*a*; Text-fig. 11*Ap*).

A deep depression (Text-fig. 11*Ar*), making up an attachment area of the gemelli is situated ventrally of the posterior part of the spina ischiadica and anteriorly of the lesser sciatic notch.

Femur. (Pl. XX, Figs. 2*a*, *b*; Pl. XXI, Figs. 1*a*, *b*; Pl. XXII, Figs. 1*a*, *b*). — It is the longest of all long bones in the entire skeleton of the woolly rhino. Its physiological length fluctuates within limits of about 450 and 520 mm, the ratio of the minimum width of shaft to its physiological length being 1.75 to 1.92.

The plantar surface of the bone is flat, the dorsal flat proximally and becoming convex distally. A crest dividing the dorsal surface into two areas, runs ventrally along it from the level of the external border to the medial ridge of the trochlea.

The head of femur is round, 90 to 100 mm in diameter, strongly convex and with only slightly separated neck. It is inclined medially at an angle of 60° to the axis of shaft and separated from the muscular part of the proximal end by a wide (about 40 mm) groove. The trochanter major is situated below the level of head and is not divided into the anterior and posterior part. It occurs in the form of a pyramid with a truncate, rounded apex and triangular base. One of its angles faces anteromedially, the other anteroexternally and the third posteriorly. The posterior angle of the trochanter turns distally into the posterior trochanteric ridge running parallel to the shaft towards the third trochanter. This ridge makes up an external limitation of the trochanteric fossa. An about 100 mm long crest runs distad from the anteroexternal angle of the trochanter major.

The third trochanter occurs more or less halfway the length of the external border of femur in the form of a quadrangular plate strongly projecting externally of the shaft and bent anteriorly. Its sharp proximal and distal borders gradually turns into the external border of shaft.

The trochanter minor is developed in the form of a triangular crest with a rounded apex, beginning about 45 mm under the notch of the femoral head and descending to a point about halfway the length of the bone. Its apex, turned anteriorly, is situated at the level about the upper one-third the length of the bone.

The plantar surface of the shaft is very rough in its distal half. In its distal part, a deep supracondyloid fossa (shifted medially as compared with the supracondyloid fossa in the horse) occurs over the intercondyloid fossa and externally of it, there is a shallower, rough depression divided lengthwise by a vertical crest and limited laterally by the lateral supracondyloid crest.

The distal extremity of femur is almost identical with that in the horse, except only for the lateral condyle which is somewhat larger than the medial condyle in the rhino. The articular surface of the lateral condyle overlaps the lateral side farther than the surface of the medial condyle overlaps the medial side. The medial ridge of the trochlea is much stouter and more strongly projecting anteriorly than the lateral ridge. Its articular surface strongly overlaps the medial side.

Table 46

Dimensions (in mm) of the femur in *Coelodonta antiquitatis* (Blum.), *Diceros bicornis* L., and *Rhinoceros sondaicus* Desm.

Species	*C. antiquitatis*			*D. bicornis*					*Rh. sondaicus*
Dimensions / Cat. No.	ZAPUJ No. 683		GI No. 9/1	MIZ	ZIN No. 24729		ZIN No. 615		MIZ
	left	right			left	right	left	right	
Distance from the middle of head to the farthermost point of the medial condyle	452	—	520	466	424	430	447	445	459
External length in projection on the longitudinal axis	440	445	494	—	421	420	432	435	—
Length of shaft on the medial side	—	—	about 366	—	302	306	—	—	—
Maximum width of the proximal end	207	207	225	174	183	186	190	188	197
Width of head	97	94	100	78	88	83	93	90	88
Antero-posterior dimension of head	92	91	100	76	79	79	87	84	89
Minimum width of shaft at the level of the trochanter minor	127	124	146	93	118	110	126	118	119
Width of shaft together with the third trochanter	148	142	—	111	126	123	135	131	139
Width * of the base of the third trochanter	73	68	72	72	74	70	72	69	79
Width of distal end	148	146	153	121	126	127	127	133	152
Minimum width of shaft below the third trochanter	87	85	91	60	62	65	62	62	71
Distance between the lowermost point of the trochanter minor and the distal end	258	266	292	290	268	265	255	252	271
Distance between the lowermost point of the third trochanter and the distal end	176	187	214	178	163	180	193	180	207

* Width here = vertical dimension.

Posteriorly, the epicondyles reach the articular surfaces of condyles and anteriorly approximately the boundary between the condyles and the trochlea. The lateral epicondyle reaches somewhat more anteriorly and distally than the medial one. In its distal part, the extensor fossa in the form of a depressed, triangular surface, is wedged in between the borders of the lateral condyle and the trochlea. On the medial side, a distinct groove for the middle patellar ligament occurs between the epicondyle and the trochlea.

A triangular depression for the round ligament is situated in the posteromedial part of head near its base, that is, in a position corresponding to that of the acetabular notch. The height of this notch amounts to about a half of the radius of the femoral head.

The attachments of the following muscles are visible on the surface of femur.

The trochanter major is occupied by the gluteal muscles, of which the gluteus profundus is attached on its anterior wall facing anteriorly, proximally and laterally and on its proximal wall ornamented by transverse crests and furrows parallel to each other. The posteroexternal wall serves as an attachment area of the gluteus medius, which also attaches itself to the lateral, strongly ornamented wall of the shaft of the bone between the posterior trochanteric ridge and a crest running distal from the anteroexternal angle of the trochanter.

The plantar, rough surface of the third trochanter and its proximal and distal borders were attachment areas of the gluteus superficialis.

The dorsal surface of the femur was covered with two vastus muscles: the vastus lateralis and vastus medialis, the vastus intermedius being probably absent in the woolly rhino or fused with one of the adjoining vastus muscles, as it is in *D. sumatrensis* (see BEDDARD & TREVES, 1889). A line running through the middle of the dorsal surface of the shaft separates the two parts of the vastus.

In the horse, the vastus lateralis is attached to the entire anteroexternal surface of the femur. According to BRESSOU (1961), in the tapir, this muscle is attached by a tendon under the trochanter major. In the woolly rhino, the proximal quarter of the dorsal surface for the vastus lateralis is covered with a network of crests (Text-fig. 12*A*, *e*), while the rest of this surface is smooth, which might indicate that this muscle was attached to the bone in this region.

The vastus medialis was attached to the dorsomedial part of the surface of femur, which is slightly ornamented in its upper part and bordered proximally by the rough line, a dorsal limit and origin of the attachment of this muscle. It is impossible to conclude on how far this attachment reached distally and on what was the relation of this muscle to the vastus intermedius, if it occurred at all.

The trochanter minor serves as an attachment place for the common tendon of the psoas major and the iliacus, which is attached to its dorsal surface covered with conspicous, irregular roughnesses.

A longitudinal, narrow, rough scar of the pectineus begins directly under the trochanter minor and runs along the shaft over a length of about 12 cm.

Many traces of muscle attachments are observed on the plantar surface of femur. Rough depressions, limited by distally convex ridges occur in the trochanteric fossa and below it. On the other hand, a small tubercle is situated in the upper part of the trochanteric fossa. This depression and tubercle make up an attachment area of the obturator internus, the obturator externus and the gemelli muscles. Judging from the mutual positions of these muscles in their initial parts in the pelvis, it should be expected that the attachment of the obturator externus was lowermost of the obturator internus higher and of the gemellus highermost (the last-named is frequently connected with the tendon of the obturator internus).

The facies aspera (Text-fig. 12*C*) begins at the level of the distal part of the trochanter minor with a medially situated roughness for the quadratus femoris (Text-fig. 12*C*, *k*) converging distally with an externally situated attachment area of the tendon of the biceps femoris which is (Text-fig. 12*C*, *l*), however, also near the axial part of the femur. These muscle attachment areas fuse together at the level of the medial part of the third trochanter and turn distally into a sharp, externally bent and distally directed crest for the adductor femoris (Text-fig. 12*C*, *m*) which terminates near the supracondyloid fossa.

Another attachment area of the adductor femoris is situated in the region of the medial epicondyle. Of two muscle scars occurring in the posterior part of this epicondyle, the adductor femoris was probably served by that situated higher-up dorsally of the epicondyle (judging

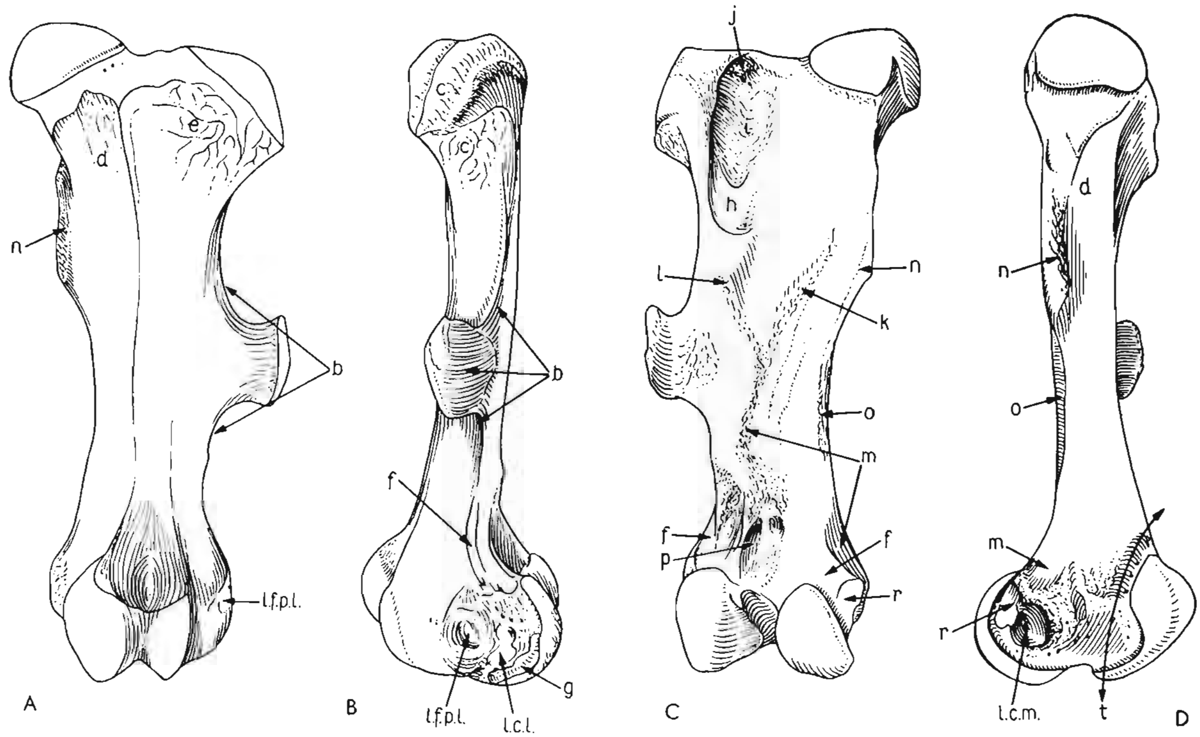

Fig. 12
The left femur of *Coelodonta antiquitatis* (BLUM.) with muscle and ligament attachment areas marked, × ca 1/6; *A* anterior view, *B* lateral view, *C* posterior view, *D* medial view, *a* m. gluteus profundus, *b* m. gluteus superficialis, *c* m. gluteus medius, *d* m. vastus medialis, *e* m. vastus lateralis, *f* m. gastrocnemius, *g* m. popliteus, *h* m. obturator externus, *i* m. obturator internus, *j* mm. gemelli, *k* m. quadratus femoris, *l* m. biceps femoris, *m* m. adductor femoris, *n* m. iliopsoas, *o* m. pectineus, *p* m. flexor digitalis superficialis, *r* m. semimembranaceus, *t* groove for the medial patellar ligament, *s* m. extensor digitalis longus, l. c. l. and l. c. m., ligamentum collaterale laterale and mediale, l. f. p. l., ligamentum femoropatellare laterale.

from the position of the trace of this attachment in man). The lower situated trace might be connected with the medial head of the gastrocnemius or with the attachment of some fibers of the semimembranaceus, if such an attachment existed at all, since it was not described in *D. sumatrensis* (BEDDARD & TREVES, 1889).

A roughness, situated on the lateral side of the crest of medial epicondyle (axially of the attachment of the adductor femoris) seems, however, to be a more likely attachment area of the medial head of the gastrocnemius (Text-fig. 12*C*, *f*) and, therefore, the muscle scar occurring below the trace of the adductor femoris is here interpreted as a trace of the semimembranaceus.

In *D. sumatrensis*, the adductor magnus, a part of the adductor femoris, contributed to the formation of a tendon arch for the artery, situated at the level of the distal one-third of femur (according to BEDDARD & TREVES, 1889) and, at the same time, at the level of the attachment of the pectineus.

In *C. antiquitatis*, a nutrient foramen, through which the nutrient artery, a branch of the arteria femoralis profunda, penetrates inside the femur, occurs in the proximal part of the surface of the attachment of the pectineus slightly below a point halfway the length of this bone.

A deep supracondyloid fossa (Text-fig. 12) an attachment area of the flexor digitalis superficialis, is situated directly over the intercondyloid fossa (see above). A shallower, very rough depression, limited laterally by the crest of the lateral epicondyle and which probably makes up an attachment area of the lateral head of the gastrocnemius, occurs externally of it.

A trace of the attachment area of the popliteus in the form of two smooth depressions situated above each other occurs on the external epicondyle (Text-fig. 12*C*, *g*) directly over the condyle. A trace of the attachment of the external femoro-tibial ligament is discernible directly above it and somewhat anteriorly. In the most anterior part, there occurs a round scar of the lateral femoro-patellar ligament.

The presence of a strongly developed extensor fossa on the distal surface of the lateral epicondyle is indicative of the presence of a femoral attachment of the extensor digitalis longus. No such attachment is described by BEDDARD & TREVES (1889) in *D. sumatrensis* (the Extensor communis digitorum they describe probably corresponds to the extensor digitalis longus and lateralis).

A round, depressed scar of the medial femoro-tibial ligament is situated on the medial epicondyle followed posteriorly by an oval scar which is likely to belong to the semimembranaceus (see above).

In the intercondyloid fossa, a depression for the femoral ligament of the lateral meniscus occurs posteromedially, for the anterior cruciate ligament — posteroexternally and for the posterior cruciate ligament (a less distinct trace) — close to the patellar trochlea (Text-fig. 13*F*, *l. c. a.*, *l. c. p.*).

Tibia. — In *C. antiquitatis*, the tibia is massive, which is manifested in a considerable width and thickness of its extremities. The width of the proximal extremity amounts to about 43 to 46% and its anteroposterior dimension to about 44 to 48% of the external length of this bone, while the width of the distal extremity makes up 35 to 37% of this length. Minimum width of the shaft, occurring approximately halfway the length of shaft represents about 22 to 25% of the external length of tibia.

A strong development of the external part of the tibial tuberosity results in a shift of its apex towards the external side of the proximal extremity. The groove for the middle patellar ligament (Text-fig. 13*A*, *E*) is deep and wide (about 30 mm).

The lateral part of the spine is situated at the same level as its medial part. The surface of the medial condyle is slightly concave and that of the lateral condyle concave in the apical region and flat near the external border. The popliteal notch deep (about 20 mm).

The tibial crest very stout and rounded in the proximal one-third of the bone and tapering distally. It runs down to the medial maleolus.

The medial surface of tibia is slightly convex in its proximal part and flattening distally. In its proximal part, the medial border of the bone is bent, with its concavity facing posteriorly. This border is most strongly concave about halfway the length of bone, in the place where the medial border contacts the popliteal line. Farther, it suddenly turns into an almost straight distal part of the border. Moreover, the proximal part of the medial border is very sharp, strongly projecting posteriorly and, consequently, the attachment area of the popliteus is limited to the plantar surface of the bone only.

The medial malleolus projects distally (a dozen or so millimeters below the medial border of the distal articular surface) and medially. Posteriorly, it is limited by a groove running upwards and posteriorly (more or less along the anteromedial curve of the surface of shaft, see below).

The dorsolateral surface of the tibia, slightly convex in its proximal part, turns distally into the dorsal surface.

Two triangular surfaces for the articulation with the fibula are situated on the postero-lateral border of the tibia. The proximal one, occupying about a quarter or slightly more of

Table 47

Dimensions (in mm) of the tibia in *Coelodonta antiquitatis* (BLUM.), *Diceros bicornis* L., and *Rhinoceros sondaicus* DESM.

Species	*C. antiquitatis*			*D. bicornis*					*Rh. sondaicus*
Dimensions / Cat. No.	ZAPUJ No. 683		ZIN No. 4071	MIZ	ZIN No. 24729		ZIN No. 615		MIZ
Distance between the spine and the middle of the articular surface of the distal extremity	326	324	368	—	309	309	320	319	—
Medial length	296	292	335	303	279	280	275	276	280
Lateral length	276	276	319	299	268	269	270	273	280
Width of the proximal extremity	125	120	137	108	107	106	116	114	123
The anteroposterior dimension of the proximal extremity	127	124	144	about 125	111	110	128	117	135
Width of shaft	63	60	75	60	52	53	51	53	55
The anteroposterior dimension of shaft	58	61	67	43	55	52	65	60	50
Width of distal extremity	96	95	107	90	97	96	about 110		102
The anteroposterior dimension of the distal extremity	75	79	89	66	71	70	73	75	71
Width of the articular surface of the distal extremity	75	76	89	—	73	71	—	—	—
The anteroposterior dimension of the articular surface of the distal extremity	48	53	60	—	67	59	—	—	—

the length of bone, is, slightly convex, turned posteriorly and with its apex directly downwards. Anteriorly, it fuses with the posterior attachment area of the tibialis anterior (see below). The distal surface, directed with its apex upwards, turned posterolaterally, is shaped like an isosceles triangle extended by a sharp border which halfway the height of shaft passes onto the posterior surface of the bone. A small, flat, semilunar articular surface for the fibula occurs in the distal part of the distal surface for this bone.

The interosseous space is situated approximately in the third (counting from the bottom) quarter of the length of tibia. Its border, formed by the tibia, is blunt, slightly concave and intersected by oblique grooves for the anterior tibial artery and for the accompanying veins running anteriorly and downwards from the plantar surface of the bone.

The tibia fuses with the fibula relatively lately, which is indicated by the fact that only a relatively low percentage of the bones of shank is preserved connected with each other, (of thirteen tibiae, only three are fused with the fibula).

The plantar surface of tibia is concave in its proximal half and along its entire lateral border and convex in the mediodistal part. The popliteal line runs obliquely upwards from a point halfway the medial border. At a distance equalling one-third the length of the bone from its proximal extremity, the popliteal line meets the above mentioned extension of the external border of the bone and forms, together with it, a distally open angle, inside of which there usually occurs the nutrient foramen.

The lateral articular groove of the distal extremity is wider and shallower than the medial one. Its posterior, lowermost part reaches distally the level of the apex of the medial malleolus. A narrow (a few mm), smooth surface, stretching from the external border of the bone to the apex of the medial articular surface of the distal extremity, runs along its border on the plantar surface of the tibia.

Fibula (Pl. XXIII, Figs. 1*a*, *b*, 2). — The fibula is developed over its entire length but strongly reduced in size. The width of its shaft at the level of the interosseous space makes up a bare 38 per cent of the width of the shaft of tibia at the corresponding level. This ratio changes yet more in favor of the tibia towards the extremities (about 32 per cent at the proximal and about 29 at the distal).

In its posteromedial part, the proximal extremity of the fibula is rounded and as compared with the shaft, extended and truncate anteriorly so that its anterior border forms, together with the anterior border of the shaft, a more or less straight line (Pl. XXIII, Fig. 16). Directed posteroexternally, the surface of the head is strongly convex. Its medial part turns distally into the external border of the shaft.

Over its entire length, the shaft is approximately triangular in transverse section, but its distal half is, in relation to the proximal one, slightly twisted clockwise in the right bone and

Table 48

Dimensions (in mm) of the fibula in *Coelodonta antiquitatis* (Blum.)

Dimensions \ Cat. No.	PS No. 13	MG No. 12
Length	285	273
Width of proximal extremity *	40	—
The anteroposterior dimension of the proximal extremity	40	—
Width of shaft	25	24
The anteroposterior dimension of shaft	19	19
Width of distal extremity	32	29
The anteroposterior dimension of the distal extremity	50	50

* Measured posteriorly.

anti-clockwise in the left bone, so that the anteromedial and lateral borders turn below the interosseous space into the anterior and posterior borders and the posteromedial into the medial one. In this connection, an external surface extending distally and turning into a macelike distal extremity occurs in the distal part instead of the external border.

A deep groove, running upwards and slightly anteriorly and surrounded posteriorly and anteriorly with tuberosities, occurs on the lateral surface of the distal extremity. The posterior surface of the proximal part of shaft is covered with strong longitudinal tuberosities parallel to the axis of shaft. The posteromedial surface, also, if to a smaller degree, covered with tuberosities, forms, together with a concave external part of the posterior surface of the tibia, a deep fossa.

As a result of the lack of separate specimens of the fibula, its surface facing the tibia has not been studied. Without any doubt it corresponds in its shape to an appropriate surface of the tibia.

An oval, about 30×20 mm, vertically disposed (with its longer axis horizontal) articular surface, limiting externally the lateral articular groove of the extremity of the tibia, is situated on the medial surface of the distal extremity.

Traces of attachments of many ligaments which serve the stifle joint are visible on the surface of the proximal extremity of the tibia (Text-fig. 13*E*).

The tibial tuberosity makes up an attachment area of the patellar ligaments. A semilunar trace, concave dorsally and situated in the distal part of the groove for the medial patellar ligament on the tibial tuberosity, makes up an attachment area of this ligament (Text-fig. 13*E*, *l. p.*).

A slightly convex oval (59×22 mm), smooth surface for the lateral patellar ligament and accompanying aponeurosis of the biceps femoris occurs in the proximal part of the tibial tuberosity laterally of the groove. This surface, arranged with its longer diameter nearly horizontal, turns distally into a rough, convex part of tibial tuberosity, covered with vertical ridges and which probably makes up an attachment area of the apeneurosis of the fascia lata (Pl. XXIII, Fig. 2).

A slightly separated, oval (41×22 mm) area facing anteromedially and slightly proximally, with its longer diameter horizontal, makes a trace of the attachment of the medial patellar ligament, together with which the aponeurosis of the sartorius and the gracilis are attached in this place.

The attachments of the meniscal and cruciate ligaments (Text-fig. 13*E*) are distributed much the same as in the horse except for the trace of the attachment of the posterior cruciate ligament (Text-fig. 13*E*, *l. c. p.*) which does not contact the external condyle of the tibia but is separated from it by a deep and wide (about 20 mm) groove probably serving as an attachment area of the posterior ligament of the medial meniscus (Text-fig. 13*E*, *l. t. m. m*). In the horse, the last-named ligament is attached more laterally along the posterior border of the lateral condyle. The following ligamental scars are distributed posteroanteriorly along the spine: a scar of the posterior ligament of the medial meniscus, a longitudinal scar of the anterior cruciate ligament (between the apexes of the spine) and a round scar of the anterior ligament of the lateral meniscus. The attachment area of the anterior ligament of the medial meniscus is situated anteriorly of the medial condyle in a notch on its anterior border.

The groove separating the tibial tuberosity from the lateral condyle, which in the horse serves for the tendons of the extensor digitalis longus and of the peroneus tertius running from the extensor fossa of the femur and which in *C. antiquitatis* contains only the tendon of the

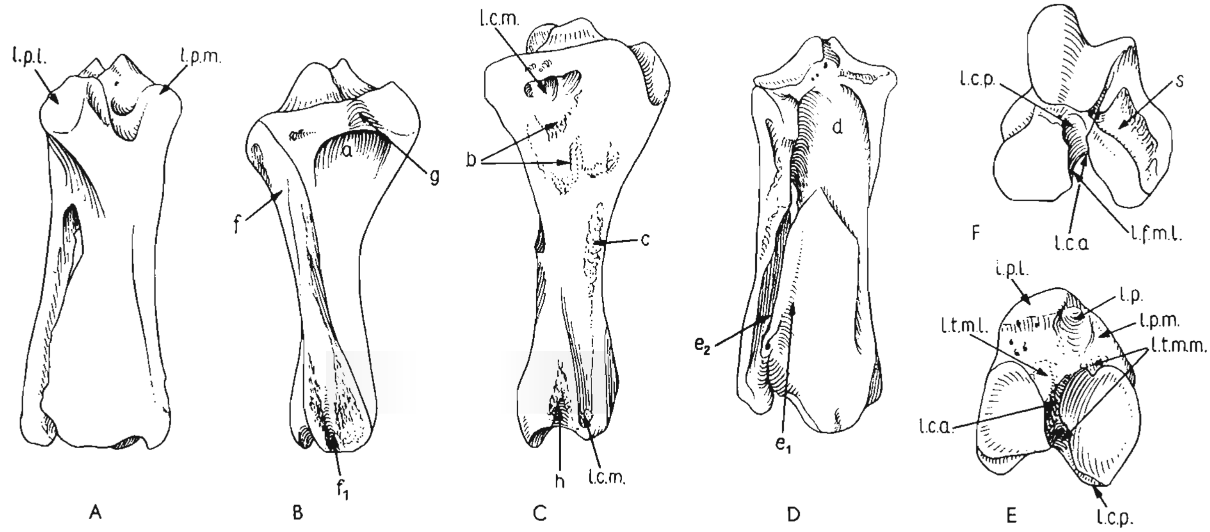

Fig. 13

Bones of *Coelodonta antiquitatis* (BLUM.) with muscle and ligament attachment areas marked, × ca 1/6; *A* the right tibia and fibula, anterior view, *B* the same bones, lateral view, *C* the left tibia, medial view, *D* the left tibia and fibula, posterior view, *a* m. tibialis anterior, *b* m. gracilis, *c* m. semitendineus and m. semimembranaceus, *d* m. popliteus, *e* m. flexor digitalis profundus, e_1 m. flexor hallucis longus, e_2 m. tibialis posterior, *f* mm, peronei, f_1 groove for the tendon of m. peroneus I, *g* groove for the tendon of m. extensor digitalis longus, *h* groove for m. flexor digitalis longus, l. c. m., ligamentum collaterale mediale, l. p. l., ligamentum patellare laterale, l. p. m., ligamentum patellare mediale, l. p., ligamentum patellae, l. t. m. m., ligamentum tibiale menisci medialis, l. t. m. l., ligamentum tibiale menisci lateralis, l. c. a., ligamentum cruciatum anterior, l. c. p., ligamentum cruciatum posterior, l. f. m. l., ligamentum femorale menisci lateralis, s, m. extensor digitalis longus.

extensor digitalis longus [9], is in the latter animal very shallow and its width reaches approximately twenty odd millimeters (Text-fig. 13*B*, *g*).

The tibialis anterior was attached in the proximal part of the anterolateral surface of the tibia. The laterodistal surface of the tibial tuberosity and a triangular, rough area in the posteroproximal, angle of the shaft, adhering anteriorly to the fibula, were probably its attachment area. This rough area extends onto the anterior surface of the proximal extremity of the fibula and, therefore, it is not unlikely that the attachment of the muscle passed onto this bone. The lateral attachment areas of the tibialis anterior are connected with each other by a rough area occupying the proximal part of the lateral surface of the bone (sometimes the proximal one-third of this surface). Sometimes, however, they are separated from this area by distally running crests. On the basis of a bifid structure of this muscle, found by BEDDARD & TREVES (1889) in *D. sumatrensis*, we suppose that it was also bifid in *C. antiquitatis*, but there is no possibility to trace a boundary between its heads.

In its ventral two-thirds, the lateral surface of the tibia is smooth and without any traces of muscle scars. In the life-time, this surface was covered with the heads of the tibialis anterior and the extensor digitalis longus.

A smooth, shifted posteriorly and sometimes depressed attachment area of the medial femoro-tibial ligament occurs on the medial surface of the tibia just below the medial condyle

[9] The peroneus tertius has not been identified in *D. sumatrensis* (BEDDARD & TREVES, 1889). In the tapir, it tightly grows together with the tibialis anterior (BRESSOU, 1961) and is not attached in the extensor fossa, while this animal's extensor digitalis longus *(l. c.)* is attached to the condyle of the femur.

(Text-fig. 13*C*). An extensive, irregular roughness, an attachment area of the gracilis is situated ventrally of it, but in the upper one-third of the bone. In its medial one-third a rough area, shaped like an elongate rectangle (about 75 mm and high 15 mm wide), to which the semitendinosus and the semimembranaceus (Text-fig. 13C_c) are attached, occurs close behind the tibial crest.

In *D. sumatrensis* (according to BEDDARD & TREVES, 1889), the two muscles are fused with each other and form a single muscle unit, attached with a flat tendon parallel to the tibial crest and posteriorly of it.

A groove, occurring posteriorly of the medial maleolus, probably served as a passage for the tendon of the flexor digitalis longus running (Text-fig. 13C_h) from the posterior surface of the tibia onto the medial side and distally towards the last digital phalanxes. A posterodistally oblique trace of this groove is not always quite distinct. Its direction is emphasized by a deflection of the medial surface in this region. Proximally this deflection the medial surface turns anteromedially (see above).

A smooth area, to which the short medial ligament is attached, stretches over the distal and posteromedial surface of the medial maleolus. The long medial ligament was attached posteriorly of the short one along the border of the distal articular surface.

The popliteus, running obliquely from the medial border of the tibia, through the posterior surface of its lateral condyle, to the lateral epicondyle of the femur, was attached to the muscular lines which are situated in the dorsal part of the posterior surface of the tibia distally of the popliteal line. In addition, particular parts of the flexor digitalis profundus (= the flexor communis digitorum in BEDDARD & TREVES, 1889) are attached to the posterior surface of the shank. In *D. sumatrensis (l. c.)*, the flexor digitalis profundus is attached to the tibia only in its distal and external part and, besides,to the fibula up to the proximal border of its head and on the fascia of the popliteus. The depression of the external surface of the tibia below the level of the popliteal line and the surface of fibula, which adheres to it and forms together with it a deep fossa, would make up an attachment area of a part of the flexor digitalis profundus, most likely the flexor hallucis longus. Two vertical crests (one of them running along the posteromedial border of the bone) situated in the proximal half of the fibula on its posteromedial surface, as well as a longitudinal tuberosity near the lateral border make up traces of attachments of the tibialis posterior and part of the flexor hallucis longus. The flexor digitalis longus was probably attached mostly or completely to the fascia of the popliteus.

The distribution of the attachments of particular parts of the flexor digitalis profundus is, however, hypothetical to a considerable extent and, therefore, it seems advisable to consider this muscle as a whole (cf. Text-fig. 13).

The fibula provided attachments for the peronei over its entire anterolateral surface. The number and trace of these muscles cannot be, however, determined. They were probably developed similarly as those in *D. sumatrensis* in which, according to BEDDARD & TREVES (1889), four peronei muscles occur. Two of them are attached in the distal part of the fibula, the third (non-homologous to the peroneus tertius of the horse) somewhat below and the fourth branches off from the first.

In *C. antiquitatis*, the muscle scars, which occur on the lateral surface of the fibula, are grouped in its proximal and posterior part, the remaining part of the lateral surface of the shaft being smooth. A groove running vertically over the lateral side of the distal extremity of fibula was probably assigned for the tendon of the first fibular muscle. The long lateral ligament was attached to the tuberosities which surround the groove and the short lateral ligament — to the anterior and proximal parts of the fibula. In addition, the ligamentum annulare, keeping the tendon of peroneus I inside the groove, was probably attached to these tuberosities.

Calcaneum. — The length of the shaft of calcaneum amounts, on the external side, to about 110 mm, the width below the tuber calcis to about 40 mm and the anteroposterior dimension in this same place to about 55 mm. Surfaces for the articulation with the astragalus are situated on the anteromedial side of the calcaneum. The highest of these surfaces, situated medially, is concave in the distal and convex in the proximal part which is caused by its passing onto the upper surface of the processus cochlearis. The distal and medial surfaces are connected with each other. The distal one is shaped like a narrow strip running anteriorly and outwards, the medial one is subround.

A longitudinal, distinctly bifid surface for the lateral part of the cuboid, whose both parts are arranged at an obtuse angle to each other, occurs on the distal side of the shaft. Its anterior, shorter and narrower part is flat, the posterior concave.

Table 49

Dimensions (in mm) and indexes (in %) of the calcaneum and os tarsale I and IV in *Coelodonta antiquitatis* (BLUM.) Cat. ZAPUJ No. 683

Dimensions	
Total length	120
Length of shaft up to the apex of processus coracoideus	48
Maximum width (in projection)	87
Maximum width to total length	72
Anteroposterior dimension of the tuber calcis	71
Anteroposterior dimension of the tuber calcis to total length	59
Width of the tuber calcis	53
Width of the tuber calcis to total length	44
Anteroposterior dimension at the level of processus coracoideus	66
Width to length of the fossette for the cuboid	25/45
Total height of os tarsale I	59
Width of os tarsale I	20
Length of os tarsale I	30
Height of os tarsale IV	37
Width of os tarsale IV	42
Length of os tarsale IV (together with the posterior process)	67

The sustentaculum tali angularly converges medially. Its dorsal surface slopes towards the astragalus, so that the fossa for the tendon of the hallucis longus is open externally. The tubercles for part of the short medial ligament, which should be situated on the dorsal surface of the sustentaculum tali, are invisible in the specimen from Podbaba (ZAPUJ No. 683). On the other hand, a tubercle for part of the short lateral ligament occurs on the external surface of the shaft of calcaneum in the place where it turns into the processus cochlearis.

The tuber calcis strongly project posteriorly, forming a posteriorly facing wall, while the posterior border of the shaft is directed posteriorly and downwards. A strong trace of Achilles' tendon in the form of a distinctly separated, oval protuberance and with its longitudinal, 50 mm long axis arranged transversally, occurs in the posterior part of the tuber calcis. A projection for the flexor digitalis superficialis, adhering to it anteriorly, turns ventrally into swollen borders of the lateral surfaces of the tuber calcis. These surfaces are strongly swollen.

A tuberosity, occuring in the posterior and lower corner of the lateral wall of the calcaneum, continues along the posterior border of the shaft. This tuberosity was related to the plantar ligament running towards the posterior surface of the cuboid and metatarsale IV or maybe to the long lateral ligament.

Astragalus (Pl. XIX, Figs. 3*a-b*). — The trochlea consists of a narrower, more strongly domed medial and a wider, less curved lateral crest. Both crests are separated from each other by a not very deep groove, slightly deflecting anterolaterally (which is not equally distinct on the distal articular surface of the tibia). The articular surface of the trochlea overlaps the lateral and medial sides forming on them a surface for the articulation with the lateral and tibial meleolus respectively.

Two articular surfaces occur on the distal extremity. The medial one, assigned for the navicular is large (about 43 × 39 mm), quadrangular, slightly convex sagittally and very slightly convex, nearly flat, transversally. The lateral one is oval (about 60 × 20 mm) and arranged with its longer diameter obliquely anteriorly and outwards.

Three articular surfaces for the calcaneum occur on the posterior side of the astragalus. The proximal and dorsolateral surface is undulate, concave in its upper, wider part and convex in its lower part. It is shaped like a triangle with its apex directed laterally and downwards and

Table 50

Dimensions and indexes (in %) of the astragalus of *Coelodonta antiquitatis* (Blum.) (linear dimensions in mm)

Dimensions / Cat. No.	ZAPUJ No. 683	IG Z No. 373
Lateral height (perpendicular to the distal articular surface)	73	80
Medial height (as above)	77	80
Maximum width (in projection)	91	105
Maximum width to length on the medial side	118	131
Maximum anteroposterior dimension on the medial side	56	65
Anteroposterior dimension to length on the medial side	73	84
Maximum width of the distal articular surface in projection	71	80
Anteroposterior dimension of the distal articular surface	44	52
Inclination angle of the crests of trochlea to the distal articular surface	—	36

its purpose is to articulate with the shaft of the calcaneum, similarly as the underlaying oval surface running over the surface for the cuboid and proximally limited by a wide fossa of the astragalus. The surface for the sustentaculum tali, a rounded square in outline, is slightly convex and connected with the distal surface for the shaft of the calcaneum.

A ligamental fovea for the short medial ligament is situated on the lateral side of the bone posteriorly of the articular surface for the lateral moleolus. A tubercle, strongly projecting in its posterior part outside the medial surface of the bone and distally, occurs in a similar position but slightly more posteriorly on the medial side. A trace of the short lateral ligament in the form of a round surface about 20 mm in diameter is visible on its surface. Anteriorly, this trace turns, without any distinct boundary, into the medial surface of the bone. A projecting tuber (processus medialis tali, POPLEWSKI, 1948), to which are attached a part of the long lateral ligament and the dorsal tarsal ligament, running towards os tarsi centrale, os tarsale III, metatarsale II and III, occurs above the surface for the navicular (also on the medial surface). A destroyed, semilunar surface, which makes up an extension of the surface for the navicular, is situated on the posteromedial side of the bone over the surface for the navicular.

Os tarsale IV and V. — The anterior, approximately square surface turns into the lateral surface of the bone. The boundary between these surfaces is emphasized by the presence of a tuberosity, occurring at a bend between them.

The medial surface is composed of two walls arranged at an angle to each other (the proximal one is almost horizontal) and forming a projecting part of the cuboid which wedges in between the navicular and os tarsale III. Articular surfaces for corresponding bones are visible on these walls.

The purpose of the proximal surface is to articulate the cuboid externally with the calcaneum and medially with the astragalus. The distal surface articulates with os metatarsale IV and maybe also with the lateral process of os metatarsale III.

The cuboideum extends posteriorly in the form of a robust, posteriorly directed process for the plantar ligament.

The surface for the articulation with os metatarsale IV is concave sagittally but convex transversally and overlaps the lateral wall of the bone.

Os tarsale I. — A flat bone turning posteriorly into a tapering process provided with a tuberosity and probably related to the attachment of the tibialis anterior. In a physiological position of the bone, this process is directed laterally (that is, towards the axis of the limb) and somewhat distally so that its tuberosity is situated at the level of os metatarsale III and its flat part on the posterior surface of os tarsale II.

The anterior part of os tarsale I is provided with three surfaces: the upper one, for the navicular, subround and facing proximally, the middle one, for os tarsale II and the lower one, situated on the posterior surface of the bone behind the surface for os tarsale II.

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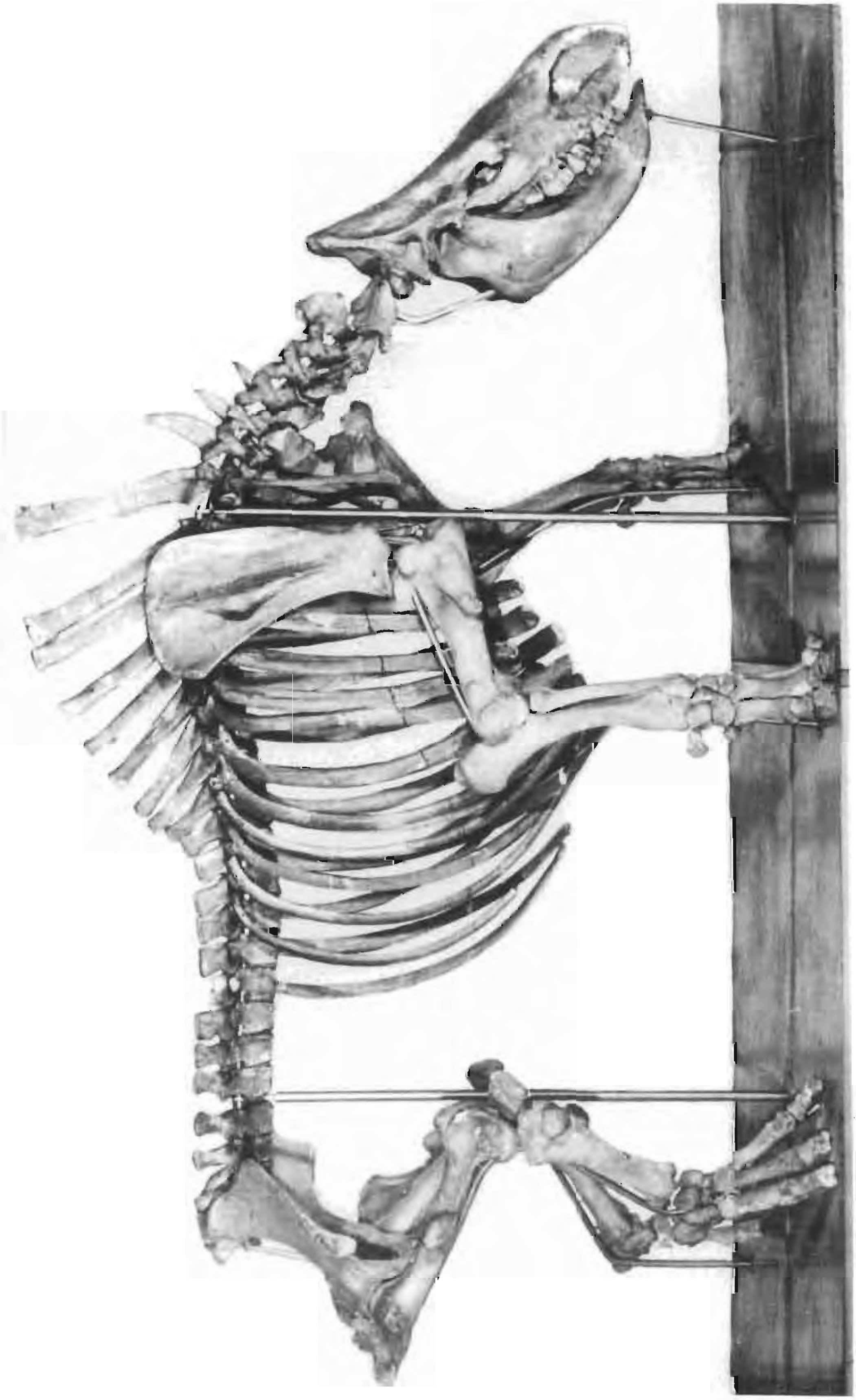
PLATE I

from Podbaba, Czechoslovakia. ZAPUJ No. 683.

× ca 1/12



M. Borsuk-Białynicka: Pleistocene rhinoceros *Coelodonta antiquitatis*

M. BORSUK-BIAŁYNICKA: PLEISTOCENE RHINOCEROS *COELODONTA ANTIQUITATIS*

PLATE II

Fig. 1. UŁ No. IV-3 from Łódź.
Fig. 2. MZ No. VIII/Vm-234 from Góra Puławska (see also Pl. III, Fig. 3; Pl. VI, Fig. 2).
Fig. 3. MZ No. VIII/Mm-452 from Konin (see also Pl. III, Fig. 2; Pl. VI, Fig. 1; Pl. VII, Fig. 3).

All photographs × ca 1/5

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Skull of *Coelodonta antiquitatis* (BLUM.), lateral view. . . 10-13, 15-17

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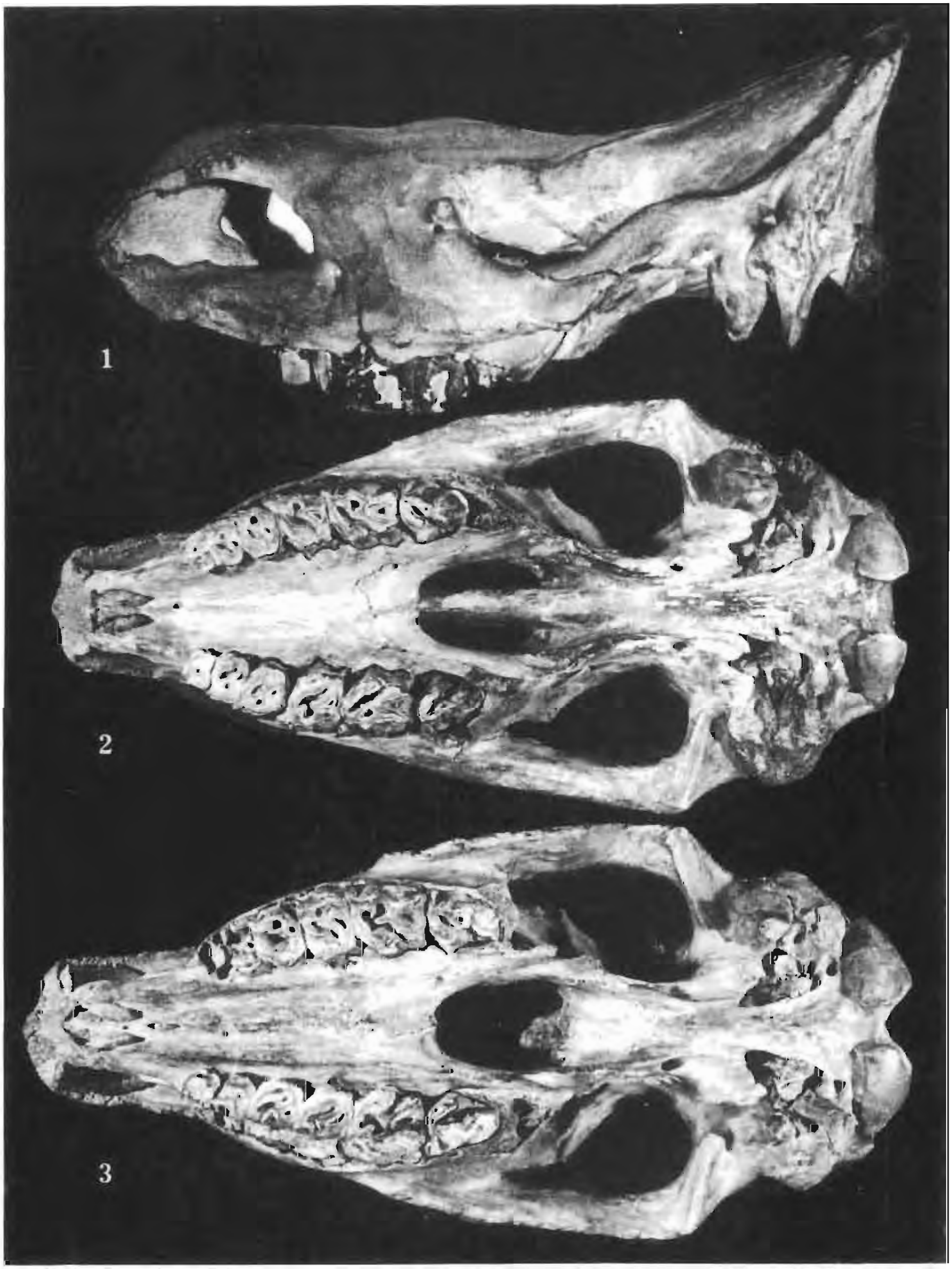
Skulls of *Coelodonta antiquitatis* (BLUM.), ventral view 43-45

Fig. 2. MZ No. VIII/Vm-452 from Konin (see also Pl. II, Fig. 3; Pl. VI, Fig. 2; Pl. VIII, Fig. 3).
Fig. 3. MZ No. VIII/Vm-234 from Góra Puławska (see also Pl. II, Fig. 2; Pl. VI, Fig. 2).

All photographs × ca 1/5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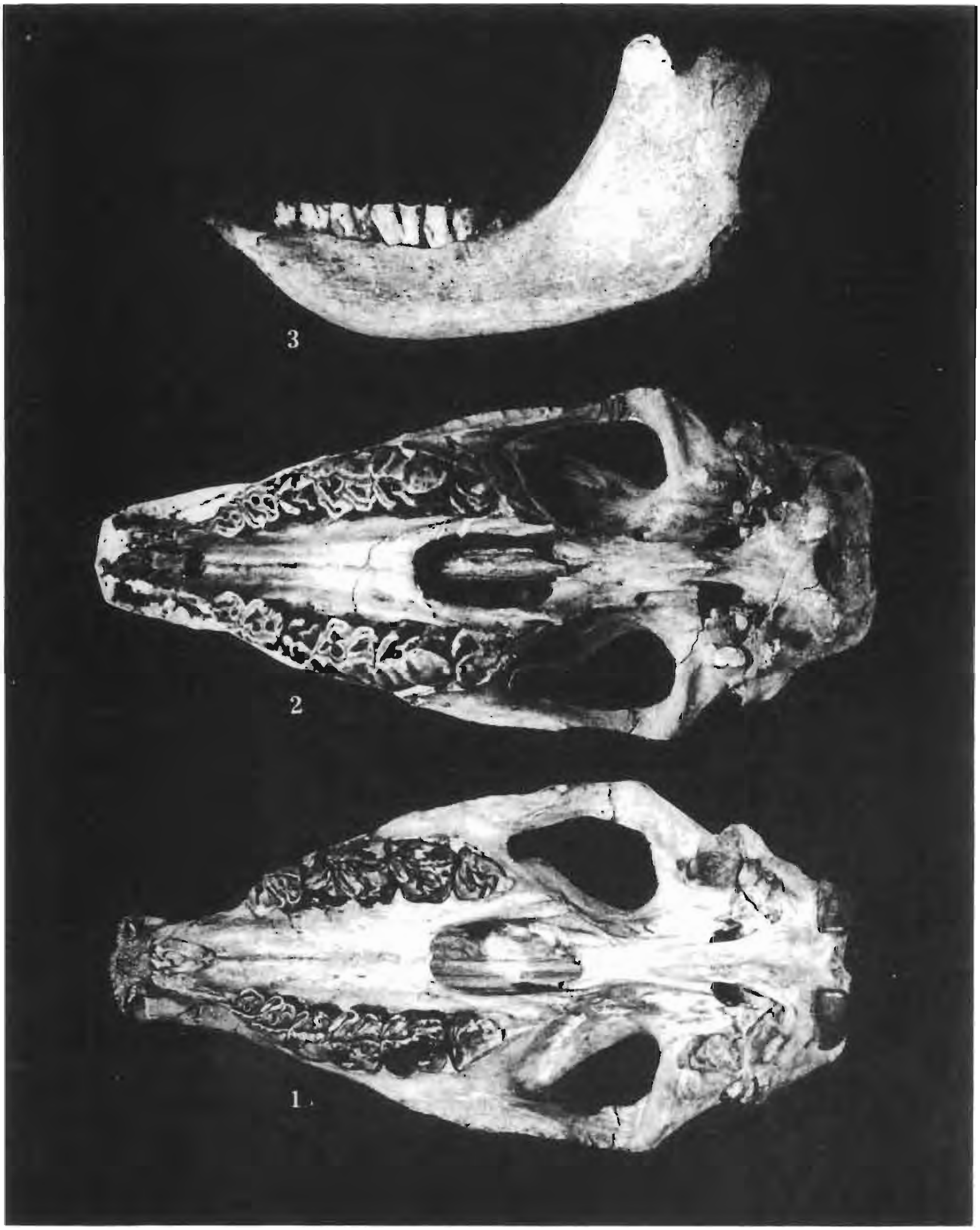
Mandible of *Coelodonta antiquitatis* (BLUM.), lateral view. 49-50

from Podbaba, ZAPUJ No. 683.

All photographs × ca 1/5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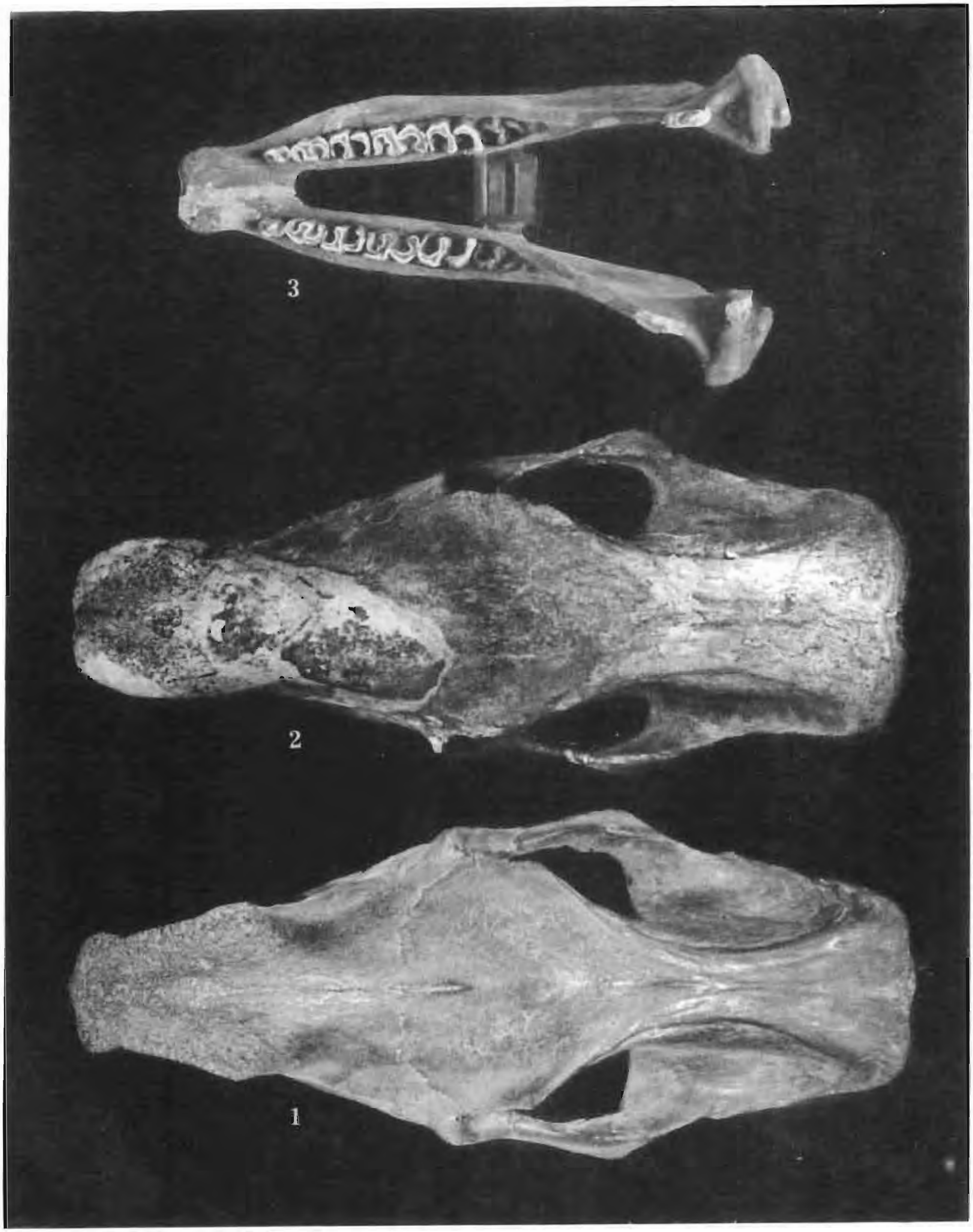
Mandible of *Coelodonta antiquitatis* (BLUM.) 49-50

Fig. 3. ZAPUJ No. 683. from Podbaba viewed from the occlusion surface of teeth, (see also Pl. IV, Fig. 3).

All photographs × ca 1/5



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M. BORSUK-BIAŁYNICKA: PLEISTOCENE RHINOCEROS *COELODONTA ANTIQUITATIS*

PLATE VI

Page

Skulls of *Coelodonta antiquitatis* (BLUM.), occipital view . . 41, 45, 47

Fig. 1. MZ No. VIII/Vm-452 from Konin (see also Pl. II, Fig. 3; Pl. III, Fig. 2; Pl. VII, Fig. 3).
Fig. 2. MZ No. VIII/Vm-234 from Góra Puławska (see also Pl. II, Fig. 2; Pl. III; Fig. 3).
Fig. 3. M. Wiś. No. 10 fiom Czarków on the Nida.
Fig. 4. ZAPUJ No. 683 from Podbaba (see also Pl. IV, Fig. 2; Pl. V, Fig. 2).
Fig. 5. MZ No. VIII/Vm-233 from Góra Puławska.
Fig. 6. MZ No. VIII/Vm-137 from Pyskowice.

All photographs × ca 2/9

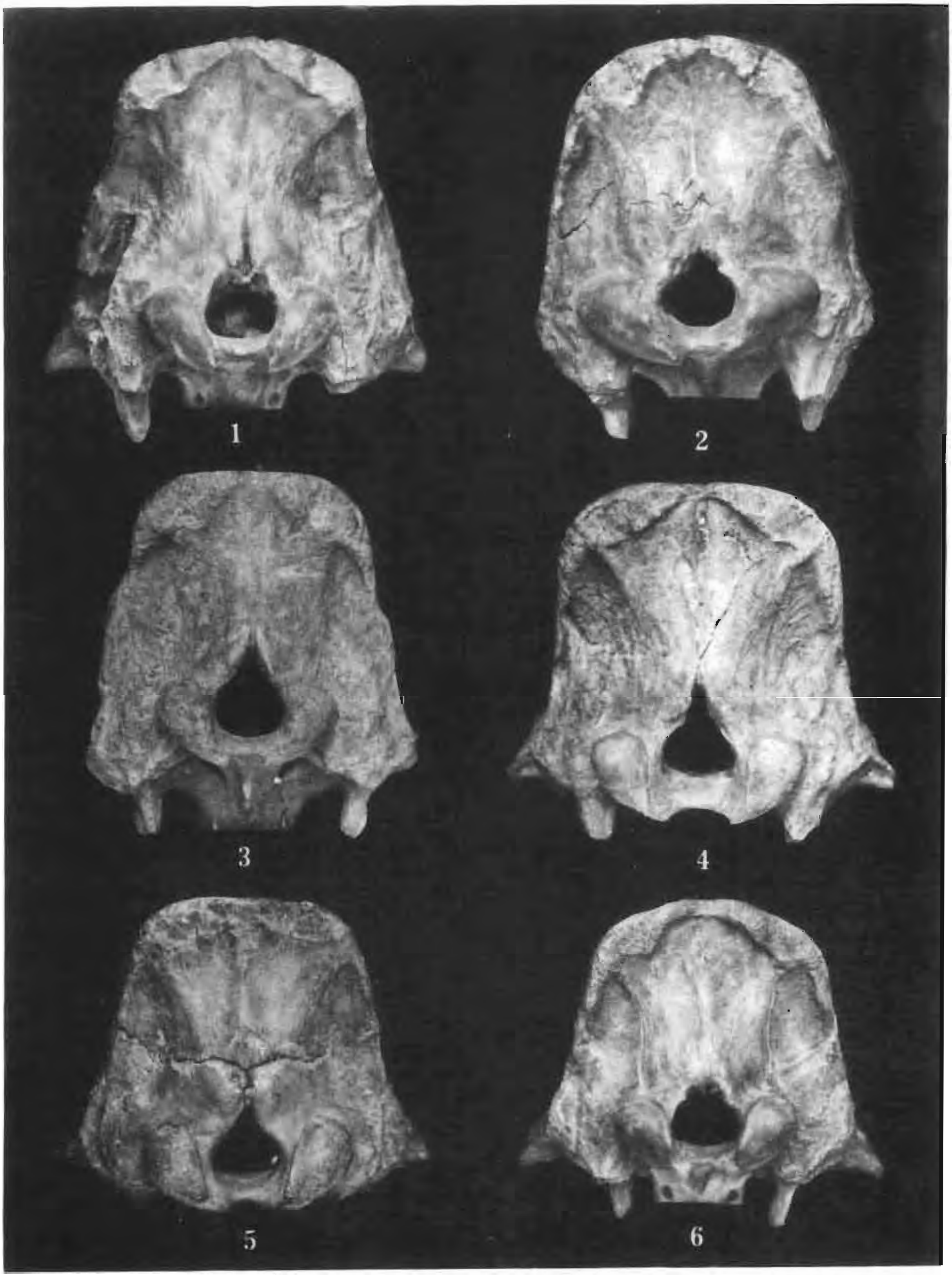
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PLATE VII

Page

Coelodonta antiquitatis (BLUM.) . . . .

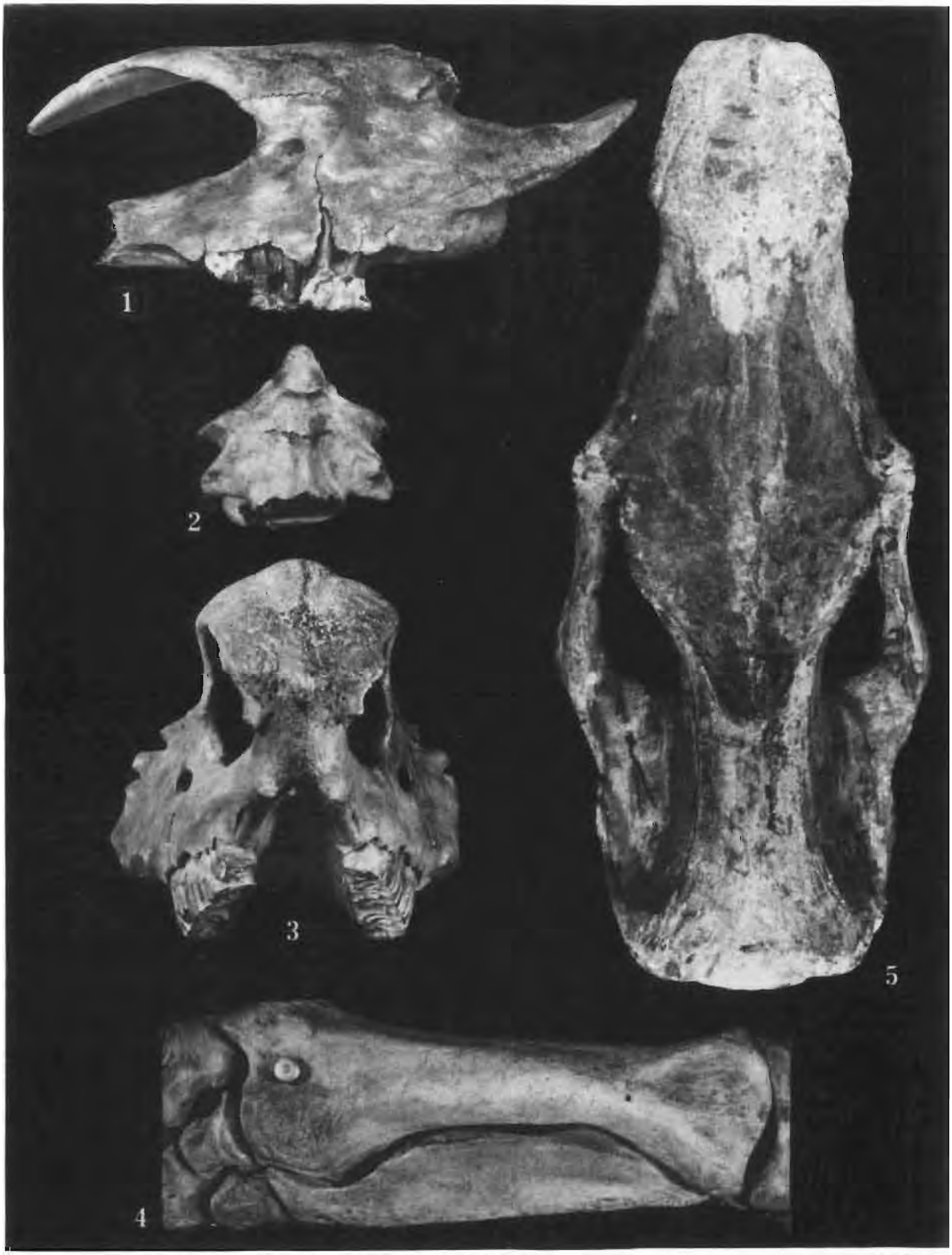
Fig. 1. A fragmentary visceral part of the skull with DP^3, DP^4 and P^2. The last named tooth coming out of the alveolus. Lateral view. MZ No. VIII/Vm-453 . . . . 9, 10, 14-16

Fig. 2. Axis. Ventral view; × ca 1/5. . . . . 52, 53

Fig. 3. Anterior part of skull. Frontal view. MZ No. VIII/Vm-452 from Konin (see also Pl. II, Fig. 3; Pl. III, Fig. 2; Pl. VI, Fig. 2); × ca 1/4. 44

Fig. 4. Right forearm bones. Frontal view. ZAPUJ No. 683 from Podbaba: × ca 1/4. 67-73

Fig. 5. A skull. Dorsal view. UŁ No. IV-3; × ca 1/5. 41-43


1
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M. BORSUK-BIAŁYNICKA: PLEISTOCENE RHINOCEROS *COELODONTA ANTIQUITATIS*

PLATE VIII

All photographs × ca 1/4.

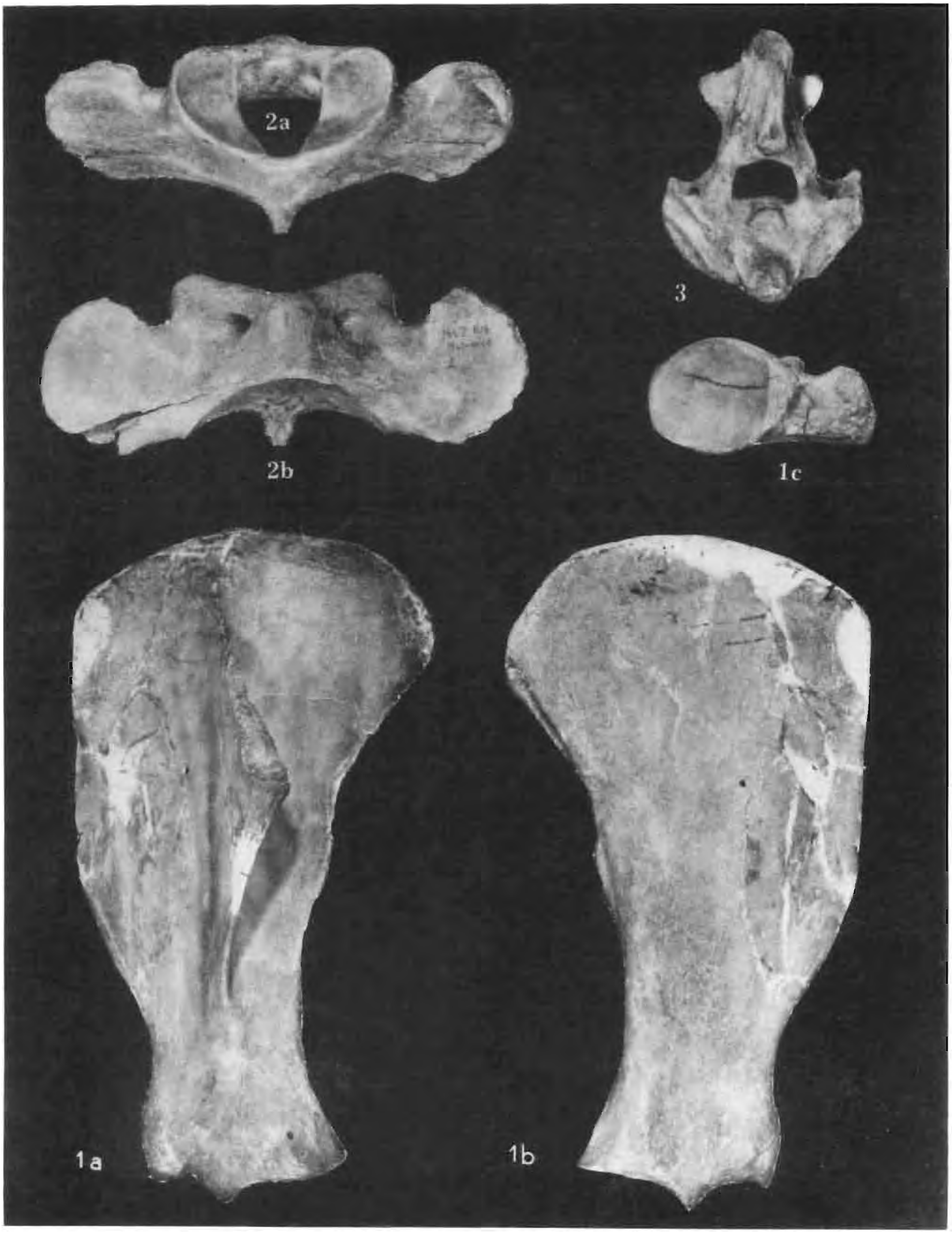

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PLATE IX

Page

Rhinoceros sondaicus DESM. 33

MJZ

Fig. 1. Scapula: *a* medial view, *b* lateral view; × ca 1/4.

Diceros bicornis L. 33

MJZ

Fig. 2. Scapula: *a* lateral view, *b* medial view; × ca 1/4.

Coelodonta antiquitatis (BLUM.) 63, 73-76

ZAPUJ No. 683 from Podbaba

Fig. 3. Os carpi accessorium: *a* lateral view, *b* medial view (see also Pl. XVII, Figs. 1*a-d*); × ca 3/5.
Fig. 4. Cuneiforme, volar view (see also Pl. XV, Fig. 1; Pl. XVI, Fig. 2).
Fig. 5. Distal extremity of the right humerus, PS No. 374 MZB from Silesia, volar view; × ca 1/4.


3a
3b
1a
2a
2b
1b
4
5

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PLATE X

Fig. 1. A fragment of skeleton ZAPUJ No. 683 from Podbaba, including the cranial part of the axial skeleton and anterior limbs. Dorsal view.

Fig. 2. Left humerus ZAPUJ No. 683 from Podbaba. Frontal view.

All photographs × ca 1/4

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PLATE XI

Pag

Rhinoceros sondaicus DESM. 33, 34

MIZ

Fig. 1. Left humerus, lateral view.

Diceros bicornis L.. . . . . 33, 34,

MIZ

Fig. 2. Left humerus, lateral view.

Coelodonta antiquitatis (BLUM) 33, 34, 63-67

Fig. 3. Left humerus, lateral view. ZAPUJ No. 683 from Podbaba (cf. also Pl. X, Fig. 2).
Fig. 4. Damaged, right humerus: *a* frontal view, *b* posterior view. PS No. 374 M. Z. B. from Silesia.

All photographs × ca 1/4


4a
4b
3
2
1

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PLATE XII

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Coelodonta antiquitatis (BLUM.) 33, 34, 63-70

Fig. 1. Right radius, MG. No. 4 from Silesia, lateral view.
Fig. 2. Left radius, PS No. 1 from Silesia: *a* medial view, *b* posterior view.
Fig. 3. Left humerus, ZAPUJ No. 683 from Podbaba, medial view.

Diceros bicornis L. 33, 34

MIZ

Fig. 4. Left humerus, medial view.

Rhinoceros sondaicus DESM. 33, 34

MIZ

Fig. 5. Left humerus, medial view.

All photographs × ca 1/4

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PLATE XIII

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Coelodonta antiquitatis (BLUM.) 34, 67-73

Fig. 1. Left forearm, ZAPUJ No. 683 from Podbaba: *a* medial view, *b* lateral view.
Fig. 2. Right ulna, MG No. 1 from Silesia: *a* posterior view, *b* frontal view.

All photographs × ca 1/4

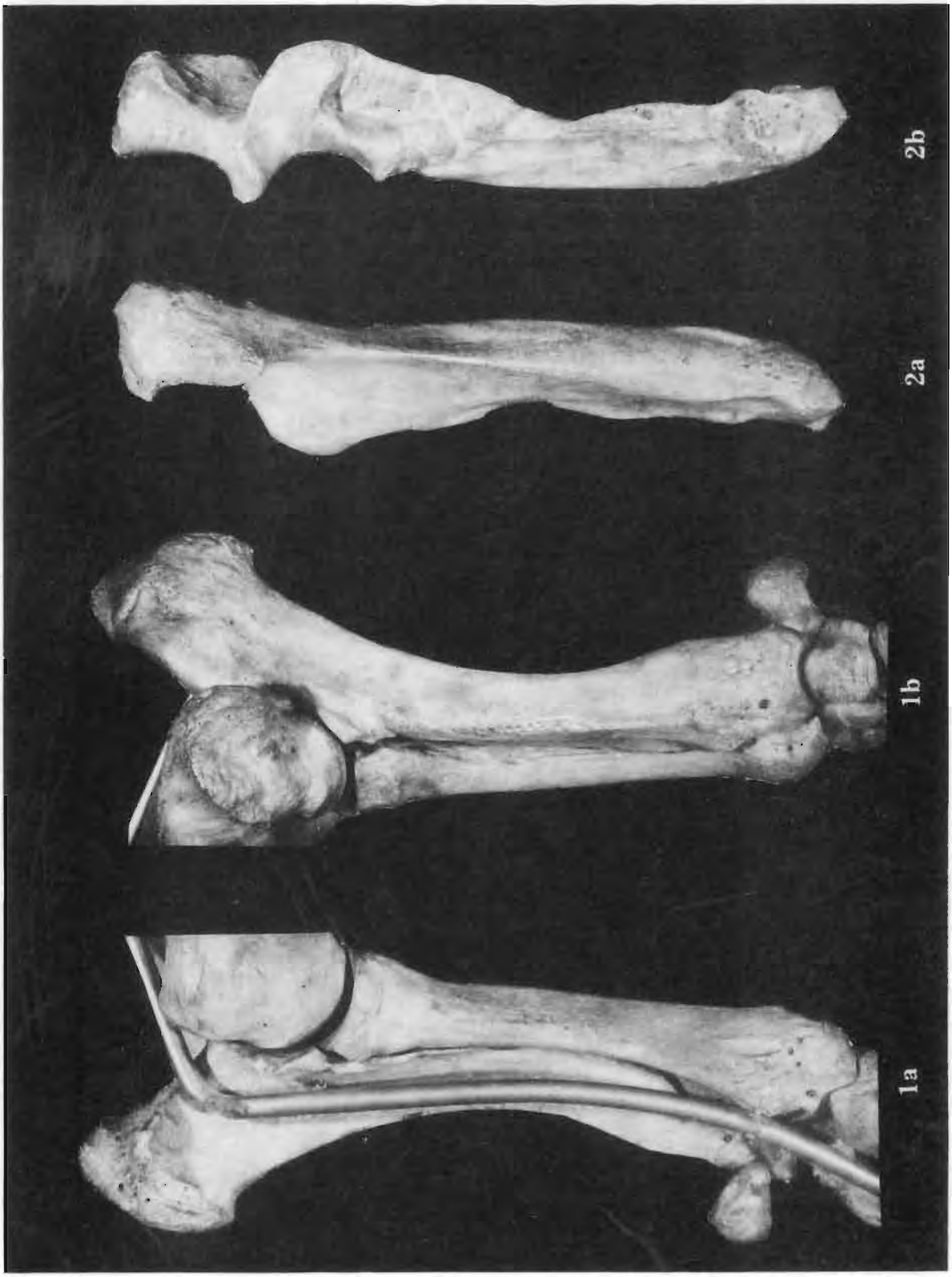
2b
2a
1b
1a

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PLATE XIV

Page

Coelodonta antiquitatis (BLUM.) 34, 35, 73-76

Fig. 1. Distal region of the anterior limb; ZAPUJ No. 683 from Podbaba: *a* frontal view, *b* lateral view, *c* posterior view, *d* medial view.

Rhinoceros sondaicus DESM. 34, 35

MIZ

Fig. 2. Distal region of the anterior limb; frontal view.

Diceros bicornis L. 34, 35

MIZ

Fig. 3. Distal region of the anterior limb; frontal view.

All photographs × ca 2 9

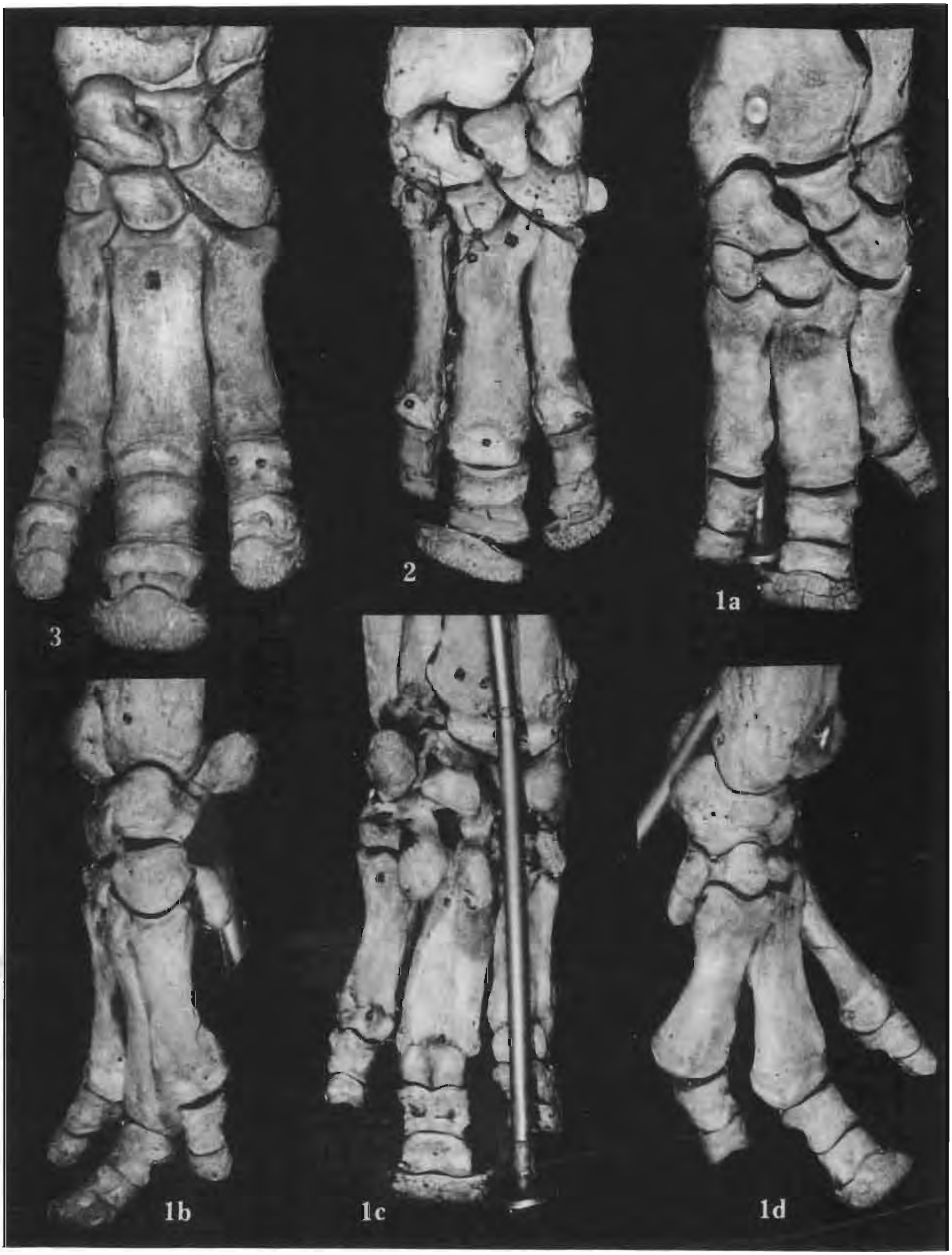

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PLATE XV

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Coelodonta antiquitatis (BLUM.) 34, 35, 73-76

Right side carpal bones, ZAPUJ No. 683 from Podbaba (see also Pl. IX, Figs. 3*a*,3*b*, 4; Pl. XVI, Figs 1-4; Pl. XVII Fig. 1*a-d*).

Fig. 1. Cuneiforme, dorsal view.

Fig. 2. Unciforme: *a* dorsal view, *b* medial view, *c* volar view, *d* lateral view.

Fig. 3. Magnum: *a* dorsal view, *b* medial view, *c* volar view, *d* lateral view.

Fig. 4. Unciforme, magnum, trapezoideum in life-time position: *a* proximal view, *b* distal view.

All photographs × ca 3/5

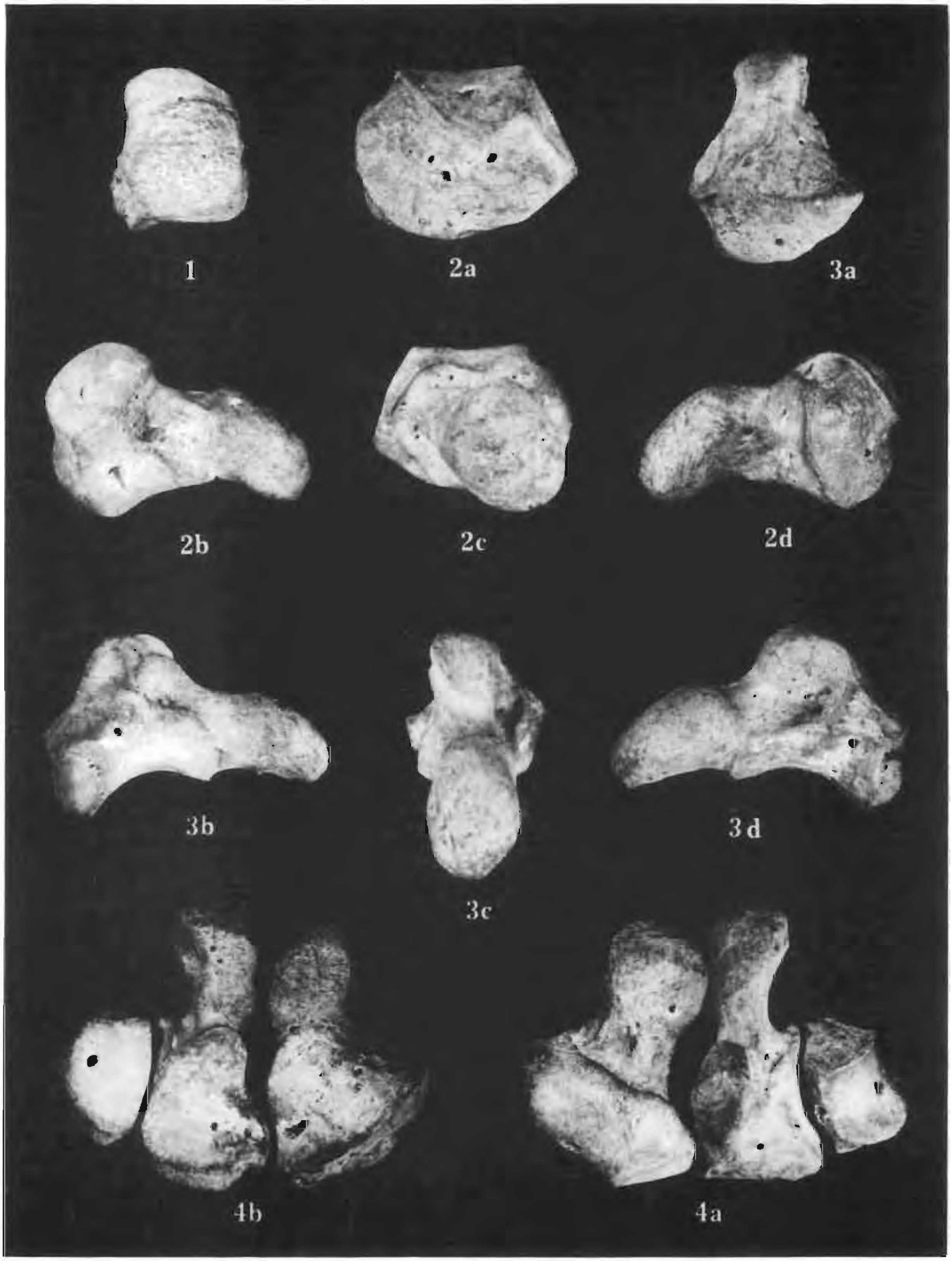

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PLATE XVI

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Coelodonta antiquitatis (BLUM.) 34, 35, 73-76

Right side carpal bones ZAPUJ No. 683 from Podbaba (see also Pl. IX, Figs. 3*a*, 3*b*, 4; Pl. XV, Figs. 1-4; Pl. XVII, Fig. 1*a-d*).

Fig. 1. Lunare: *a* lateral view, *b* dorsal view, *c* medial view, *d* volar view.

Fig. 2. Cuneiforme: *a* medial view, *b* lateral view (see also Pl. IX, Fig. 4 and Pl. XV, Fig. 1).

Fig. 3. Scaphoideum: *a* medial view, *b* lateral view, *c* dorsal view.

Fig. 4. Scaphoideum, lunare and cuneiforme: *a* distal view, *b* proximal view.

All photographs × ca 3/5

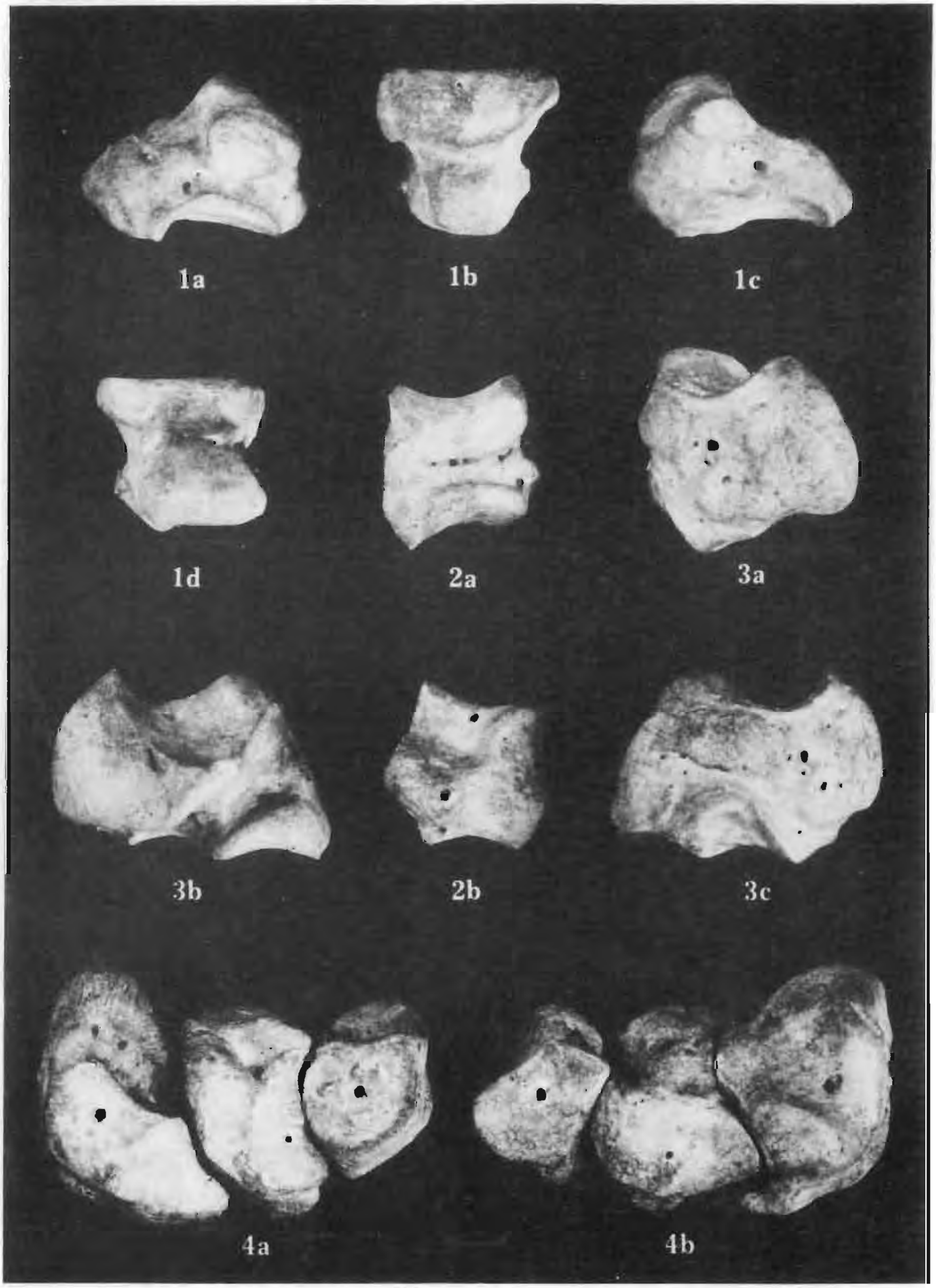
1a
1b
1c
1d
2a
3a
3b
2b
3c
4a
4b

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PLATE XVII

ZAPUJ No. 683 from Podbaba. The bones of the right thoracic limb.

Fig. 1. Os carpi accessorium: *a* proximal view, *b* anterior view, *c* posterior view, *d* distal view (see also Pl. IX, Figs. 3*a*, 3*b*).

Fig. 2. The third metacarpal bone together with phalanxes of the digit: *a* medial view, *b* dorsal view, *c* volar view, *d* lateral view.

All photographs × ca 3/5


1a
1b
1c
1d
2a
2b
2c
2d

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PLATE XVIII

Page

Coelodonta antiquitatis (BLUM.) 36-38, 73, 76

ZAPUJ No. 683 from Podbaba. The bones of the right thoracic limb.

Fig. 1. The fourth metacarpal bone together with the phalanxes of the digit: *a* dorsal view, *b* medial view, *c* volar view.

Fig. 2. The second metacarpal bone together with the phalanxes of the digit, phalanx III missing: *a* dorsal view, *b* lateral view, *c* volar view.

All photographs × ca 3/5

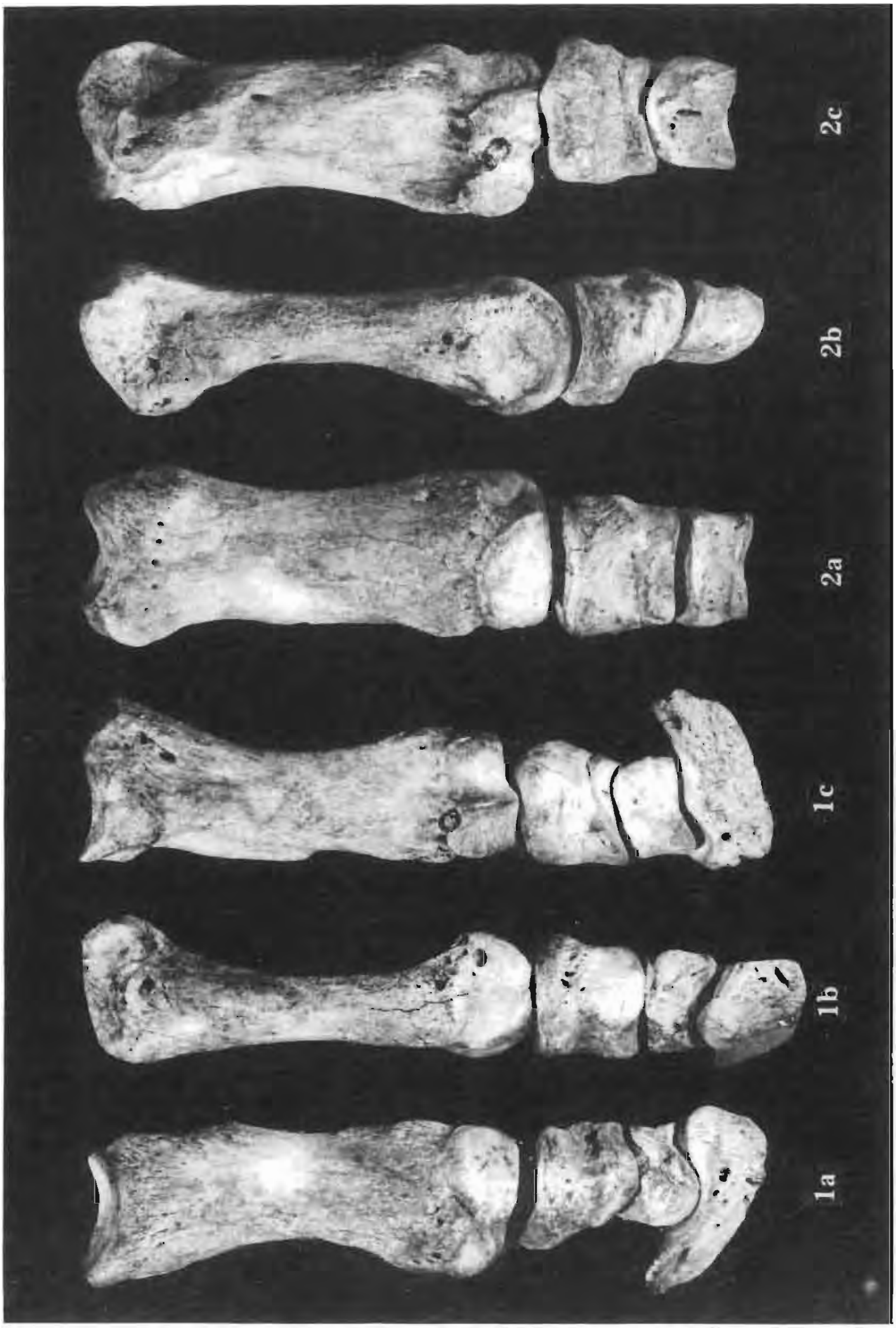
1a
1b
1c
2a
2b
2c

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PLATE XIX

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Coelodonta antiquitatis (BLUM.) . . . .

Fig. 1. Pelvis together with sacral bone; ZAPUJ No. 683 from Podbaba, dorsal view; × ca 1/6. . . . 35, 76-80
Fig. 2. Sacrum, PS No. 906-4: *a* dorsal view, *b* ventral view. 58-60
Fig. 3. Astragalus, IG No. 2.373: *a* dorsal view, *b* plantar view. 91-92
Fig. 4. A fragment of vertebral column (the lumbar region and the posterior part of the thoracic region), ZAPUJ No. 683, lateral view. 32, 55-58

Photographs 2, 3 and 4 × ca 1/4

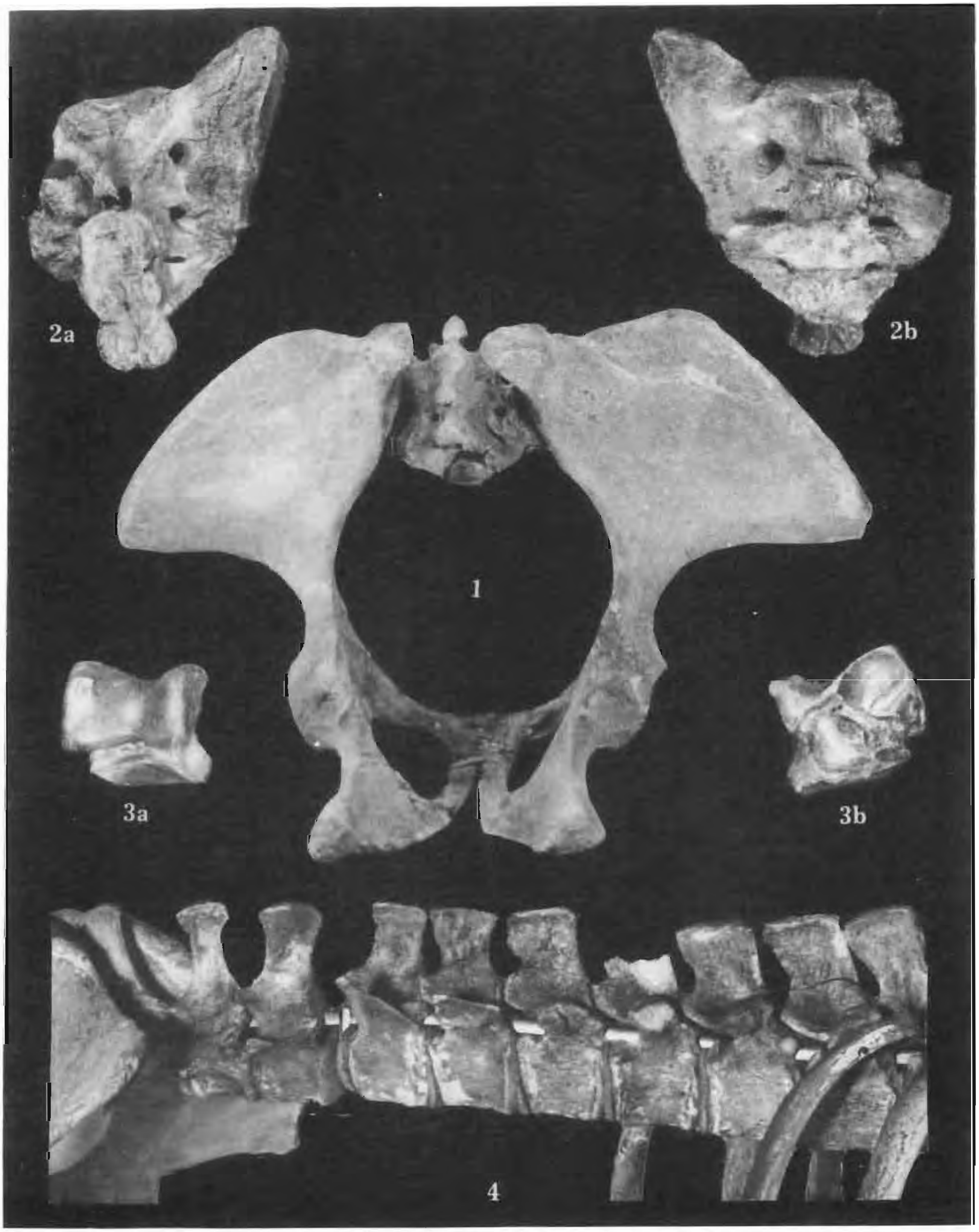
2a
2b
1
3a
3b
4

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PLATE XX

Fig. 1. Right innominate bone, PS No. 898 from Silesia: *a* dorsal view, *b* lateral view, *c* ventral view; × ca 2/7

Fig. 2. Left femur, MPŁ No. 858/1 from Łódź: *a* distal extremity, *b* proximal extremity; × ca 2/3

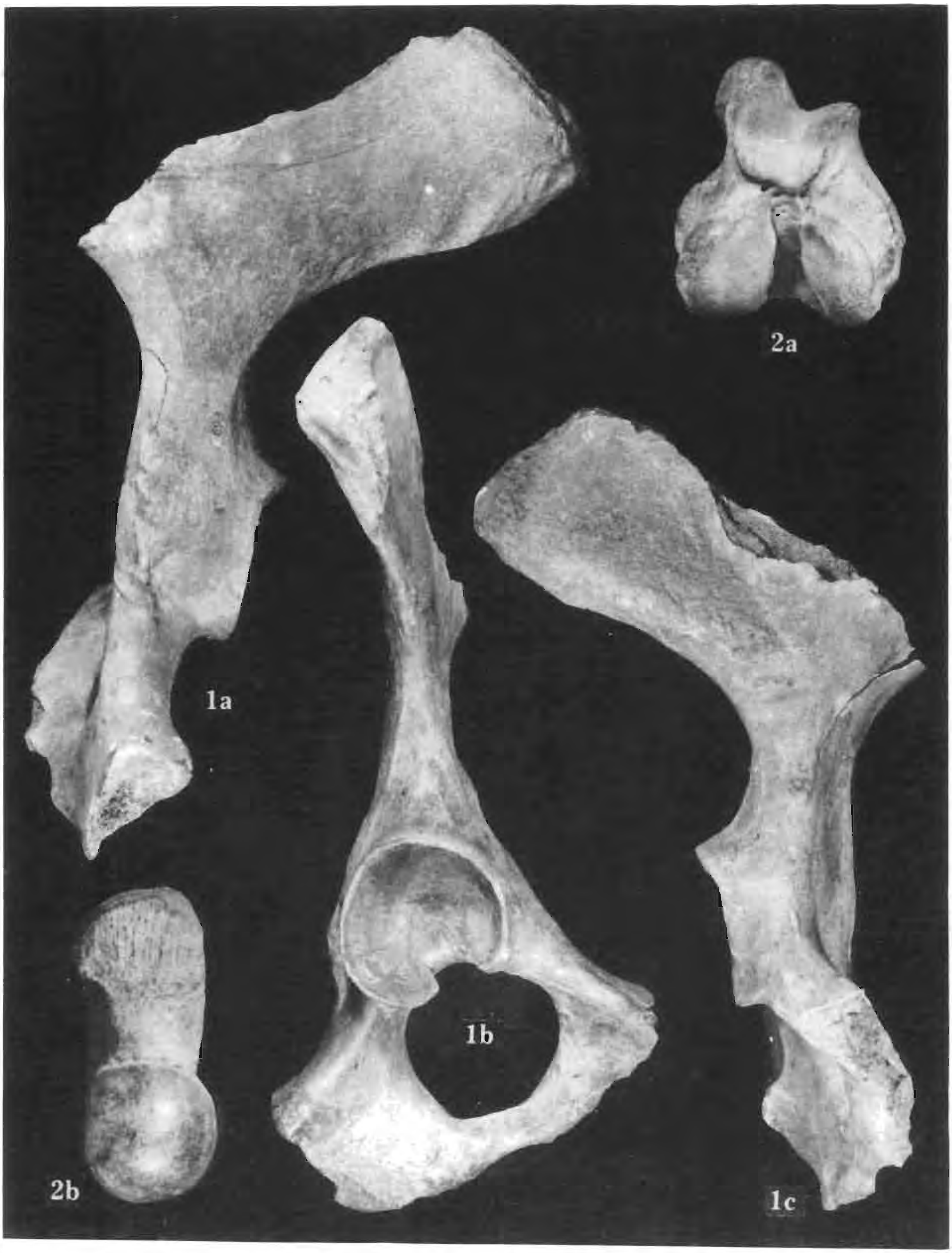
2a
1a
1b
2b
1c

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PLATE XXI

Page

Coelodonta antiquitatis (BLUM.) 35, 80-84

MPŁ No. IV-39 from Łódź

Fig. 1. Left femur: *a* dorsal view, *b* plantar view.

Rhinoceros sondaicus DESM. 35

MIZ

Fig. 2. Left femur, plantar view.

Diceros bicornis L. 35

MIZ

Fig. 3. Left femur, plantar view.

All photographs × ca 1/4

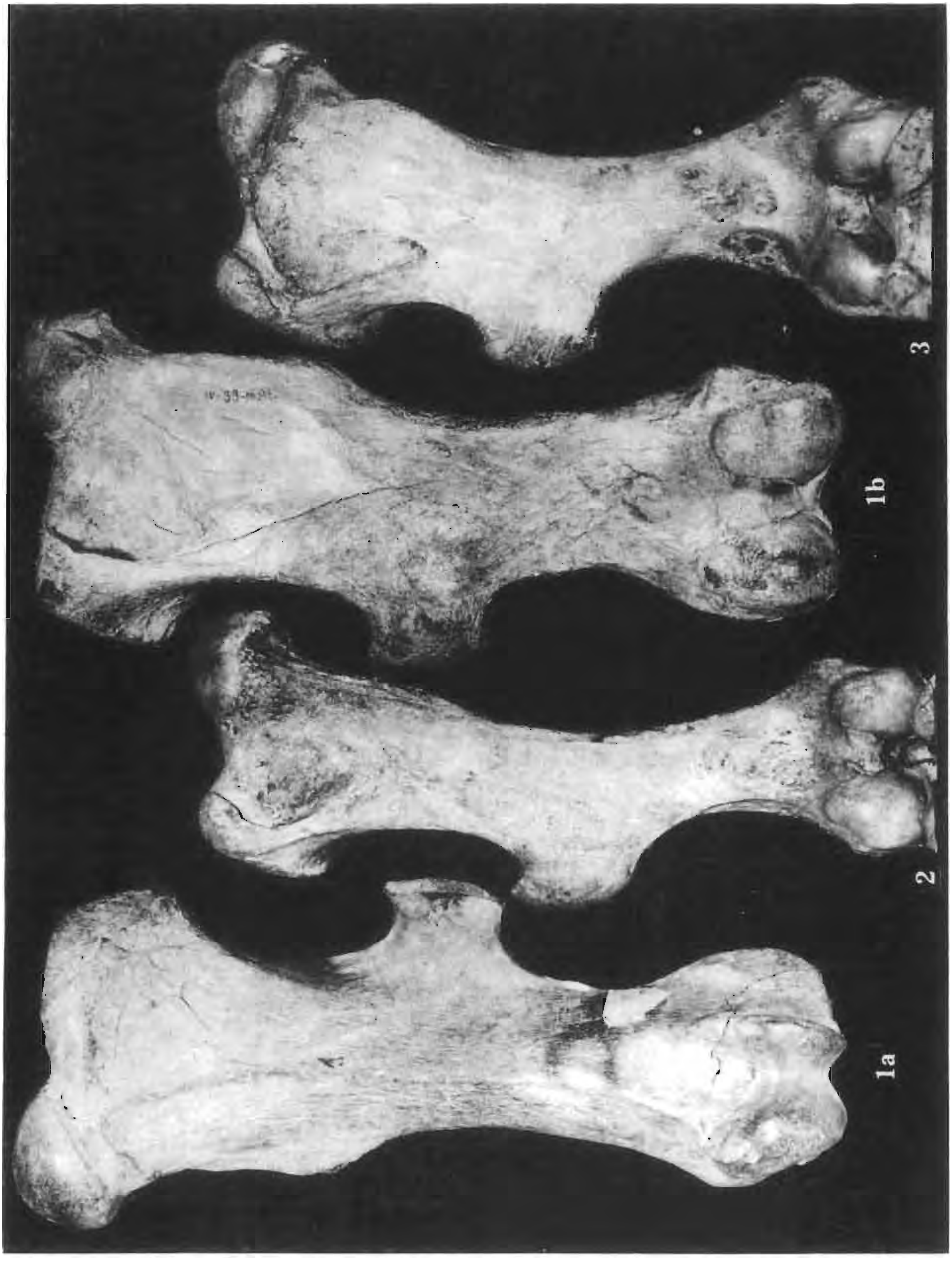

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PLATE XXII

Page

Coelodonta antiquitatis (BLUM.) 35, 80-84

MPŁ No. IV-39 from Łódź

Fig. 1. Left femur: *a* medial view, *b* lateral view.

Diceros bicornis L. 35

MIZ

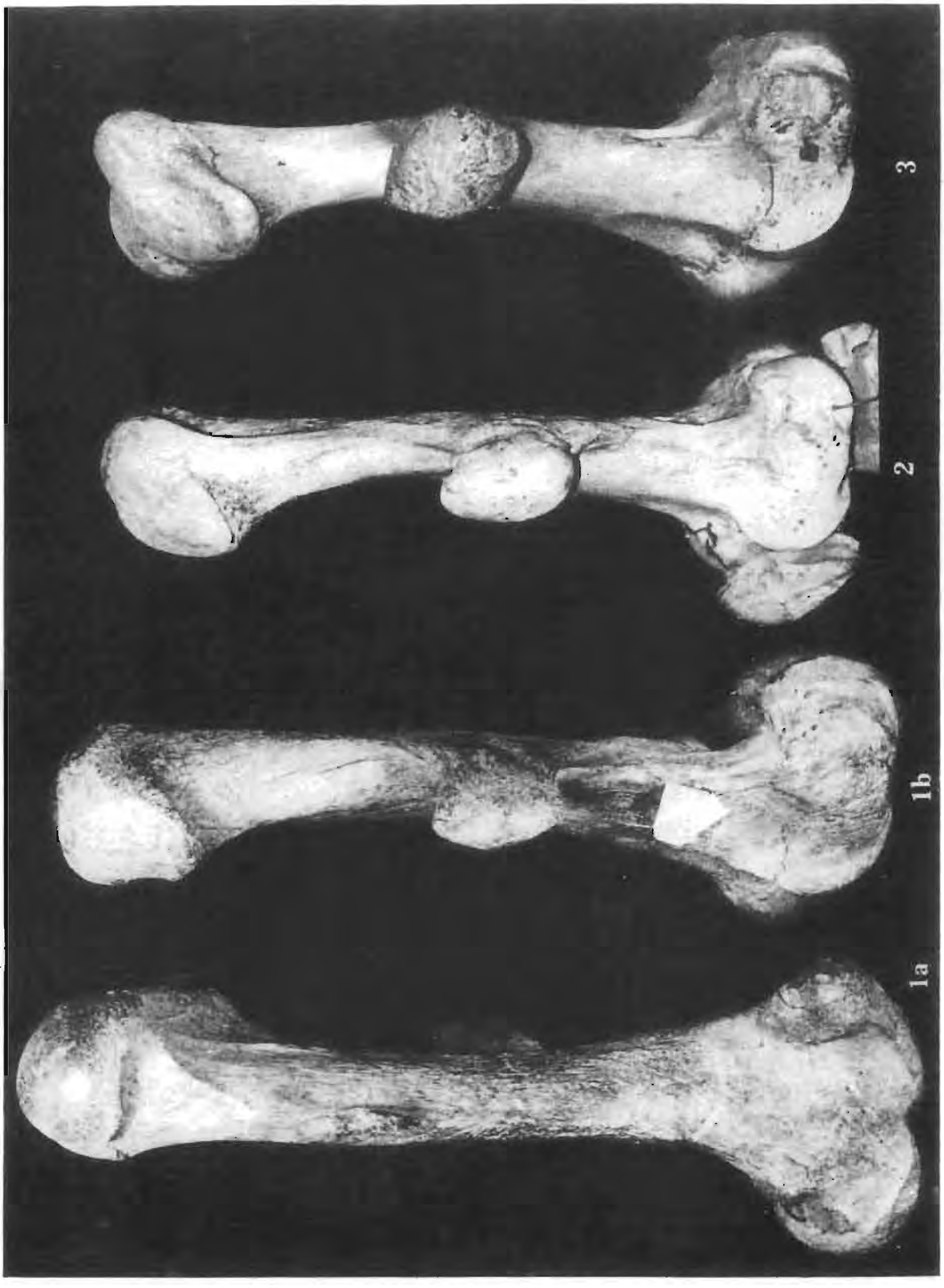
Fig. 2. Left femur, lateral view.

Rhinoceros sondaicus DESM. 35

MIZ

Fig. 3. Left femur, lateral view.

All photographs × ca 2/7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1a

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PLATE XXIII

Fig. 1. Left side shank bones, PS No. 13 from Silesia: *a* plantar view, *b* lateral view, *c* medial view.
Fig. 2. Right tibia with a fragmentary fibula, PS No. 14 from Silesia, dorsal view.
Fig. 3. Left tibia and the calcaneum, ZAPUJ No. 683 from Podbaba, lateral view.

MIZ

Fig. 5. Left side shank bones, lateral view.

All photographs × ca 1/4


1a
1b
2
1c
3
4
5