Pleistocene Vertebrate Fauna from the Kuchinotsu Group of West Kyushu : Part II. Two New Species of Fossil Deer

Otsuka, Hiroyuki
Institute of Earth Sciences, Kagoshima University

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Pleistocene Vertebrate Fauna from the Kuchinotsu Group of West Kyushu

Part II. Two New Species of Fossil Deer

By

Hiroyuki OTSUKA

Abstract

Part II contains the descriptions of two new species of the Cervidae from the Kuchinotsu Group. Their close relationships with the species from the Lower to Middle Pleistocene of Java and China are stressed.

Systematic Descriptions [continued from Part I]

Order Artiodactyla
Family Cervidae GRAY, 1821
Genus *Cervus* LINNAEUS, 1758
Subgenus *Axis* SMITH, 1827
Type-species—*Cervus* (*Axis*) *axis* ERXLEBEN, 1777

Remarks.—One living species of *Axis*, including two subspecies, is distributed mainly in Ceylon Island and the Indian Peninsula northwards to Kumaon, Nepal, Sikkim and Bengal.

Fossil species of *Axis* have been reported from the Plio-Pleistocene formation in eastern Asia, one of which is from northern China, two from Java, two from India, and one (?) from Mongolia: *C.* (*A.*) *shansius* from the Villafranchian of the south-eastern Shansi, China (TEILHARD and TRASSAERT, 1937); *C.* (*A.*) *axis javanicus* and *C.* (*A.*) *lydekkeri* from the middle Pleistocene formation of Pitoe and Trinil, Java (KOENIGSWALD, 1933); *C.* (*A.*) *punjabiensis* from the upper Siwaliks (BROWN, 1926) and *C.* (*A.*) *axis* from late Pleistocene Karnel Cave deposits (LYDEKKER, 1884) of India; *Axis* (?) *speciosus* from Mongolia (SCHLOSSER, 1924).

Cervus (Axis) japouicus sp. nov.

Pl. 3, Figs. 1–5; Pl. 4, Fig. 1–4; Pl. 5, Figs. 1–4; Pl. 6, Figs. 1–7;
Pl. 7, Figs. 1–2; Pl. 8, Figs. 1–2; Pl. 10–14; Text-figs. 1–10.

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Continued from Part I [Mem. Fac. Sci., Kyushu Univ., Ser. D, Vol. XVII, No. 3, pp. 251–269, text-figs. 1–10, pls. 27–29, September 15, 1966].
Hiroyuki OTUKA: Institute of Earth Sciences, Kagoshima University, Kagoshima. (This paper is a result of the study carried out at the Department of Geology, Kyushu University.).

Material.—Holotype: GK. M1000 (Pl. 3, Figs. 1; Text-fig. 1), a left antler collected from a dark blue mudstone bed, the third bed in the upper part of the Kazusa formation, at loc. KS3920, Tsubami, Kazusa-machi, Minamitakaki-gun, Nagasaki Prefecture. The illustrated paratypes from the type locality, are GK. M1001–1005, M1015, M1099, M1101, M1120, M1112, M1114–1117, M1119 (antler); GK. M1054, M1062, M1120, M1126 (lower jaw); GK. M1062, M1090–1094, M1127 (upper tooth); GK. M1176, M1124 (cervical vertebrae); GK. M1123 (thoracic vertebrae); GK. M1051, M1157, M1158 (lumber vertebrae); GK. M1068, M1062–1064 (innominate bone); GK. M1064, M1112, M1148 (scapula); GK. M1058 (humerus); GK. M1059 (radius); GK. M1135, M1136, M1165 (ulna); GK. M1060, M1045 (metacarpus); GK. M1078, M1159 (femur); GK. M1161 (tibia); GK. M1057, M1097 (metatarsus); GK. M1132 (cubo-navicular); GK. M1085–1087, M1167–1170 (carpus); GK. M1085, M1126 (astragalus); GK. M1046, M1066, M1067, M1086, M1094, M1113–1115, M1149–1151 (pharanges).

Specific diagnosis.—Large deer. The antler is very large, stout, strongly constructed, and somewhat curved outwards. The beam below the first bifurcation is stout and subcircular in section, and its axis inclines somewhat outwards. The first tine is usually bifurcated at a very high position above the burr. It is long, stout, subcircular, and projected strongly forwards and somewhat outwards, making a very wide angle (more than 90 degrees) with the beam. The angle and the height of the first bifurcation generally become wider and higher with the growth of the body. The beam above the first bifurcation is long and stout, and is much lyrated backwards in the median part, then upward in the distal part and finally bifurcates into two tines, in lateral view. A characteristic prong exists on the inner surface of the beam diverging from the point of the first bifurcation. Except for this prong, small snags recognized on the surface of the first tine or on the distal part of the beam.

•In the immature stage, however, the first tine is bifurcated at a shorter distance above the burr and makes narrower angles with the beam than in the adult. In general, the beam is not bifurcated at the distal portion. It is more slender, less lyrated backwards and has smoother surface than in the adult.

The lower jaw is large and strongly constructed for cervids; the horizontal ramus is much curved upwards in the anterior part. The teeth are also large, and have a well developed enamel wall and a small accessory column.

Description of type antler specimens.—The holotype (GK. M1000; Pl. 3, Fig 1; Text-fig. 1) is represented by a left antler. It is very large and stout. The pedestal is lost. The burr is rather thick, moderately rugose and subcircular in section. The first tine is long, stout and projected strongly forwards in the basal part, making an angle of about 128 degrees with the beam. The surface of the first tine is very rugose and has numerous tubercles and several longitudinal grooves.

The beam above the first bifurcation is stout, long and irregularly circular. It is projected obliquely upwards in the lower part, then curved upwards in the middle part and finally projected forward. The apical part is missing. The beam is irregularly oval in the lower part but is depressed antero-posteriorly

Table 1. Material of *Cervus* (*Axis*) *japonicus* sp. nov., from the coast of Tsubami, Kazusa-machi, Shimabara Peninsula.

Skeletal position	Number	State of preservation
Skull:		
Premaxilla	1 right	Incomplete, without teeth
Upper tooth	3 left, 2 right	Mostly complete
Lower jaw:		
Complete lower jaw	3 left, 1 right	Mostly well preserved, with complete teeth
Isolated angular of ramus	1 right	Fragmentary
Isolated teeth	3 right, 2 left	Mostly complete, but a few are water-worn
Antler:	10 right, 9 left	Complete
	7 left, 8 right	Fragmentary
Vertebrae:		
Cervical vertebrae	1 fouth, 1 sixth	Incomplete
Lumber vertebrae	1 third	Incomplete
Thoracic vertebrae	3	Incomplete
Sacrum	1	Fragmentary
Anterior limb:		
Scapula	1 right, 2 left	1 complete, 2 incomplete
Humerus	1 right	Complete
Radius	1 left	Mostly incomplete
Ulna	1 left, 2 right	Incomplete (shaft is completely broken up)
Metacarpus	1 left, 1 right	Complete
Corpus	1 paired, right	Complete
	1 paired, left	Complete
Posterior limb:		
Pelvic bone		
Femur	1 right	Mostly incomplete
Tibia	1 left	Complete
Metatarsus	2 right	1 complete, 1 with broken distal part
Astragalus	2 right, 1 left	Complete
Cubo-navicular	1 right, 2 left	1 complete, 1 much worn
Pharanges	7 proximal, 5 middle, 1 distal	Complete
Calcaneum	1 right, 1 left	Complete
Patella	1 right	Complete
Costa	2 right, 5 left	Mostly incomplete

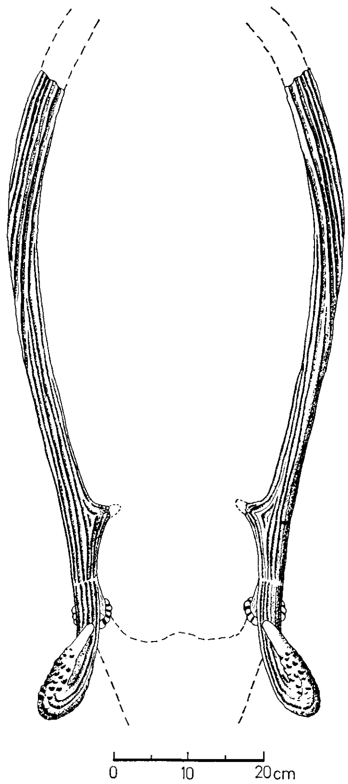


Fig. 1. Restored figure of antlers of *Cervus (Axis) japonicus* sp. nov. [holotype (GK.M 1000)]. Viewed from in front and somewhat from above.

in the distal part; the surface of the basal part is moderately rugose with many longitudinal grooves which are relatively wide and shallow without any peculiar tubercles, but near the distal part, many deep grooves are developed.

On the inner surface of the beam near the first bifurcation, there is a prominent projection (accessory prong) diverging from the point of the first bifurcation.

A pair of antlers stretch outwards making an angle of about 25 degrees with each other, if restored.

A paratype of left antler (GK. M1116, Pl. 6, Fig. 3; Figs. 4 and 6) considerably differs in form from the holotype. It is smaller than any other specimens and measured 400 mm from the burr to the apex in straight line. The burr is moderately thick and rugose. The first tine is bifurcated at rather lower position above the burr (44.8 mm) than in other specimens. The beam below the first bifurcation is subtriangular in section, and its inner and posterior surfaces are somewhat concave. The first tine is relatively short (about 168 mm in straight line), smooth and projected obliquely upwards, making about 93 degrees with the beam. In lateral view, the beam above the first bifurcation is less lyrated backward than other specimens and its distal part is concave irregularly without any peculiar bifurcation. The accessory prong diverging from the point of the first bifurcation is very long (about 85 mm in straight line), rugose and provided with many deep grooves. Judging from the size and the ornamentation of the antler, this deer is still immature.

Another paratype of right antler (GK. M1015, Pl. 4, Fig. 4) is represented by a fragmental beam just above the first bifurcation. It is much stouter than other specimens but is nearly as large as specimen GK. M1114 (Fig. 5). The beam is strongly curved and its distal part ornamented with deep and wide longitudinal grooves. The point of the second bifurcation is preserved only in the present specimen, although the second and the third tines are deficient. The beam near the second bifurcation becomes tabular. The second tine is projected backward, somewhat inward, making an angle of about 20 degrees with the third tine. Judging from the transverse section of the tine, the third tine is probably longer and stouter than the second.

A paratype of left antler (GK. M1119, Pl. 3, Fig. 2; Fig. 6) is represented by the basal part of the antler, lacking in the main part of the first tine and the beam above the first bifurcation. It is nearly as large as the holotype and GK. M1114 but has a larger angle of the first bifurcation. The first tine is bifurcated at 79 mm above the burr, making an angle of about 135 degrees with the beam. The main beam below the first bifurcation is subrectangular in its transverse section, and its axis inclines outward with an anticlockwise tortion.

A paratype of a right antler (GK. M1115, Pl. 6, Fig. 5) is smaller than the holotype, has shorter and more slender first tine, less lyrated beam above the first bifurcation and cylindrical beam at the distal portion, where a small and tabular snag is recognized on the outer surface. This specimen closely resembles specimen GK. M1116 in general outline.

The specimen of a left antler (GK. M1114, Fig. 5) is stouter and longer than any other specimen and has a shorter first tine, smaller angle of the first bifurcation (about 115 degrees), much more outwardly inclined beam below the first bifurcation and less rugose surface of the beam than the holotype.

The other antlers (paratypes GK. M10001, M1002, M1099) much resemble the holotype in general form, except for the minor difference in the density of the ornamentation, height of position of the first bifurcation and its angle, etc.

Abnormal specimens.—There are three abnormal specimens (GK. M1097, M1004, M1101).

GK. M1097 (Pl. 3, Fig. 5; Fig. 2)—The beam (?) above the burr is about 155 mm long lateral border and its growth seems to be impeded for some reason. It curves strongly forward without any bifurcation; the surface is ornamented with rather wide and deep grooves which are especially remarkable on the outer surface. In addition to these grooves, a few, rather large tubercles are developed on the upper-outer surface of the beam. The transverse section of the beam in the basal part is nearly circular, while in the distal part it is depressed antero-posteriorly. The larger thickness and the complexity of the ornamentation this antler specimen strongly suggest an adult stage.

GK. M1004 (Fig. 3)—The burr is very thick, circular and rugose. The

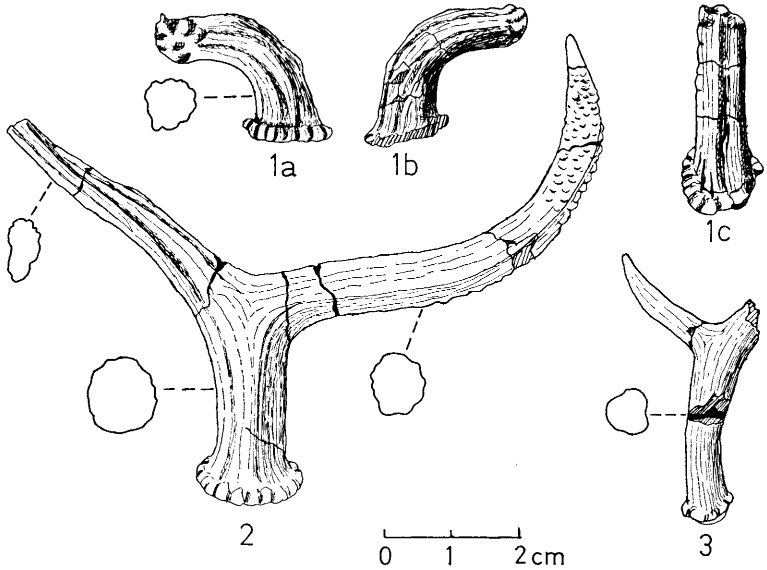


Fig. 2. Antler of abnormal specimens of *Cervus (Axis) japonicus* sp. nov.

main beam and the first tine are strong, stout and ornamented with several longitudinal, deep grooves. The axis of the main beam below the first bifurcation somewhat inclines outward with a slight anticlockwise tortion. The abnormal growth is shown in the beam above the first bifurcation by several characters, such as the length of only 207 mm from the first bifurcation and the distal part of the beam which is depressed antero-posteriorly and narrower and thinner in proportion to the distal end. The abnormal character of this specimen seems to be result from some sudden accident at a stage of its growth.

GK. M1101 (Pl. 6, Fig. 4; Fig. 2)—Abnormal characters are seen on the main beam and the first tine. The pedestal is lost. The burr is rather thin and moderately rugose. The point of the first bifurcation is very high above the burr (about 122.7 mm long). The main beam is very long, slender and has smooth surface. The first tine is very short. The present deer seems to be still immature, judging from the thickness and the ornamentation of the antler. As mentioned above, there is a tendency that the first tine of the immature deer is bifurcated at rather lower position making narrower angle with the beam than in the adult. It is noticeable, however, that the present specimen representing an immature stage is bifurcated at much higher position than any other adult specimen without sufficient growth of the first tine. This is, thus, abnormal specimen.

Measurements of antler.—See Table 2.

Variation of antler.—Considerable variability in form and ornamentation is recognized.

The height of the first bifurcation, for instance, ranges in measured examples from 63.4 mm to 122.7 mm, but this may include the difference in growth-

Table 2. Measurements of antlers (in mm or degrees):

	GK.M 1000	GK.M 1001	GK.M 1002	GK.M 1003	GK.M 1004	GK.M 1005	GK.M 1006	GK.M 1008	GK.M 1009	GK.M 1012	GK.M 1016	GK.M 1015	GK.M 1095	GK.M 1097	GK.M 1099	GK.M 1100	GK.M 1001	GK.M 1018	GK.M 1120	GK.M 1116	GK.M 1115	GK.M 1119	GK.M 1117	GK.M 1114	GK.M 1121	GK.M 1112
Fore-and-aft diameter of the burr	61.9	65.8	65.3	47.6	69.2	31.5	—	—	—	—	—	—	49.0	57.9	60.7	—	35.9	—	40.7(+)	47.9	52.2	61.2	37.5	65.6	—	27.6
Side-to-side diameter of the burr	59.8	61.5	59.3	46(+)	66.6	32.8	—	—	—	—	—	—	48.6	53.9	57.9	—	63.6	—	31.8	43.9	47(+)	60.4	—	44.0	—	44.1
Maximum thickness of the burr	11.0	12.0	11(+)	8.7	11.5	10(+)	—	—	—	—	—	—	9.7	10.5	13.0	—	6.1	8.7	5.4(+)	12.0	7.8	9.8	—	10.1	—	11.5
Fore-and-aft diameter of the beam below the first bifurcation	48.5	46.1	42.7	41.5	53.0	26.8	—	—	—	—	—	—	48.5	35.3	45.1	—	26.4	—	28.0	32.0	37.0	44.8	—	45.4	—	38.5
Side-to-side diameter of the beam below the first bifurcation	38.1	36.6	36.7	29.8	41.7	25.6	—	—	—	—	—	—	33.0	32.7	34.2	—	24.4	—	22.4	34.0	32.2	39.2	—	44.0	—	36.3
Circumference of the beam below the first bifurcation	135.0	128.0	125.5	103.4	138.0	85.0	—	—	—	—	—	—	124.5	105.7	130.5	—	82.0	—	84.0	101.0	180.0	136(+)	—	140.0	—	119.0
Height of the first bifurcation (including the burr)	83.8	82.4	84.5	84.5	117.0	75.0	—	—	—	—	—	—	119.7	—	73.0	—	122(+)	—	66.6	44.8	63.4	79.0	—	97.5	—	81.0
Fore-and-aft diameter of the first tine above the first bifurcation	38.1	35.0	35.6	28.6	36.1	21.2	—	—	—	20.8	—	—	39(+)	—	38.8	—	22.7	—	25.2	21.7	31.3	34.4	—	39.7	—	30.8
Side-to-side diameter of the first tine above the first bifurcation	31.5	30.7	31.0	23.0	33.6	19.9	—	—	—	17.3	—	—	28.0	—	30.3	—	17.8	—	16.2	21.8	22.3	33.6	—	37.2	—	27.5
Circumference of the first tine above the first bifurcation	110.0	107.0	112.5	83.0	112.0	65.5	—	—	—	—	—	—	—	—	110.0	—	57.0	—	65.0	70.0	85.0	110.0	—	119.0	—	90.1
Length of the first tine along outer side	397.0	220(+)	357(+)	158.0	356.0	—	—	—	—	—	—	—	—	—	202(+)	—	106.0	—	183(+)	169	202.0	170(+)	—	237.0	—	—
Length of the first tine in straight line	286.6	211(+)	278.6	187(+)	282(+)	—	—	—	—	—	—	—	—	—	196(+)	—	100.1	—	170(+)	155.0	180.0	—	—	208.0	—	—
Fore-and-aft diameter of the beam at the middle part	37.1	37.1	34.3	—	43.6	20.1	—	24.0	36.0	—	33.5	41.9	—	—	36.8	84.7	—	—	25.2	23.7	28.7	41.1	40.5	43.4	28.5	34.3
Side-to-side diameter of the beam at middle part	34.6	34.1	29.8	—	44.9	19.6	29.0	20.5	30.8	—	29.0	38.1	—	—	33.8	18.0	—	—	21.4	21.8	27.3	39.2	34.8	41.3	26.0	30.4
Circumference of the beam at middle part	113.0	115.5	110.0	—	—	67.0	—	—	—	—	—	—	—	—	116.0	14.8	—	—	73(+)	73(+)	94.0	—	119.0	137.0	—	100.4
Length of the beam as preserved (outer side)	810(+)	443(+)	407(+)	—	207(+)	—	660(+)	—	—	—	600(+)	555(+)	—	—	340(+)	—	—	—	—	480(+)	655(+)	—	—	599(+)	—	560.0
Length of the beam as preserved (in straight line)	650(+)	382(+)	379(+)	104(+)	205(+)	175(+)	480(+)	—	—	—	320(+)	462(+)	—	—	322(+)	—	—	—	126(+)	400(+)	570(+)	—	—	558(+)	—	470(+)
Height of the accessory prong as preserved	31.9	34.3	24(+)	29.5	—	14(+)	—	—	—	—	—	—	—	—	31(+)	—	—	—	13.1(+)	—	29.7	—	—	—	—	32.6
Angle of the first bifurcation	128(±)	124(±)	115(±)	115(±)	125(±)	110(±)	—	—	—	—	—	—	110(±)	—	122(±)	—	95(±)	—	97(±)	93(±)	112(±)	112(±)	135(±)	—	—	115(±)
Circumference of the burr	187.0	199.0	199.0	48.5	211.0	105(±)	—	—	—	—	—	—	144(+)	181(+)	195(+)	—	116.0	—	110(+)	140.0	—	190.0	—	200.5	—	150(±)

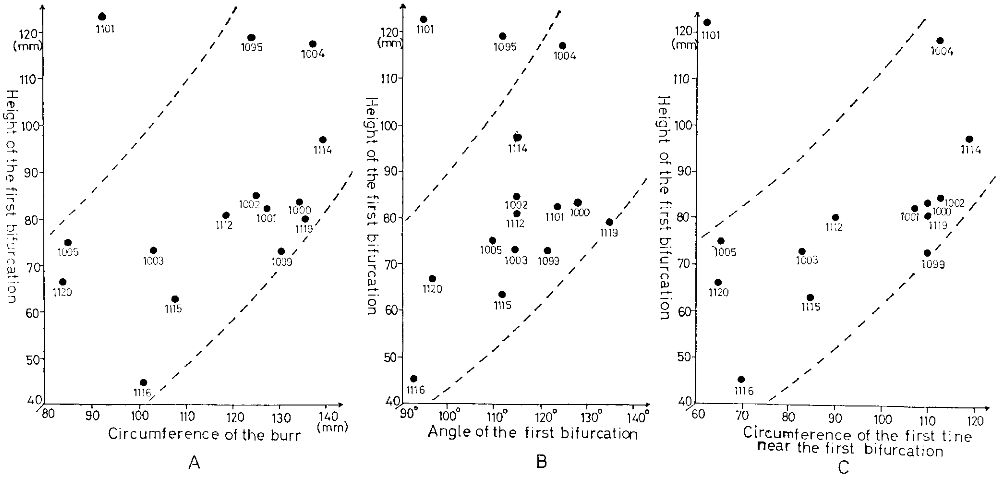


Fig. 3. Graph showing the relationships of circumference of the beam below the first bifurcation (A), angle of the first bifurcation (B) and circumference of the first tine near the first bifurcation (C) to the height of the first bifurcation respectively.

stage. These specimens, are classified roughly into three groups based on the height of the first bifurcation (Figs. 3 and 6).

The first group, consisting of GK. M1116 (Pl. 6, Fig. 3), GK. M1120 (Pl. 5, Fig. 4), GK. M1115 (Pl. 6, Fig. 5), shows rather low position of the first bifurcation, ranging from 63.4 mm to about 70 mm. These specimens are considered to be of immature deer, judging from the thickness and the ornamentations.

The second group, consisting of GK. M1003 (Pl. 5, Fig. 3), GK. M1009 (Pl. 4, Fig. 2), GK. M1005 (Pl. 3, Fig. 4), GK. M1112, GK. M1119 (Pl. 3, Fig. 2), GK. M1001 (Pl. 5, Fig. 1), GK. M1000 (Pl. 3, Fig. 1), GK. M1002 (Pl. 4, Fig. 1; Pl. 5, Fig. 2), GK. M1114 (Fig. 5), shows a moderate height of the first bifurcation, ranging from 70 mm to 100 mm. This group, however, comprises both immature and the adult specimens.

The third group, containing GK. M1004, GK. M1095 (Pl. 3, Fig. 3) and GK. M1101 (Pl. 6, Fig. 4), shows the highest bifurcating point at above 100 mm. The former two specimens are of adult stage but the latter one is probably immature, judging from the thickness and the ornamentations.

The angle of the first bifurcation ranges in measured examples from 93 to 135 degrees (Fig. 6). That of two immature specimens, for instance, are less than 100 degrees, while that of adult ones more than 100 degrees. That of specimen GK. M1114 is the largest, attaining about 135 degrees.

The antler specimens are considerably variable in surface ornamentation, such as density of grooves and tubercles. Usually the beam below the first bifurcation is ornamented with numerous wide grooves. Specimens GK. M1099 and M1000 (holotype), for instance, show moderately ornate beam, in which 11 primary and 11 secondary ribs are separated by grooves narrower than ribs themselves. GK. M1002 has more crowded, more numerous and finer ribs (16 primaries and 17 secondaries), but they are rather shallow and indistinct. GK. M1003, M1101, M1116 and M1120, which are regarded as immature specimens, have weakly ornate beam, on which the ribs and grooves are very faint.

The accessory prong above the first bifurcation is fairly variable in its shape. In general, it shows tabular shape in anterior view. But in specimens GK. M1001 and M1116 it shows cylindrical shape. In the case of the specimen GK. M1116, cylindrical accessory prong is diverging at the middle point between the first tine and the beam (Fig. 4).

Fig. 5 shows a figure of the antlers in front view, restored from the isolated specimens. In comparison with the holotype, specimen GK. M1114 shows a much more widely stretching form. An immature specimen GK. M1115 has the same kind of anter as the holotype in regard to the general form.

Lower jaw. The lower jaw is represented by four paratypes (GK. M1054, M1062, M1063, M1126; Pl. 7, 8; Fig. 7). Right and left unpaired rami are preserved. The jaw is very large, strongly constructed for cervid; the horizontal ramus is relatively high, long and rather thick, and its ventral border is curved remarkably upward in the anterior part.

The symphysis is narrow and long; the mental foramen is relatively large, suboval or spindle shape and measured 13.8×10.6, 12.4×7.6 and 15.9×7.4 mm, respectively. The ascending ramus is broad and not so strongly bent backward; outer surface is relatively flat and smooth, while inner surface is irregularly sculptured with many grooves and ridges; the mandibular foramen is almost circular, deep and 9.5 mm in diameter. The coronoid process is transversely wide and not much curved backward. The condicle is rather thick; a conspicuous groove runs obliquely from the posterior-lower corner of the foramen downward.

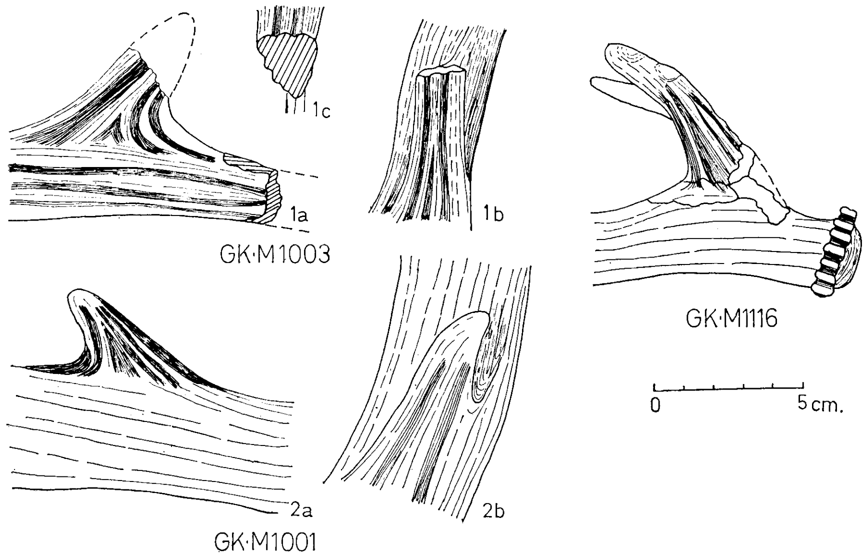


Fig. 4. The accessory prong of the beam above the first bifurcation. Lateral (a), inner (b) views and its transverse section (c).

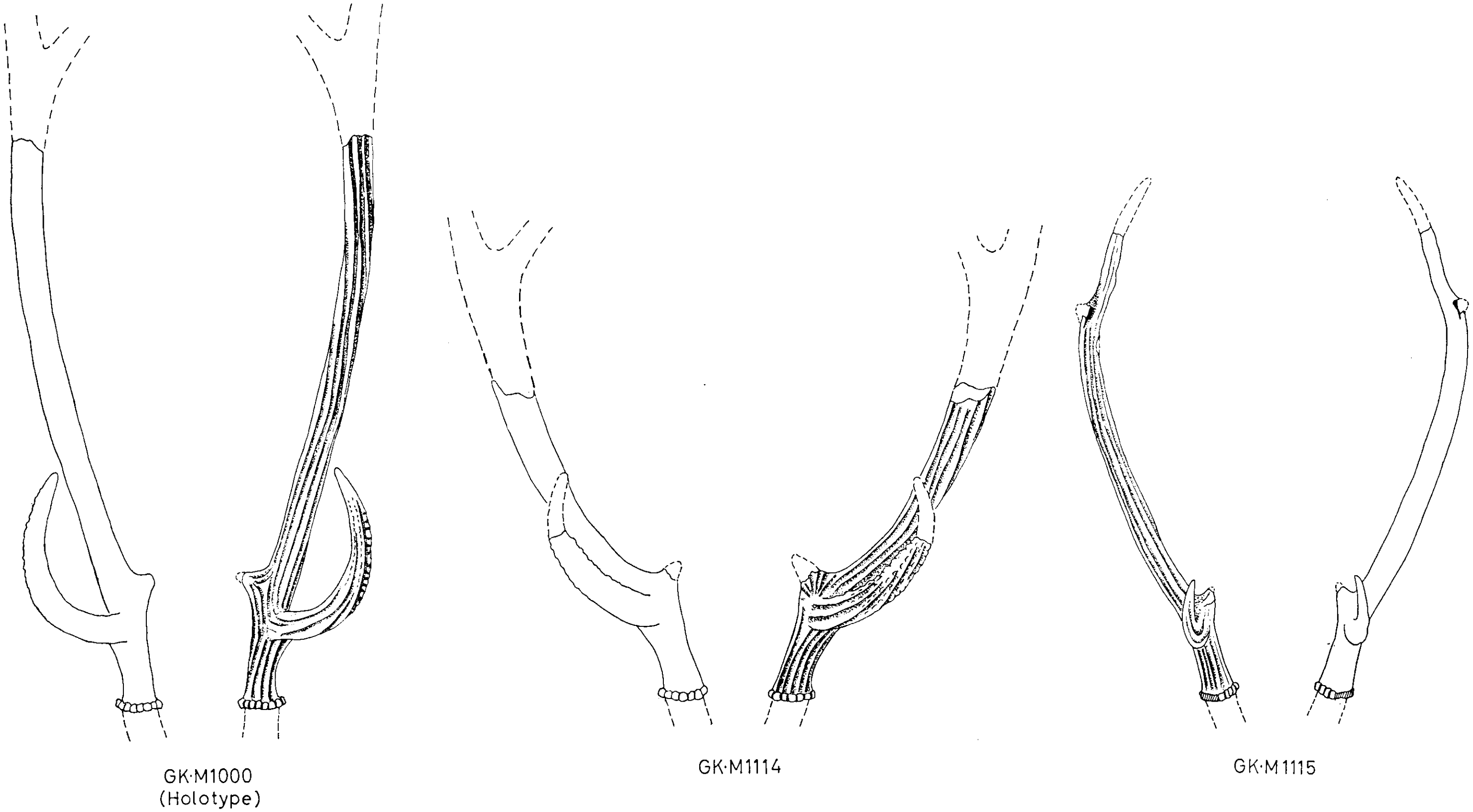


Fig. 5. Restored figures of antlers of *Cervus (Axis) japonicus* sp. nov., viewed in front.

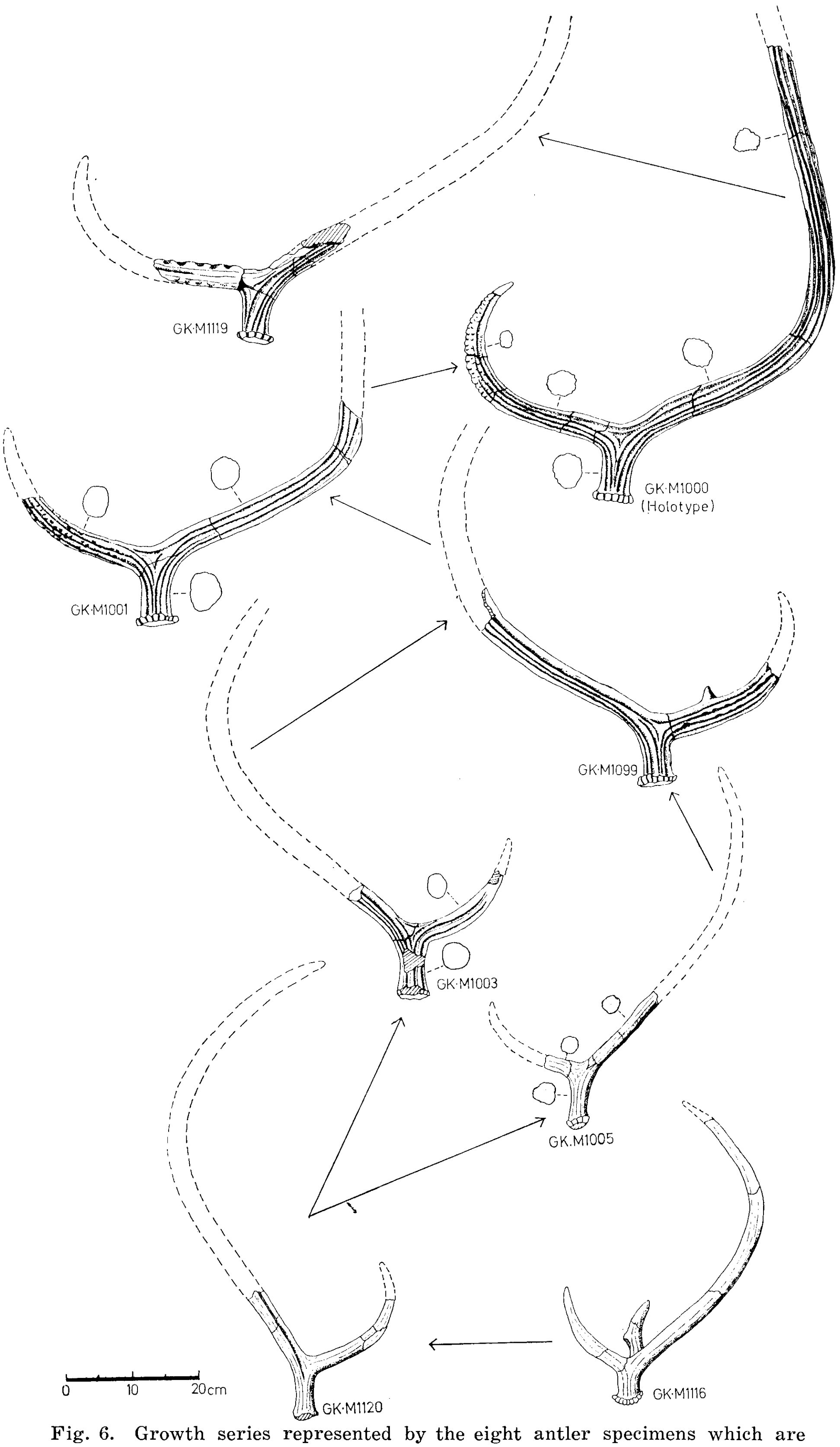


Fig. 6. Growth series represented by the eight antler specimens which are arranged in the order of their growth stage.

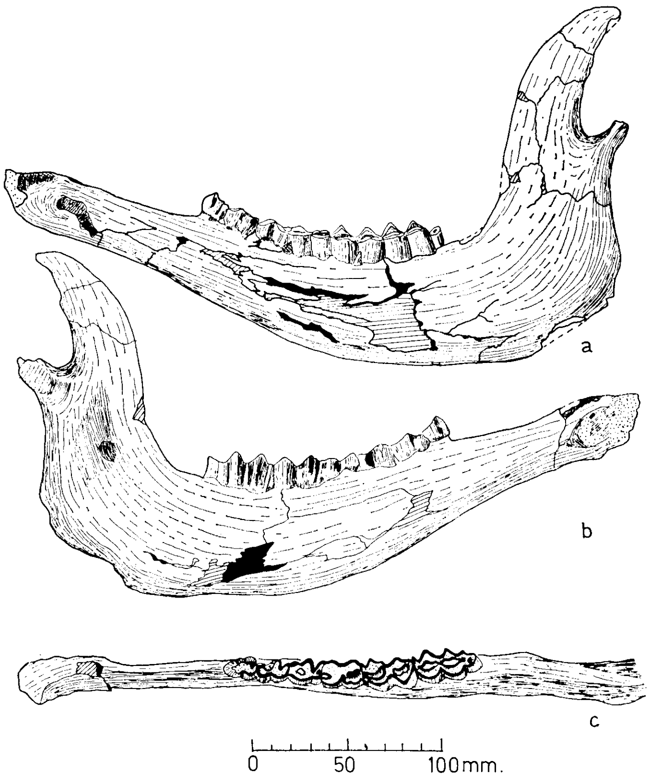


Fig. 7. Lower left jaw of *Cervus (Axis) japonicus* sp. nov. [GK.M 1126)]. Outer (a), inner (b) and upper (c) views.

The foramen of antero-upper corner of the ascending ramus is deeply concave outwards.

The lower teeth are preserved in the above described four jaws and also occur as several isolated specimens (GK. 1128, M1129). In general, the row of teeth (P2-M3) is rather long. The enamel wall of the crown is thick and rugose. Accessory columns exist usually in antero-outer lobe of M2, postero-outer wall of M1, antero-outer wall of M3 and the third lobe of M3.

P2 is moderately large and massive, and inclines backward. Distinct folding exists on the posterior surface of the inner wall.

P3 is also large and remarkably folded. The inner wall of the crown is provided with three distinct fossette of which prefossette is large, deep and wide, while the posterior one is divided into two fossette, of which the anterior one is larger and deeper than the posterior.

. P4 is also large and massive. The inner margin is almost straight and has a distinct pre-fossette, while the outer margin streches outward and has a rather smooth surface.

In upper view, M1 is subquadrate in outline and has stout and inflated lobes. The accessory column of the outer wall between anterior and posterior lobes is small and indistinct in specimens GK. M1062 and M1054 and undeveloped in

Measurements in mm:

	GK.M 1062	GK.M 1063	GK.M 1054	GK.M 1126	*C. (Axis) lydekkeri*[1]	*C. (A.) javanicus*[2]	*C. (Sinomegaceros) yabei*[3]
Preserved length of ramus	300.8	278(+)	320(+)	327.5	—	—	326.8–363.2
Distance between anterior end and tip of coronoid process	290(+)	—	—	334.0	—	—	361 –402.0
Preserved length of symphysis	85.5	75.0	—	101.5	—	—	56.2– 58.8
Thickness of region of mandibular angle	5.3	—	5.0	—	—	—	—
Width of ascending remus just above the mandibular angle	67.0	—	70.3	74.0	—	—	87.6– 87.7
Transverse length of condicle	22.5	18.8(+)	28.4	31.2	—	—	—
Vertical thickness of condicle	8.7	9.7	11.3	10.5	—	—	—
Height of ascending ramus	153.6	—	173.1	187.0	—	—	169.0–171.0
Depth of ramus at anterior end of symphysis	30.7	—	—	35.2	—	—	—
Depth of ramus at anterior of P2 on outer side	35.0	37.0	35.4	37.4	—	—	27.3– 33.0
Depth of ramus at anterior of P2 on inner side	35.0	—	35.4	37.4	—	—	29.0– 35.8
Depth of ramus at posterior of P4 on outer side	40.6	38.4	42.4	44.0	—	22.5	35.0– 38.7
Depth of ramus at posterior of P4 on inner side	40.6	—	41.7	44.0	—	—	35.0– 38.0
Depth of ramus at posterior of M1 on outer side	40.6	43.7	46.6	49.5	—	—	39.2– 43.0
Depth of ramus at posterior of M2 on outer side	49.8	48.0	52.0	56.3	—	—	43.7– 46.0
Depth of ramus at posterior of M2 on inner side	48.4	52.0	52.3	55.7	—	—	49.4– 51.0

	GK.M 1062	GK.M 1033	GK.M 1054	GK.M 1126	*C. (Axis) lydekkeri*[1]	*C. (A.) javanicus*[2]	*C. (Sinomegaceros) yabei*[3]
Depth of ramus at posterior of M3 on outer side	55.5	—	55.7	59.8	26–32	32	47.8– 53.3
Depth of ramus at posterior of M3 on inner side	63.0	—	60.3	63.7	—	—	57.0– 58.0
Maximum thickness of ramus posterior to symphysis	10.0	12.0	—	13.4	—	—	—
Maximum thickness of ramus below P2	13.1	13.5	11.1	14.1	—	—	19.5– 20.2
Maximum thickness of ramus below P3	15.7	—	15.0	15.4	—	—	22.0– 24.0
Maximum thickness of ramus below P4	17.8	19.6	17.4	16.3	—	—	27.0– 28.8
Maximum thickness of ramus below M1	18.2	21.8	19.4	18.6	—	—	30.0– 31.8
Maximum thickness of ramus below M2	21.0	22.2	22.0	18.6	—	—	33.4– 34.6
Maximum thickness of ramus below M3	22.8	22.5	23.0	22.9	—	—	35.8– 39.2
Length of three premolars	47.0	52(+)	48.7	50.0	—	—	—
Length of three molars	62.0	88.5	88.2	80.3	—	—	—
Length of mandibular tooth row (P2-M3)	131.0	140(+)	136.7	130.8	—	—	154–159
Diameter of mental foramen	13.8×10.6	12.4×7.6	—	15.9×7.4	—	—	—
Mandibular index	14.1	43.2	38.1	36(+)	—	—	62–68

1), 2) : R. KOENIGSWALD (1933) ; *Weten. Meded.*, (23).
3) : T. SHIKAMA and S. TSUGAWA (1962) ; *Bull. Nat. Sci. Mus. Tokyo,* (50).

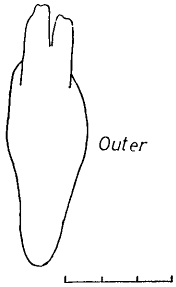


Fig. 8. Transverse section of a right jaw below M3 (GK.M 1062).

specimens GK. M1063 and M1126. The inner wall, which is oblique to the grinding surface, has only weak costa and folds; the outer wall moderately streches outward. The outer crescent is lower and longitudinally longer than the inner crescent in the specimen GK. M1126. The valley is deep and indistinct.

M2 is developed. The accessory column on the anterior lobe of the outer wall is long and cylindrical in specimen GK. M1062 but indistinct in specimen GK. M1126. In upper view antero-inner wall is more undulated than the posterior one; the outer crescent is eminently projected outward. The valley is distinct and deep. The inner crescent is eminently projected upward. The inner wall of the anterior and posterior lobes is weakly folded and has a less developed metastyle.

M3 is also large. The accessory column exists at the end of the posterior inner wall, which is relatively broad and high. In upper view the outer wall of the anterior lobe is only weakly folded and apparently smoothish. The third lobe is relatively large and nearly circular in outline.

Measurements in mm:

		GK.M 1062	GK.M 1063	GK.M 1054	GK.M 1126	GK.M 1128	GK.M 1129	*C. (Axis) lydekkeri*
PM2	width	7.0	—	7.4	8.6	—	—	2.3– 2.9
	length	12.0	—	12.0	13.0	—	—	4.9– 5.4
PM3	width	9.2	—	9.2	10.5	11.8	—	3.7– 4.8
	length	17.5	18.5	16.8	16.4	18.9	—	7.3– 8.4
PM4	width	11.5	—	11.7	11.4	—	—	3.7– 4.8
	length	17.4	21.0	19.8	18.6	—	—	7.7– 9.2
M1	width	13.7	12.8	13.6	14.1	—	—	6.8–11.9
	length	22.3	24.6	24.7	21.2	—	—	9.4–11.9
M2	width	14.1	13.2	14.0	15.2	—	—	7.8– 9.1
	length	27.7	32.1	29.0	26.0	—	—	10.7–12.9
M3	width	14.6	12.4	14.0	14.6	—	—	7.2– 8.8
	length	33.1	36.4	36.2	34.1	—	—	16.5–19.1
Incisor tooth								
	width	—	—	—	—	—	8.3	—
	length	—	—	—	—	—	15.8	—

The ramus of the present species is somewhat smaller than that of *C.* (*Sinomegaceros*) *yabei* (SHIKAMA & TSUGAWA, 1962), from the Pleistocene deposits of Japan, *Euryceros odosianus* (TEILHARD de CHADIN, 1941), from the middle Pleistocene of China, and *Elaphurus menziesianus* (TEILHARD & YOUNG, 1936), from the archaeological site of Anyang, north China, but much larger than that of *C.* (*Axis*) *axis javanicus* (KOENIGSWALD, 1933), from the middle Pleistocene deposits of Java. Length of the mandibular tooth row of the present species is generally equal to or somewhat smaller than that of the Chinese *Euryceros*, *Elaphurus* and Javanese *Axis*. The present species, furthermore, is characterized by a prominently curved ventral border of the horizontal ramus and less inclined ascending ramus compared with the above mentioned cervids.

Mandibular index[1] of the present species is about 38 on the average (Maximum, 41.4; minimum, 39.5) while it is about 75 in *Euryceros flabellatus*, 90 in *Euryceros pachyosteus* and 64 in *C.* (*Sinomegaceros*) *yabei* respectively.

The upper teeth are represented by six paratypes (GK. M1062, M1090, M1092, M1093, M1094, M1127; Fig. 15). M2 represented by a right specimen (GK. M1094) is relatively long antero-posteriorly. The enamel wall of the teeth is well developed, though the folding is indistinct. Accessory columns are two, very stout and long (cylindrical), of which the inner one is higher than the outer. Both the meta- and parastyles prominently project outwards. Valleys are very wide, deep and remarkably projected exteriorly. The outer crescent is higher than the posterior one. Both the anterior and posterior enamel walls have strong, linear ridges. The outer enamel wall is irregularly undulated.

M3 is represented by three left and one right specimens. The teeth are large and stout. The accessory column exists in a left specimen (GK. M1092), but it is not so distinct. Both the para- and metastyle prominently project exteriorly. Folding is moderately developed. M3 is longer than wide and almost quadrate in outline in upper view. Both inner and outer crescents are relatively broad and flat in specimen GK. M1093 (left specimen). The outer crescent more strongly projects inward than the inner one.

Measurements in mm:

		width (W)	length (L)	inner height of enamel wall	L/W
M1	GK.M 1090	23.0	25.3	22.4	1.38
	C. (*Axis*) *axis javanicus*[1]	16(+)	14.5–16.5	—	0.73–0.74
	C. (*A.*) *lydekkeri*[2]	11.8–13.7	8.7–10.4	—	0.74–0.76
	C. (*A.*) *shansius*[3]	—	—	—	0.95–1.60
M2	GK.M 1094	24(+)	23.5(+)	12.3	1.0
	C. (*A.*) *axis javanicus*[1]	—	—	—	0.83–0.83
	C. (*A.*) *lydekkeri*[2]	10.4–12.6	10.4–12.6	—	1.00
	C. (*A.*) *axis*[4]	23.5	22.0	—	0.94
	C. (*A.*) *shansius*[3]	—	—	—	1.00

1) Mandibular index $= \frac{\text{Breadth of ramus under M3}}{\text{Internal depth under M3}} \times 100$

M3	GK.M 1092	26.5	27.2	17.1	1.05
	GK.M 1093	26.6(+)	25.7(+)	12.6(+)	1.32
	GK.M 1127	26.0	28.3	16.0	1.09
	C. (A.) axis javanicus[1]	—	—	—	0.93–0.98
	C. (A.) lydekkeri[2]	11.4–14.5	11.5–14.5	—	1.00
	C. (A.) shansius[3]	—	—	—	1.05–1.25

The upper molar of the present species are massive and very similar in shape and size to *C.* (*A.*) *shansius* and larger than *C.* (*A.*) *axis javanicus.*

Cervical vertebra. The fourth and the sixth cervical vertebrae, paratypes (GK. M1176, M1124; Pl. 11, Pl. 14), are in the collection. The fourth cervical vertebra is large, thick and stout, and provided with strongly projecting postzygapophysis which is oval in outline. The transverse process is very long and broad, and its ventral border is much convex and the anterior surface rounded. The neural canal is almost circular in frontal view. The dosal arch is concave in middle part and has a nearly straight posterior border. The lateral surface between postzygapophysis and transverse process is deeply concave and provided with oval foramen.

The most part of the neural spine and the parapophysis of the sixth cervical vertebra are missing. The neural canal broad in anterior view, but it is almost circular in posterior view. The diaphysis steeply inclines posterior view and its longest axis runs from upper-lateral corner to lower inner one.

Measurements in mm:

	fourth	sixth
Longitudinal length of centrum	90.5	54(+)
Longitudinal length along median line of dosal arch	62.1	36.6
Longitudinal length of neural spine at middle height	44.2	—
Distance between pre-and postzygapophysis	92.1	62.4
Transverse width of prezygapophysis	67.0	54.1
Transverse width of postzygapophysis	65.8	53.3
Transverse width of transverse process	108.8	17.3
Diameter of centrum at anterior end	37.7×32.9	—
Distance between prezygapophysis and anterior end of transverse process	82.3	—

Thoracic vertebra. The third thoracic vertebra is in the collection: paratype, GK. M1123 (Pl. 11). It is large and stout and is concave on the side. The centrum shows triangular shape in anterior view, and its ventral margin is remarkably pointed. The neural spine is thick and has a broad surface just above the posterior zygapophysis in the posterior view. The postzygapophysis is wider than the prezygapophysis. The transverse process is thick, rugose and long.

1), 2): KOENIGSWALD (1933); *Weten. Meded.*, (23).
3): TEILHARD and TRASSAERT (1937); *Pal. Sinica.*, [n. s. C], (1).
4): LYDEKKER (1884); *Pal. Indica,* (3), 10.

Measurements in mm:

Longitudinal length of centrum	45.3
Distance between pre- and postzygapophysis	38.5
Transverse width of prezygapophysis	19.7
Transverse width of post prezygapophysis	20.3
Longitudinal length of neural spine at middle height as preserved	90.5
Transverse width of facet for tuberculum	66.6
Diameter of centrum at posterior end	33.4×18.0
Diameter of centrum at anterior end	25.2×16.5
Length of transverse process	32.9

Lumber vertebra. Three lumber vertebrae, paratypes (GK. M1051, M1157, M1158; Pl. 11), are in the collection. The two larger specimens (GK. M1157, M1051), which seem to be the posterior ones, are deficiency of neural spine, transverse process and some part of pre- and postzygapophysis, but their centrum is relatively well preserved. The centrum is large and suboval in shape in anterior view, and its ventral margin strongly concave upward and much constricted in the middle. The posterior zygapophysis is relatively thick and distinctly projecting backward from the arch at the base of the spinous process. The basal part of the transverse process (diapophysis) is relatively broad. The prezygapophysis is large and massive.

The anterior lumber vertebra (GK. M1158) is small, light brown on the surface, and its upper part of neural spine, transverse process and prezygapophysis are broken. The centrum is shorter in the longitudinal direction than the other specimens.

Compared with the type of *C.* (*Sika*) *nippon* and *C.* (*Depereti*) *praenipponicus*, the present species is characterized by the almost straight posterior border of dosal arch and rather circular profile of centrum.

Measurements in mm:

	GK.M 1051	GK.M 1157	GK.M 1158
Longitudinal length of centrum	52.9	51.0	44.3
Longitudinal median length along ventral surface of neural arch as preserved	52.0	—	—
Diameter of centrum of anterior end	33.4×27.5	31.8×28.0	26.0×28.0
Diameter of centrum of posterior end	37.7×28.1	—	30.0×22.9
Distance between anterior end of postzygapophysis at right side	66.3	66.7	—
Transverse width of prezygapophysis	36.2	33.3	—
Transverse width of postzygapophysis	25.8	27.0	30.8

Sacrum. Sacrum is represented by a fragmental specimen, paratype (GK. M1175; Pl. 14), which is preserved from the anterior end to the first ventral sacral foramen.

The anterior surface of the centrum is elliptical in outline. The sacral canal is moderately large and shows subtriangular shape in anterior view. The neural spine is completely broken away. The wing of sacrum is moderately broad and has an extremely convex articular surface.

The sacrum is much larger in the present species than in many other species of *Cervus* but nearly as large as that of the species belonging to *Elaphurus* and *Euryceroid* group.

Measurements in mm:

Diameter of sacral canal	36.5×17.3
Direct length between the end of both wings along outer border	136.0
Diameter of the centrum at anterior end	51.4×23.0
Diameter of the first sacral foramina	38.2
Fore-and-aft length of sacral wing	63.0

Innominate bone. This is represented by four paratypes (GK. M1062, M1063, M1064, M1068), some of which are only partially broken but others fragmentary. The bone is long and rather stout. The acetabulum is relatively large, thick and provided with rounded margin and a large acetabular fossa. The pubis is rather stout and large, and has a distinct pubic tubercle and indistinct pubic groove. It is thickened ventrad and has a flat dosal and convex ventral surface.

Both the ischium and the ilium are remarkably inclined outward and have flat dosal and convex ventral surfaces; inner border of ilium is almost straight while the outer border expanded laterally. The ventral surface of the acetabular branch is rather smooth and slightly convex upward, while its dorsal surface is rather rugose and slightly concave.

Measurements in mm:

	GK.M 1068	GK.M 1062	GK.M 1063	GK.M 1064
Preserved maximum length of innominate bone	318.7	279.6	—	—
Maximum width of ilium	65.5(+)	52.8	—	—
Minumum length of ilium	41.0	30.6	—	—
Diameter of acetabulum	—	40.6×53.8	47.4×55.5	50.0×57.3
Distance between acetabulum and posterior end of ischium	—	104.8(+)	—	—
Distance between acetabulum and anterior end of pubis	—	50.0	—	—

Scapula. This is represented by three paratypes (GK. M1062, M1123, M1148; Pl. 14). It is large and much expanded in the distal part. In lateral view both the posterior and anterior borders are almost straight. The posterior border is highly elevated outward but decreasing its height toward the distal part. The spine is relatively high and thick, and that in the proximal part inclines outward while that in the distal part inclines upward. The tuber spine is moderately depressed and its surface slightly inclines downward. The supraspinous fossa is remarkably narrower than infraspinous fossa. The glenoid cavity shows oval in distal view and has much depressed surface. The coracoid process is moderately large and projected.

Scapula of the present species is much larger than that of other cervids, being as large as that of *Elaphurus* and *Rangifer*, but is smaller than that of *Megaceros*. The most diagnostic characters of the present specimens are recognized in the spine and the posterior border. The spine is much higher in the present species than in *Cervus* and slightly higher than in *Megaceros*, but almost as high as that of *Elaphurus*. The posterior border rises more highly in the present species than in *Megaceros*.

Measurements in mm:

	GK.M 1112	GK.M 1064	GK.M 1148
Preserved maximum length of scapula	300.6	216.3(+)	227(+)
Transverse width of proximal portion as preserved	164.0	148.6(+)	95(+)
Transverse width of distal end including coronoid process	62.1	—	44.2
Diameter of glenoid cavity	48.5×40.0	—	34.0×36.3
Distance between distal end of spine and border of glenoid cavity	34.2	—	32.5
Maximum height of spine at aft side	44.3	36.2	30(+)

Humerus. This is represented by a single paratype (GK. M1085; Pl. 13). It is large, stout and massive. The head is large and strongly curved backward; its upper surface is smooth, rather flat, and irregularly oval in shape. The medial and lateral tuberocities are both divided into two parts by a deep and wide internal groove. The deltoid tuberosity is rather large, somewhat rugose and oval in lateral view. The shaft is irregularly curved, somewhat compressed and oval in medial section. The medial condyle is very large. The epicondyle is prominently projected downward below the level of the medial condyle. The lateral condyle is relatively small and placed somewhat higher than the medial condyle. The coronoid fossa is very deep and gradually changes to a rough area of lateral condyle.

Measurements in mm:

	GK.M 1058	GK.M 1160
Maximum length from head to trochelea	217.5	—
Diameter of head	64.5×74.4	—
Diameter of shaft below head	35.5×42.0	—
Diameter of lateral tuberosity between inner and outer sides	69.6	—
Diameter of shaft at middle	23.7×33.1	—
Maximum length from anterior surface of middle condyle to posterior surface of medial epicondyle	54.8	58.3
Maximum length from anterior surface lateral condyle to posterior surface of lateral epicondyle	39.0	39(+)
Maximum length of both condyles	51.7	56.8
Maximum length of both epicondyles	52.1	53.5

Radius. This is represented by a single paratype (GK. M1059; Pl. 13). The bone is relatively large, broad and considerably thick. The shaft slightly curves

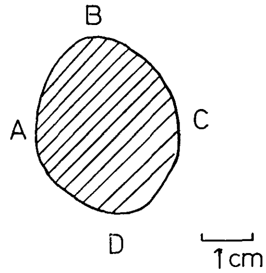


Fig. 9. Transverse section of shaft of humerus in middle part (GK.M 1058). A: inn side, C: out side, D: anterior side.

outward in the anterior view and curves backward in the lateral view. The curvature is stronger below than above. The head of the proximal end is relatively large, rugose and has a rather deep glenoid cavity, while the distal end is expanded slightly inward and has a rough prismatic surface. The grooves for extensor tendons on the distal end are wide and relatively deep. The posterior surface is moderately flat but somewhat convex near the proximal part. The posterior surface is also marked by a narrow, longitudinal furrow which runs from the distal surface to the proximal surface along the inner border.

Measurements in mm:

Maximum length	272.2
Width of shaft at proximal end	56.5×30.3
Width of shaft at middle part	30.9×19.1
Width of shaft at distal end	39.1×23.0

Ulna. This is represented by the three paratypes (GK. M1135, M1136, M1165; Pl. 11). All of them are relatively large and moderately thick. The oleclanon is rather large and flat. It is nearly quadrate in outline and has a convex inner surface. The anterior margin between oleclanon and process anconnaeous is almost straight. The posterior margin between oleclanon and backward of sigmoid notch is slightly convex anteriorly in lateral view. The sigmoid notch is very large and gently curved. The coronoid is moderately large and projected forward. The incisula radialis is very wide and deep. The shaft is almost broken away in every specimens.

Measurements in mm:

	GK.M 1135	GK.M 1136	GK.M 1165
Length of olecranon along anterior border	53.9	25(+)	71.2
Maximum longitudinal distance of sigmoid notch	30.1	27.8	—
Diameter of olecranon	46.3×13.9	36.5×12.8	46.8×18.2
Diameter of shaft below sigmoid notch	—	19.3×9.0	

Metacarpus. This is represented by two paratypes (GK. M1060, M1045;

Pl. 12). It is triangular in section, and its length is about seven times width. The proximal end is broadened. The shaft is longitudinally striated and has a distinct longitudinal groove on its median part, which begins at the distal end but disappears at about one-fifth of total length to the proximal end. A small oval hole exists in the proximal part. The inner side of the shaft more steeply inclines than the outer side, but the degrees of both inclinations approximate to each other near the proximal part.

The posterior surface has a wide and roundly-bottomed furrow, which is clearly recognized in the distal part and becomes obscure in the central part and finally disappears in the proximal part. A small, oval and deep hole presents in the proximal part. The position of which corresponds to the hole on the anterior side.

In lateral view, the surface of the proximal and distal ends are rather rugose; the anterior margin is almost straight; the posterior surface curves irregularly.

Measurements in mm:

	GK.M 1060	GK.M 1045	*C. (A.)axis javanicus*[1)]
Maximum length	295.3	262.0	122–129.5
Width of shaft at middle	26.0×29.5	22.8×24.0	—
Width of shaft at proximal end	42.5×31.7	40.5×30.5	20–23.5×13–16.5
Width of shaft at distal end	47.4×31.3	43.1×29.2	23–24.5×12–4–14

Femur. This is represented by two paratypes (GK. M1078, M1159; Pl. 12). The bone is rather long and stout. The shaft is massive and relatively wide, and its transverse section is suboval except near the end where it becomes wider and to be compressed. In anterior view the outer margin of the shaft is slightly curved outward but its inner margin is almost straight. The outer surface of the shaft is more rounded than the inner. The posterior surface is more or less flattened and limited laterally by a distinct longitudinal ridge (lateral supracondyloid). In the proximal part, the head is prominently bending inward. The trochanter minor is relatively large and rough, and its extends above the level of the head. In the distal part, the lateral condyles more prominently project downward and backward than the median condyles; the intercondyloid fossa is deep and narrow; the median condyloid is also large and has a round surface.

Measurements in mm:

	GK.M 1078	GK.M 1159
Maximum length	322.6	—
Side-to-side diameter of proximal end of shaft through head and trochanter major	88.2	—
Antero-posterior diameter of head	37.5	37.4
Diameter of shaft at middle	33.4×23.8	—
Diameter of shaft below trochanter minor	38.4×30.2	—

1): R. KOENIGSWALD (1933); *Weten. Meded.*, (23).

Diameter of medial condyle	26.1	24.5
Diameter of lateral condyle	32.4	38.5
Maximum length between medial condyle and medial trochelea	102.9	82.0
Maximum length between lateral condyle trochelea	82.3	86.5

Tibia. This is represented by a single paratype (GK. M1161, Pl. 13). The shaft is rather stout, and its outer border is almost straight while the inner is slightly concave inward. The posterior surface is divided into two part by rough, noticeable ridges of muscular line which runs obliquely from the proximal part of the lateral border to the proximal end of medial border. The posterior surface of the proximal part is somewhat convex. The procnemial ridge in the proximal part is moderately elevated.

Measurements in mm:

Diameter of shaft at middle .... 29×24.0
Diameter of shaft at distal end .... 46.0×35.3

Metatarsus. This is represented by the two paratypes (GK. M1057, M1097; Pl. 12), which are relatively large and stout, and subcircular in section. In anterior view, there is a distinct longitudinal groove in the central part of the shaft, which is wide and relatively deep but decreases its width and depth in the median part. In addition to this main groove, there is a short and shallow groove on the outer surface in the proximal part. The inner surface of the shaft more steeply inclines than the outer and is almost flat near the proximal part. The posterior surface has a longitudinal, wide and rounded furrow.

In lateral view, the anterior surface is slightly concave, while the posterior surface slightly convex. Facet for cubo-navicular is triangular. The facet for cuneiform is wide and subrectangular. The median foramen is deep and triangular in outline.

Measurements in mm:

	GK.M 1057	GK.M 1097
Preserved maximum length	204(+)	277.7
Width of shaft at proximal end	36.8×38.6	a×31(+)
Width of shaft at distal end	—	a×31(+)
Width of shaft at middle part	24.1×25.9	a×25(+)

Proximal pharange. This is represented by seven paratypes (GK. M1066, M1067, M1094, M1113, M1114, M1151; Pl. 10). The proximal part is very rugose and nearly quadrate in section. The anterior surface of the shaft has longitudinally and widely ridged borders. The basis pharange is divided into two parts by a median deep groove. The posterior margin of the basis pharange is rounded.

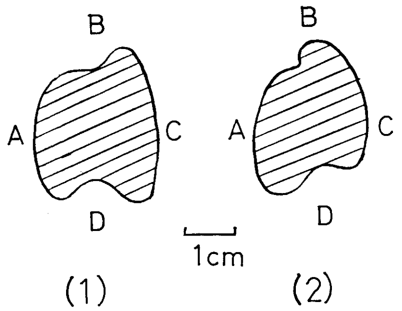


Fig. 10. (1) Profile of metatarsus near the proximal part, (2) Profile of metatarsus in middle part.
A: out side, B: anterior side, C: inn side, D: posterior side.

Measurements in mm:

	GK.M 1066	GK.M 1067	GK.M 1094	GK.M 1113b	GK.M 1114	GK.M 1151	GK.M 1167
Maximum length along anterior border	—	—	51.1	57.5	—	—	
Diameter of proximal end	—	24.6 × 21.5	25.5 × 18.1	25.7 × 22.4	25.5 × 19.5	25.4 × 21.0	23.0 × 29.0
Diameter of distal end	21.5 × 17.0	—	19.8 × 15.9	20.0 × 16.0	—	19.2 × 15.9	—

Middle pharange. This is represented by five paratypes (GK. M1086, M1094, M1115, M1149, M1150), which are relatively long and not stout. The posterior-upper corner is more projecting backward than the anterior. The basis pharange deeply concave. In lateral view, both anterior and posterior margins are gently curved.

Measurements in mm:

	GK.M 1086	GK.M 1094	GK.M 1115	GK.M 1149	GK.M 1150
Maximum length of anterior border	37.8	—	—	—	—
Diameter of distal end	24.8 × 17.6	25.8 × 19.2	16.0 × 14.2	15.7 × 19.0	16.4 × 13.2
Diameter of proximal end	18.5 × 14.5	26.5 × 16.5	—	25.8 × 19.5	22.4 × 16.4

Distal pharange. This is represented by a single paratype (GK. M1046; Pl. 10). The bone is sagittal in general form and somewhat rough in surface feature. The anterior border is almost straight in lateral view, but somewhat concave near the distal part. On the anterior-inner side there is a shallow and wide groove which runs obliquely from the proximal inner corner to the distal end. Near the proximal end the bone become very rough and rugose in surface appearance, and has two small oval foraminas. The outer surface is very rough and porous near the proximal part. The articular surface is smooth and subquadrate in outline in upper view. The extensor process and depression for the collateral ligament are not prominent.

Measurements in mm:

Maximum length along anterior border	46.8
Diameter of proximal end	18.9×28.2

The pharanges are well preserved. These are much smaller than those of species belonging to the *Elaphurus* and *Megaceros*, but almost equal in size to those of *C.* (*Sika*) *nippon* and *C.* (*Deperetia*) *praenipponicus*. But the present species apparently differs from *C.* (*D.*) *praenipponicus* and *C.* (*S.*) *nippon*, in having the more deep furrow on the posterior surface of the shaft and more constricted distal end.

Cubo-navicular. This is represented by a single paratype (GK. M1123; Pl. 10). The proximal border as viewed from above is irregularly elongated laterally, and has a convex lateral and almost straight anterior margins. The posterior margin is notched with two fossae. The facets for calcaneum are remarkably concave downward. Among them the internal one is narrow and long while the external one is broadened and has a deep and oval hole attaining to the distal end in the central part. The anterior border of cuboid is narrow and high for navicular. The posterior-inner border is highly elevated above the level of posterior-external border. The facet for the cuneiform is almost rectangular and has a straight inner margin.

Measurements in mm:

Fore-and-aft diameter of proximal border	35.5
Side-to-side diameter of proximal border	46.9
Minimum height of anterior border	10.8
Maximum height of anterior border	19.7
Transverse length of anterior border	35.5

Carpus. This is represented by seven paratypes, that is, two scaphoid, two cuneiform, two lunar and a single trapezoid.

The scaphoid is massive and conspicuously rectangular in outline. The outer surface is relatively flat or slightly convex inward; inner surface (attachment for lunar) has a transverse furrow in the median part. In lateral view, both upper and lower surfaces are deeply concave upward and downward respectively.

The lunar is rather irregular in outline and wider in the anterior part than in the posterior; the long axis is directed obliquely backward. In anterior view, it is irregularly trapezoid and has a slightly concave lateral surface.

The cuneiform is relatively narrow in anterior view and very irregular in lateral view. Its postero-external corner is remarkably projected downward; outer surface is strongly convex.

The trapezoid is large and of subquadrate outline, and has a nearly straight lateral and curved anterior margins.

Measurements in mm:

	Right paired carpus			Left unpaired carpus			
	Scaphoid GK.M 1085	Cuneiform GK.M 1086	Lunar GK.m 1087	Scaphoid GK.M 1168	Trapezoid GK.M 1169	Lunar GK.M 1170	Cuneiform GK.M 1167
Maximum transvers (distance between anterior and posterior margins)	—	24.0	26.2	33.8	25.5	23.5	23.0
Maximum width (side-to-side length)	15.3	20.4	17.4	17.0	21.3	17.4	15.0
Maximum longitudinal length	16.0	14.6	18.0	22.7	12.0	16.0	23.2

Astragalus. This is represented by two paratypes (GK. M1085, M1126; Pl. 11). In anterior view, the bone shows quadrate and both lateral margins are nearly straight; the tibial facet in the median part is very broad and deep, but near the distal part it becomes shallow. Tibial facet has highly rised borders, of which the outer border is more raised than the inner. The outer lateral surface is much depressed and its anterior margin is concave posteriorly. The posterior-upper corner is prominently projected posteriorly. The inner lateral margin shows irregular oval shape. In posterior view, the bone is quadrate in outline and little inflated in the median part; both margins are slightly higher than the inner.

Measurements in mm:

	GK.M1085	GK.M1126
Maximum length	56.0	52.0
Transverse width at proximal end	35.6	33.0
Fore-and-aft diameter at middle	29.3	28.6
Transverse width at distal end	34.0	33.1

Costa. This is represented by fragmental four specimens. *Measurements* follows:

	GK.M 1156	GK.M 1152	GK.M 1153	GK.M 1155
Diameter of rib at middle portion	20.3×5.7	19.1×19.7	—	19.1×8.0
Diameter of tubercle	14.9×23.5	23.7×19.8	18.5×19.4	—
Transverse width between tubercle and head	44.1	—	46.9	—

Patella is represented by a single specimen (GK. M1131). Measurements follows:

Diameter of proximal end .... 40.5×30.5
Maximum length 52.7

Comparisons and observations.—The present species has the closest relation to the Javanese species of *Axis* richly occurred from the middle Pleistocene deposits in Java, which were reported by R. KOENIGSWALD (1933) under the name of *C.* (*Axis*) *axis javanicus* KOENIGSWALD and *C.* (*A.*) *lydekkeri* MARTIN. The antler of the present species shows the close resemblance to *C.* (*A.*) *axis javanicus* in the following specific characters, which are common to each other.

1) the long beam above the first bifurcation which is very lyrated backward.
2) the long first tine, of which bifurcation makes a very large angle with the beam.
3) characteristic accessory prong on the first tine.

But the present species is clearly distinguished from *C.* (*A.*) *axis javanicus* by the large dimentions of the antler, the higher position of the first tine, the more obtuse angle between the first tine and the beam and by the less expanded antler. For the comparison between them, the accessory prong of the antler is very important. As mentioned above, the accessory prong of the present species is always recognized on the inner surface of the beam just above the first bifurcation, while in *C.* (*A.*) *axis javanicus* the position is not always settled. According to KOENIGSWALD (1933), the species *javanicus* is divisible into following four types based on the number and position of the accessory prong: 1) prong settled on the beam just above the first bifurcation, 2) prong settled between the first tine and the beam, 3) prong settled on the first tine near the first bifurcation, 4) prong showing the variable position-mixture of the preceding three types. All the specimens of the present species correspond to the first type of *javanicus*, with the exception of a weak prong recognized on the surface of the first tine of the specimen GK. M1099. In general, the immature specimens of the present species are somewhat different from the adult ones in having rather lower position of the first bifurcation and somewhat narrower angle between the first tine and the beam. It is noticeable that the immature characters of the present species are found in the adult stege of *C.* (*A.*) *axis javanicus*.

C. (*A.*) *lydekkeri* MARTIN (KOENIGSWALD, 1933), from the middle Pleistocene deposits of Pitoe and Trinil, Java also has the same kind of antler as the present species, that is, the antler with a long beam which is much lyrated backward and sometimes has an accessory prong. But the present species is distinguishable from the *C.* (*A.*) *lydekkeri* by several respects as seen in the comparison with *javanicus*.

C. (*A.*) *punjabiensis* BROWN from the middle Pleistocene of the upper Siwalik (immediately below the conglomerate), which was originally described by B. BROWN (1926) based upon an antler with skull, also resembles but is distinguishable from the present species in having low position of the first bifurcation and short beam between the first and the second bifurcation and in the direction of the antler and the absence of any peculiar prong on the first bifurcation.

A living species of *C.* (*Axis*) *axis*, called the Chital or spotted deer, has the same kind of antler as that of the present species; that is to say, the former commonly has a long beam, long first tine, obtuse angle between the first tine and the beam and irregular snag which is frequently developed near the base of the first tine. But *C.* (*A.*) *axis* is clearly distinguished from the present species by its distinctly low position of the first tine, short beam between the first and the second tine, the direction of the antlers and somewhat narrow angles of the first bifurcation. But the antlers of the immature specimens of the present species somewhat resemble those of adults of *C.* (*A.*) *axis*, if the absence of the second bifurcation is ignored.

The present species considerably differ from *C.* (*A.*) *shansius* TEILHARD & PIVETEAU, from the Villafranchian deposits of southeastern Shansi, China (TEILHARD & PIVETEAU, 1937), by the less lyrated beam with smooth surface, much expanded antlers, the absence of the accessory prong above the first bifurcation in the latter. But the immature form of the present species somewhat resembles "the small sized specimen" of *C.* (*A.*) *shansius*[1] in the general characters.

So far as the antler is concerned, the present species seems to be somewhat similar to the type- and allied species of subgenus *Rucervus*, which are now living in the large area of the main land of southeastern Asia. That is to say, in *Rucervus* antlers are commonly flattened or rounded, the first tine forms a wide angle (over an angle of about 90 degrees) with the beam, the beam above the first bifurcation is much lyrated backward; some small snags are sometimes recognized on the first tine or on the beam. Among the species referred to *Rucervus*, *C.* (*Rucervus*) *eldi thamin* THOMAS is most similar to the present species in general form and size, especially in having the small snags usually developed at the junction of the first tine with the beam. But the present species is apparently discriminated from the former by its higher position of the first bifurcation, the forked beam at the distal part and the characteristic accessory prong on the beam above the first bifurcation.

Recently, SHIKAMA and HASEGAWA (1956) have reported a doubtful example of the fossil *Rucervus* under the name of *C.* (*Rucervus*) *katokiyomasai*, from the bottom of the Ariake bay, adjacent to the distribution area of the Kuchinotsu group. This deer closely resembles the present species in having the long and curved first tine, the lyrated beam and the wide angle between the first tine and the beam. But the present species distinctly differs from the former in the lower position of the first bifurcation and absence of any peculiar prong.

The present species has more archaic characters than the Javanese and the recent species of *Axis*, as recognized in the more simplified characters of the antler mainly concerning the accessory prong and the bifurcation of the beam. Probably both the Japanese and the Javanese species of *Axis* may be derived from the common ancestral form of Cervidae of the Asiatic Continent in the early Pleistocene age. It seems to the writer that the simpler characters of the antler of the present species strongly suggest that the Javanese species of *Axis* may be the ancestral form of the Javanese.

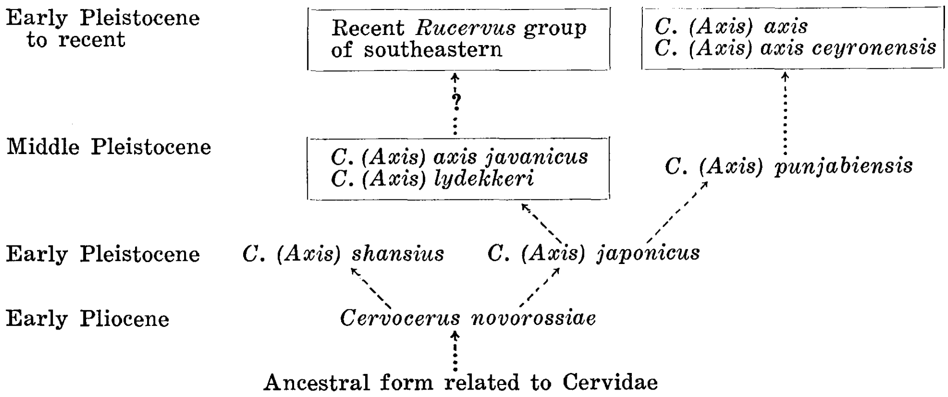
As a general tendency, the decrease in height of the first bifurcation seems to be accompanied with the evolution of antler in the *Axis* group, excepting the case of *C.* (*A.*) *punjabiensis*; that is, in *C.* (*A.*) *axis javanicus* and *C.* (*A.*) *axis* the bifurcation is recognized at the position lower than that of *C.* (*A.*) *shansius*

1): TEILAHRD & TRASSAERT (1937) described two types of *C.*(*A.*) *shansius*, that is, "large size" and "small size", from the Yushê basin, China.

and *C.* (*A.*) *japonicus*. As already mentioned, the height of the first bifurcation in *C.* (*A.*) *japonicus* changes from low to high positions through its growth stages. The lower position of the first bifurcation as seen in the immature stage of *japonicus* seems to be recognized in the adult stage of *javanicus* and the species of the recent *Axis* group. But it is still questionable to the writer these relations between them imply the true neoteny or not.

As far as the bifurcation of antler is concerned, the present species is most closely related to *C.* (*A.*) *shansius* in having higher position of the first bifurcation than in any other species of *Axis*, aside from the existence of a accessory prong. Therefore the writer thinks that those two species may be derived from a common ancestral form. But on the other hand, the Chinese and Javanese species of *Axis* are not so closely related with each other. The writer believes that the most reasonable ancestral form of the subgenus *Axis* is the archetypal cervid such as *Cervocerus* from the early Pliocene deposits of China.

Accordingly the writer tabulates the following tentative relationships between the species concerned.



Genus *Cervus* LINNAEUS, 1758

Subgenus *Deperetia* SHIKAMA, 1936

Type-species.—*Cervus* (*Deperetia*) *praenipponicus* SHIKAMA, 1936

Remarks.—The subgenus *Deperetia* was established by SHIKAMA (1936) based on *Cervus praenipponicus* SHIKAMA from the early Pleistocene Akashi group of Japan. Most of the species referred to this subgenus were originally described by SHIKAMA from the Pleistocene deposits of Japan but the rest of them has been known from Taiwan and the mainland of China.

The subgenus *Deperetia* is closely similar to the subgenus *Rusa* (Samber deer) so far as the antler is concerned, but is readily distinguished by the shorter and smaller first tine and the higher position of the first bifurcation.

Of the species referred to *Deperetia*, the following six species have been described from the Pleistocene of Japan. The occurrences are as follows.

C. (*D.*) *praenipponicus* SHIKAMA: 1. Akiyoshi brown clay bed (late Pleistocene); 2. Hayashizaki clay bed of the Akashi group (early Pleistocene); 3. Shimosueyoshi bed (middle Pleistocene); 4. Byôbugaura bed of the Naganuma bed (middle Pleistocene); 5. Lower and upper Kuzuu formation (lower and upper Pleistocene)

C. (*D.*) *naorai* SHIKAMA: Huzie bed of the Harima group of Dr. SHIKAMA (lower Pleistocene)

C. (*D.*) *urbans* SHIKAMA: Carnivora bed of the upper Kuzuu formation (upper Pleistocene)

C. (*D.*) *kazusensis* MATSUMOTO: 1. Upper part of the Umegase formation (lower Pleistocene); 2. Sanuki formation (middle Pleistocene)

The species described from Taiwan is *C.* (*D.*) *kokubuni* SHIKAMA (1937), which is based on a doubtful example from the early Pleistocene deposits near Tainan (upper part of the Kityô bed).

In the continental area of China a very interesting deer has been reported by TEILHARD and TRASSAERT (1937) from the Plio-Pleistocene of southeastern Shansi under the name of *Rusa* cf. *elegans* TEILHARD & PIVETEAU. But SHIKAMA (1941) revised its systematic position to *Deperetia* based on some characters of the antler and named *C.* (*Deperetia*) *trassaerti* SHIKAMA.

It is noticeable that the present new species of *Deperetia* which occurred in the westernmost part of the Japanese Islands is closely related to the species from Shansi.

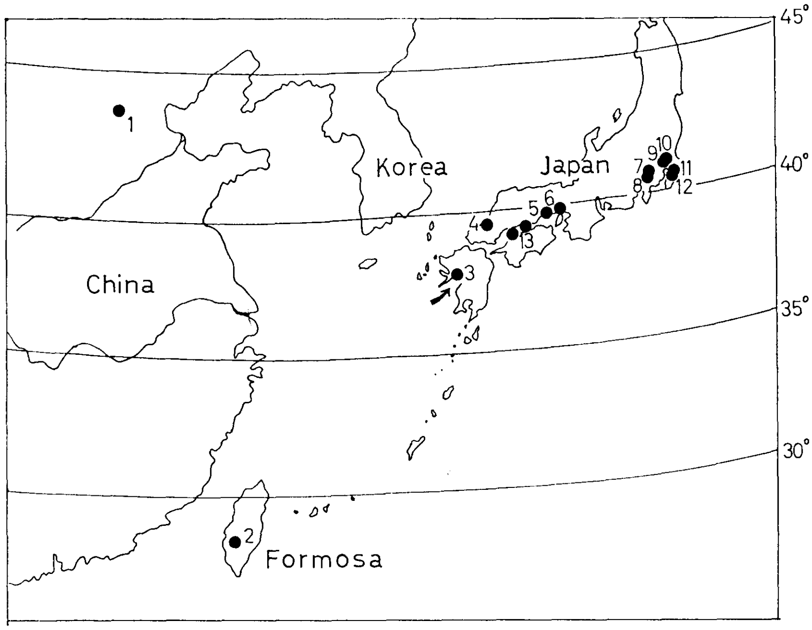


Fig. 11. Map showing the distribution of subgenus *Deperetia*.
1. *C. (D.) trassaerti*; 2. *C. (D.) kokubuni*; 3. *C. (D.) shimabarensis*; 4, 6–8, 10. *C. (D.) praenipponicus*; 11, 12. *C. (D.) kazusensis*; 5. *C. (D.) naorai*; 9. *C. (D.) urbans*.

This may suggest the existence of the paleogeographical connection between Japan and the Chinese continent at that time.

Cervus (*Deperetia*) *shimabarensis* sp. nov.

Pl. 8, Fig. 3; Pl. 9, Fig. 1; Text-figs. 12 and 13.

Material.—Holotype: GK. M1118 (Pl. 9, Fig. 1; Text-fig. 12), a frontal bone with a right antler from loc. KS3920, Tsubami of Kazusa-machi, Minamitakaki-gun, Nagasaki Prefecture, northwest Kyushu. Paratype: GK. M1173 (Pl. 8, Fig. 3; Text-fig. 13), a right lower jaw from the type-locality.

Specific diagnosis.—The antler is moderately large, stout and rugose. The pedicle on the skull is rather short, extended widely outward (with an angle of about 70 degrees or more) in the basal part, and then projected upward above the first bifurcation. The first tine is long, stout and bifurcated at a point far above the burr. It is projected outward from the beam, making an acute angle with the beam. The second tine is longer than the third and is projected upward and little outward making an acute angle with the third tine. The surface of the antler is ornamented with remarkable tubercles and grooves.

Description of the type specimens.—Holotype: GK. M1118 (Pl. 9, Fig. 1; Text-fig. 12). The antler is moderately large and stout. The pedicle on the skull is relatively short (about 25 mm in length) and both antlers branched outward making an angle of about 70 degrees with each other, if restored. The burr is rather thin, rugose and circular in section. The basal part of the beam extends straight from the pedicles. The beam above the first bifurcation is considerably long and projected straightly upward, resulting in a nearly parallel appearance of the antlers. The beam and the tine are ornamented on the surface with remarkable longitudinal, wide and deep grooves and tubercles, both of which are most remarkable on the beam above the first bifurcation. The first tine, which is bifurcated at a rather high position (about 90 mm) above the burr, is long, stout, moderately rugose, and streched strongly outward from the beam making an acute angle of about 53 degrees with the beam. The second tine is moderately stout, longer than the third tine, and extended outward making an acute angle of about 53 degrees with the third tine. The apical part of the beam somewhat inclines forward.

Measurements in mm or degrees:

Length of the pedicle	26.2
Circumference of the burr	172.0
Maximum diameter of the pedicle	37.0
Maximum diameter of the burr	47.1
Maximum thickness of the burr	7.5
Maximum diameter of the beam just above the burr	32.8
Height of the first bifurcation	90.0
Length of the first tine along outer border	305.0
Length of the first tine in a straight line	274.5
Maximum diameter of the first tine above the first bifurcation	33.4
Distance between the first and second bifurcation along the outer border	305.5

Fig. 12. Restored figure of antlers of *Cervus (Deperetia) shimabarensis* sp. nov., viewed from in front.

Maximum diameter of the beam between the first tine and the second tine	361.5
Maximum diameter of the second tine	27.8
Length of the third tine in straight line	125.0
Maximum diameter of the third tine	24.5
Total length from the burr to tip of antler	635 (±)
Angle of the first bifurcation	53 (±)
Angle of the second bifurcation	53 (±)

Lower jaw. The lower jaw is represented by a right specimen, paratype (GK. M1173). It is relatively well preserved, but for the missing region of mandibular angle. The jaw is moderately large but slender. The symphysis is rather stout and short. Acending ramus is much lyrated backward. The horizontal ramus is moderately thick but not so curved upward. It is much compressed laterally and broken at the posterior inner ramus probably due to the sedimentation.

The teeth row (P2-M3) is moderately long for cervids. The enamel wall of the crown is moderately thick and rugose. The accessory column exists in the anterior-outer wall of M2 and the anterior outer lobe of M3.

P2 is extremely worn and hence the enamel wall is barely remained. It is large, subrectangular and provided with indistinct folding. The inner margin is almost straight and the inner surface is rather smooth, while the outer wall is moderately inflated. The valley is shallow and indistinct.

M2 is much longer than M1. The accessory column of the outer wall is broad and long. The anterior-inner wall is more undulated than the posterior-inner wall. Both the meta- and the parastyles are rather distinct. The inner crescent is higher and narrower than the outer one. The valley is distinct. DM3 is also large but not fullgrown. A small accessory column exists on the outer wall of the first lobe. The inner wall is more undulated on the costa than on the median lobe and has the fairly developed meta- and parastyles.

Measurements in mm:

(Jaw)

Preserved length of the ramus	250.4
Distance between anterior end and the tip of coronoid process	311.0
Depth of the ramus at the posterior of P2 on inner side	34.1
Depth of the ramus at the posterior of P3 on outer side	37.1
Depth of the ramus at the posterior of P4 on outer side	43.8
Depth of the ramus at the posterior of M1 on outer side	46.4
Depth of the ramus at the posterior of M2 on outer side	51.4
Depth of the ramus at the posterior of M3 on outer side	53.7
Mandibular index	0.37
Maximum thickness of the ramus below P2	12.7

(Teeth)

	PM2	PM3	PM4	M1	M2	M3
Width	—	—	11.7	13.8	13.7	13.2
length	—	—	25.5	24.8	33.0	35.9

Comparisons.—The described species is more closely related to the species of *Deperetia* than those of subgenus *Rusa* and *Axis* in having rather high position of the first bifurcation, an acute angle between the first tine and the beam and an adaptative antlers. It resembles *C.* (*D.*) *praenipponicus* SKIKAMA (1936), the type-species of *Deperetia,* but differ in its longer and more stout first tine, tuberculated surface of the beam and the direction of the antlers.

The present species is closely related to *C.* (*D.*) *trassaerti* SHIKAMA (=*Rusa* cf. *elegans* TEILHARD and PIVETEAU) from the Plio-Pleistocene formation of the zone II (TEILHARD & TRASSAERT, 1937) of the Yushê series, southeastern Shansi, China in that the antlers of the both species are characterized by the long beam between the first and the second bifurcation, and long first tine which is bifurcated at a high position above the burr, making an acute angle between it and the beam. However *C.* (*D.*) *trassaerti* is distinguishable from the present species by a little lower position of the first tine above the burr, more weakly tuberculate surface

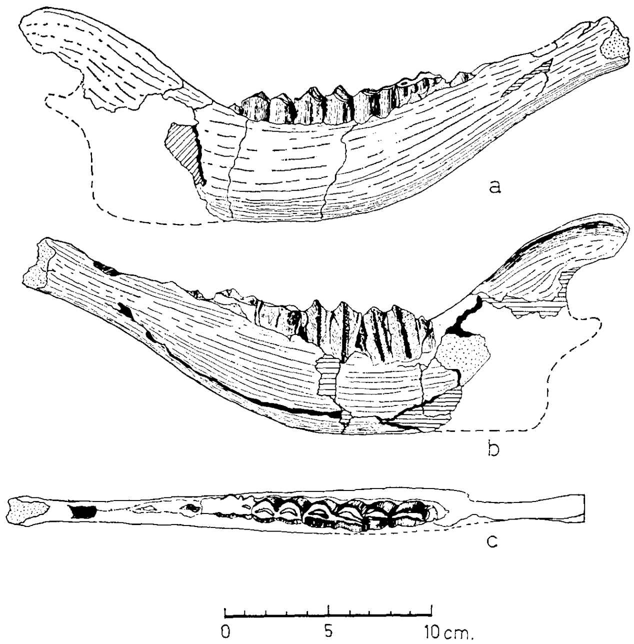


Fig. 13. Lower jaw of *Cervus (Deperetia) shimabarensis* sp. nov. Outer (a), inner (b) and upper (c) views.

of the beam, and the different direction of the both antlers.

C. (*D.*) *urbans* SHIKAMA from the upper Kuzuu formation (middle Pleistocene) of the Kwanto region, Japan is distinguishable from the present species by its higher position of the first bifurcation. *C.* (*D.*) *naorai* SHIKAMA, from the Villafranchian (?) deposits of Huzie near Akashi, and *C.* (*D.*) *kazusensis* MATSUMOTO, from the Villafranchian to the middle Pleistocene deposits of Chiba Prefecture, also differ from the present species in their larger angle between the beam and the first tine and the smooth surface of the beam.

The present species somewhat resembles the type-species of *Rusa*, in its long and stout first tine, tuberculated surface of the beam, and the long beam above the first bifurcation. But the present species cannot be referred to *Rusa* for its higher position of the first tine on the burr. Moreover, it is not referable to *Axis*, which is characterizing by the greater obtuse angle between the beam and the first tine.

C. (*Rusa*) *kyushuensis* OTSUKA (OTSUKA, 1966), from the present locality, somewhat resembles the present species, but differs in its higher position of the first bifurcation, more rugose and straight beam and more outward expanding of the first tine.

The ramus of the present species distinctly differs from *C.* (*D.*) *praenipponicus* SHIKAMA, *C.* (*Sika*) *nippon* TEMMINCK and *C.* (*S.*) *yesoensis* HEUDE in its much curved ventral border of the horizontal ramus and more developed outer or inner folds in molar teeth. The teeth of the present species are also distinguishable from that of *C.* (*D.*) *praenipponicus* by lacking of accessory columns in the second and the third lobes of M3.

Summary of Results

In this paper two new species of *Cervus* are described in detail. One is referred to the subgenus *Axis* and the other to *Deperetia*. The description of *C.* (*Axis*) *japonicus* OTSUKA, sp. nov., is based on about 100 specimens, including various skeletons and antlers, while *C.* (*Deperetia*) *shimabarensis* OTSUKA, sp. nov., is established on a specimen of right antler attached to a frontal bone and another one of lower jaw.

A living species of *Axis* is distributed mainly in the Indian subcontinent and the island of Ceylon, while fossil species of the same subgenus are known to occur in the Villafranchian of Shansi, China, and the middle Pleistocene of Java and India. The occurrence of *C.* (*Axis*) from the Kuchinotsu group is the first discovery of this subgenus in the Japanese Islands. Most species of *Deperetia* have been recorded from the early to middle Pleistocene of Japan, but some species have been known from the Plio-Pleistocene of Taiwan and the Chinese continent. As a result of the present study, it has become clear that the species of *Axis* and *Deperetia* from this group are closely related to those from Java and China, respectively. This is very interesting not only to induce the migration of these deers between the northwestern and the southern parts of Asia during early to middle Pleistocene age but also to consider the paleogeographical relation between the Japanese Islands and the Chinese continent at that time.

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Hiroyuki OTSUKA

Pleistocene Vertebrate Fauna from the Kuchinotsu Group of West Kyushu

Part II

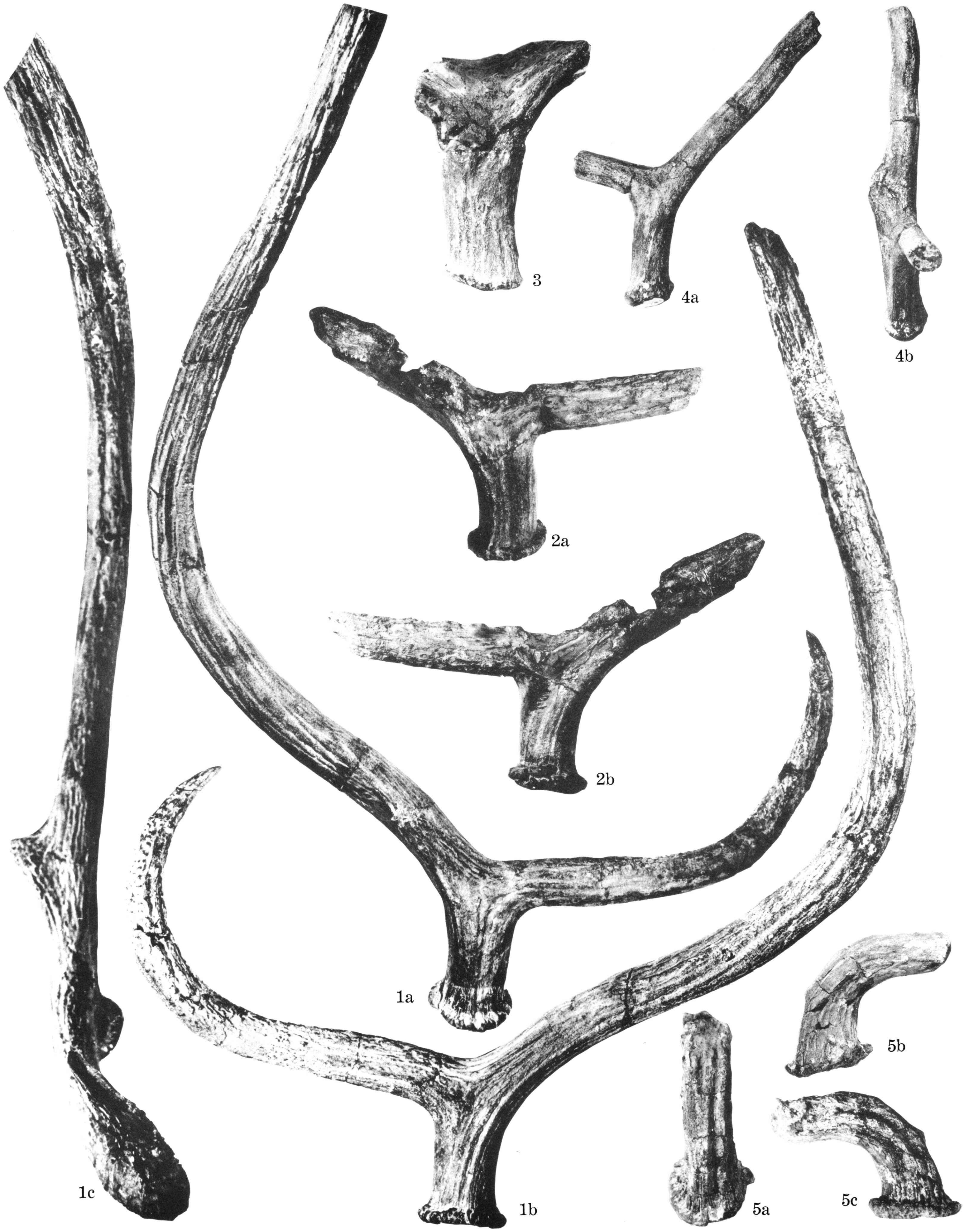
Plates 3～14

Plate 3

Explanation of Plate 3

Figs. 1–5. *Cervus* (*Axis*) *japonicus* sp. nov. ....Page 277–304

1. GK. M1000, a left antler of holotype. Lateral (a), inner (b) and frontal (c) views, ×0.3.
2. GK. M1119, a left antler of paratype. Inner (a) and lateral (b) views, ×0.3.
3. GK. M1095, a left antler of paratype. Outer view, ×0.3.
4. GK. M1005, a left antler of paratype. Lateral (a) and frontal (b) views, ×0.3. Immature specimen.
5. GK. M1097, an abnormal specimen of left (?) antler of paratype. Two laterals (b, c) and frontal views, ×0.3.



H. OTSUKA: Pleistocene vertebrate fauna

Plate 4

Explanation of Plate 4

Figs. 1–4. *Cervus* (*Axis*) *japonicus* sp. nov. .... Page 277–304

1. GK. M1002, a left antler of paratype. Upper view, ×0.3.
2. GK. M1099, a right antler of paratype. Upper (a), inner (b) and lateral (c) views, ×0.3.
3. GK. M1117, a fragmental right antler. Lateral view, ×0.3.
4. GK. M1015, a fragmental right (?) antler of paratype. Inner (a), outer (b) and frontal (c) views, ×0.3.


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

Plate 5

Explanation of Plate 5

Figs. 1–4. *Cervus* (*Axis*) *japonicus* sp. nov. ....Page 277–304

1. GK. M1001, a right antler of paratype. Upper (a), inner (b) and lateral (c) views, ×0.3.
2. GK. M1002, a left antler of paratype. Inner (a) and outer (b) views, ×0.3.
3. GK. M1003, a right antler of paratype. Outer (a) and upper (b) views, ×0.3.
4. GK. M1120, a right antler of paratype. Upper (a) and outer (b) views, ×0.3. Immature specimen.

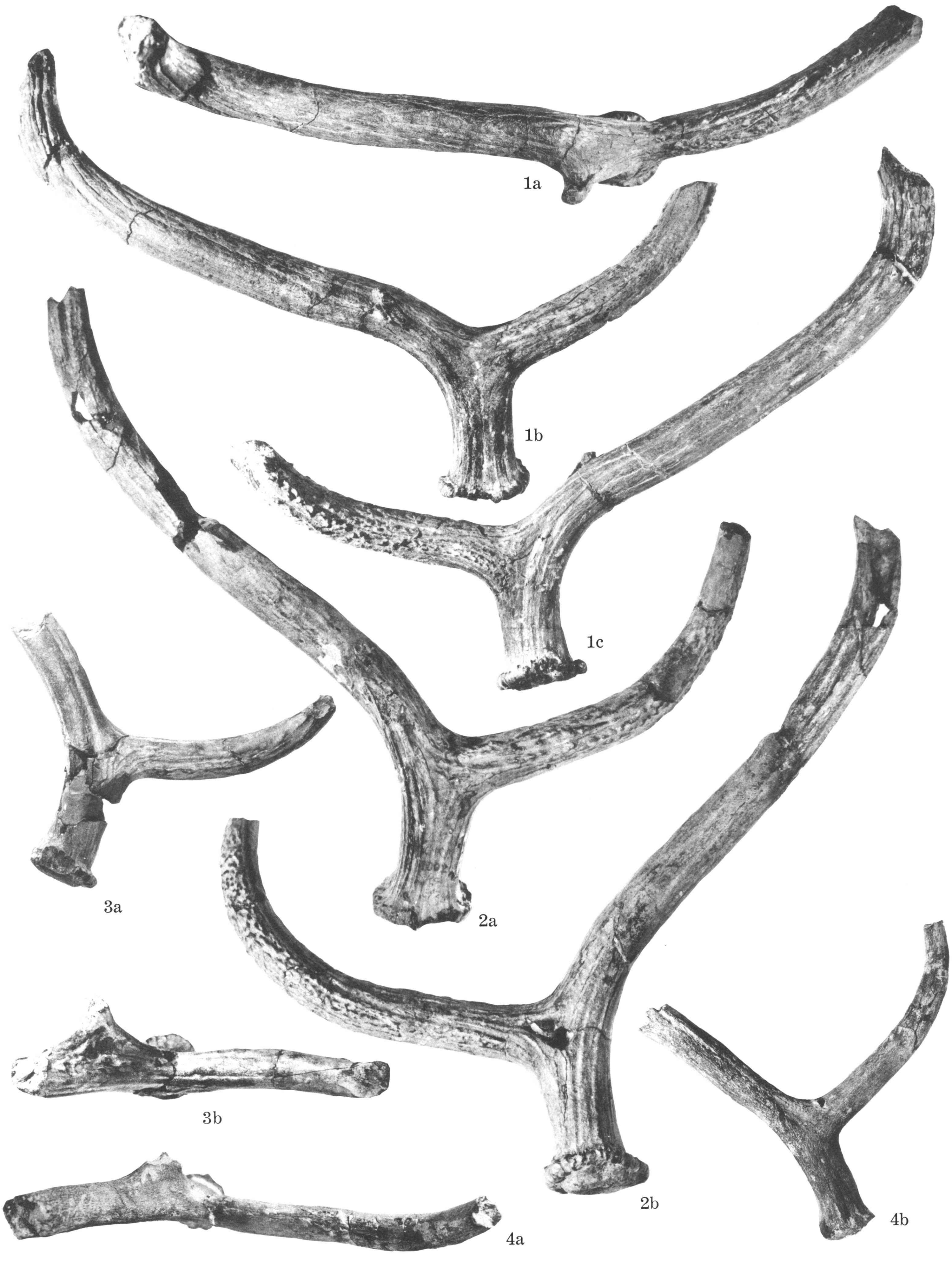

1a
1b
1c
2a
2b
3a
3b
4a
4b

Plate 6

Explanation of Plate 6

Figs. 1–7. *Cervus* (*Axis*) *japonicus* sp. nov. ....Page 277–304

1. GK.M1016, a fragmental antler. Lateral view, ×0.3.
2. GK. M1131, a fragmental antler. Lateral view, ×0.3.
3. GK.M1116, a left antler of paratype. Inner (a), outer (b) and frontal (c) views, ×0.3. Immature specimen.
4. GK. M1101, a left antler of paratype. Lateral view, ×0.3. Immature and abnormal specimen.
5. GK. M1115, a right antler of paratype. Outer (a) and lateral (b) views, ×0.3. Immature specimen.
6. GK. M1009, a fragmental specimen of beam of antler, ×0.3.
7. GK. M1006, a fragmental specimen of beam of antler, ×0.3.

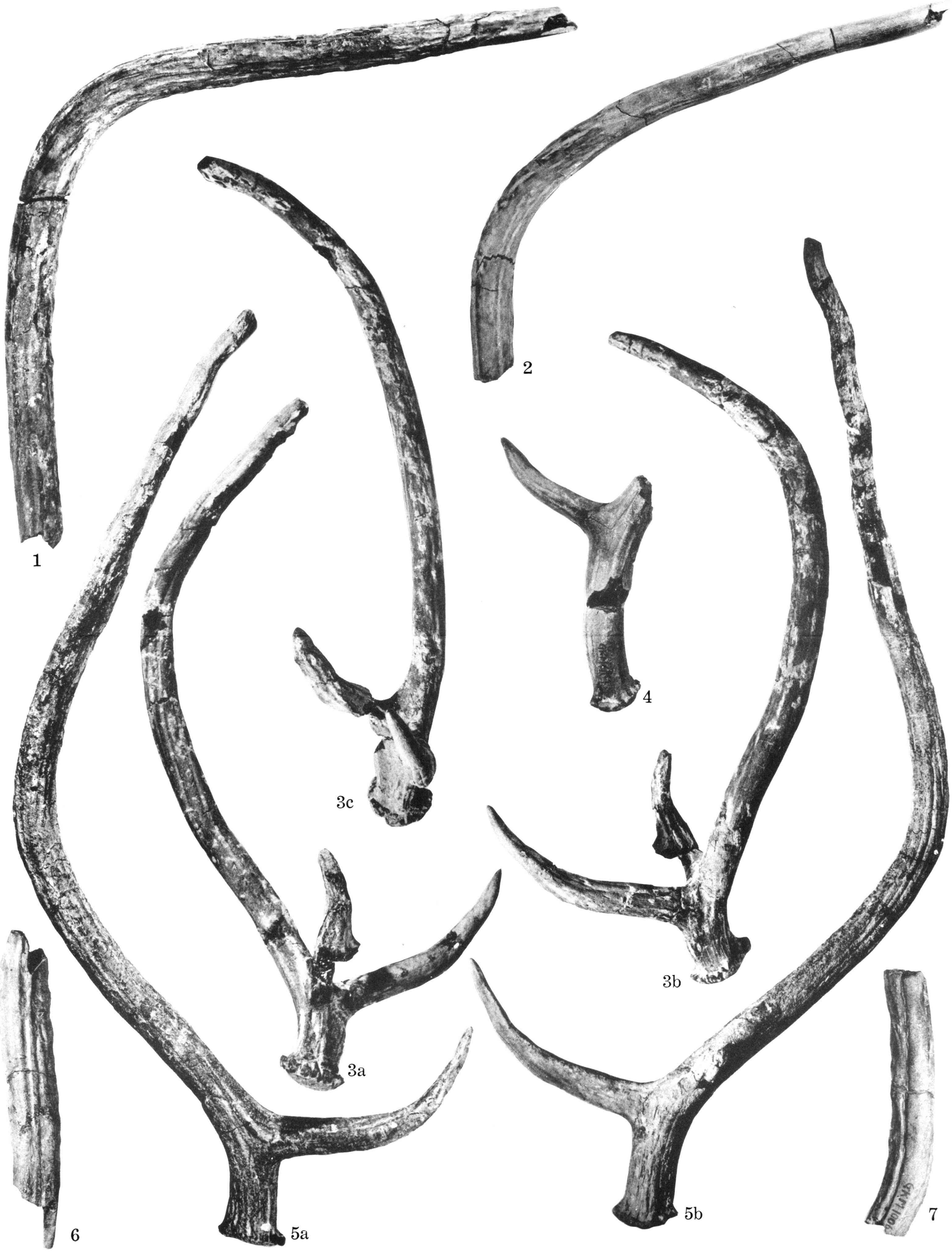

1
2
3c
4
3b
3a
5b
5a
6
7

Plate 7

Explanation of Plate 7

Figs. 1–2. *Cervus* (*Axis*) *japonicus* sp. nov. ....Page 277–304

1. GK. M1054, a left lower jaw of paratype. Upper (a), outer (b) and inner (c) views, ×0.3.
2. GK. M1112, a left lower jaw of paratype. Outer (a), inner (b) and upper (c) views, ×0.3.

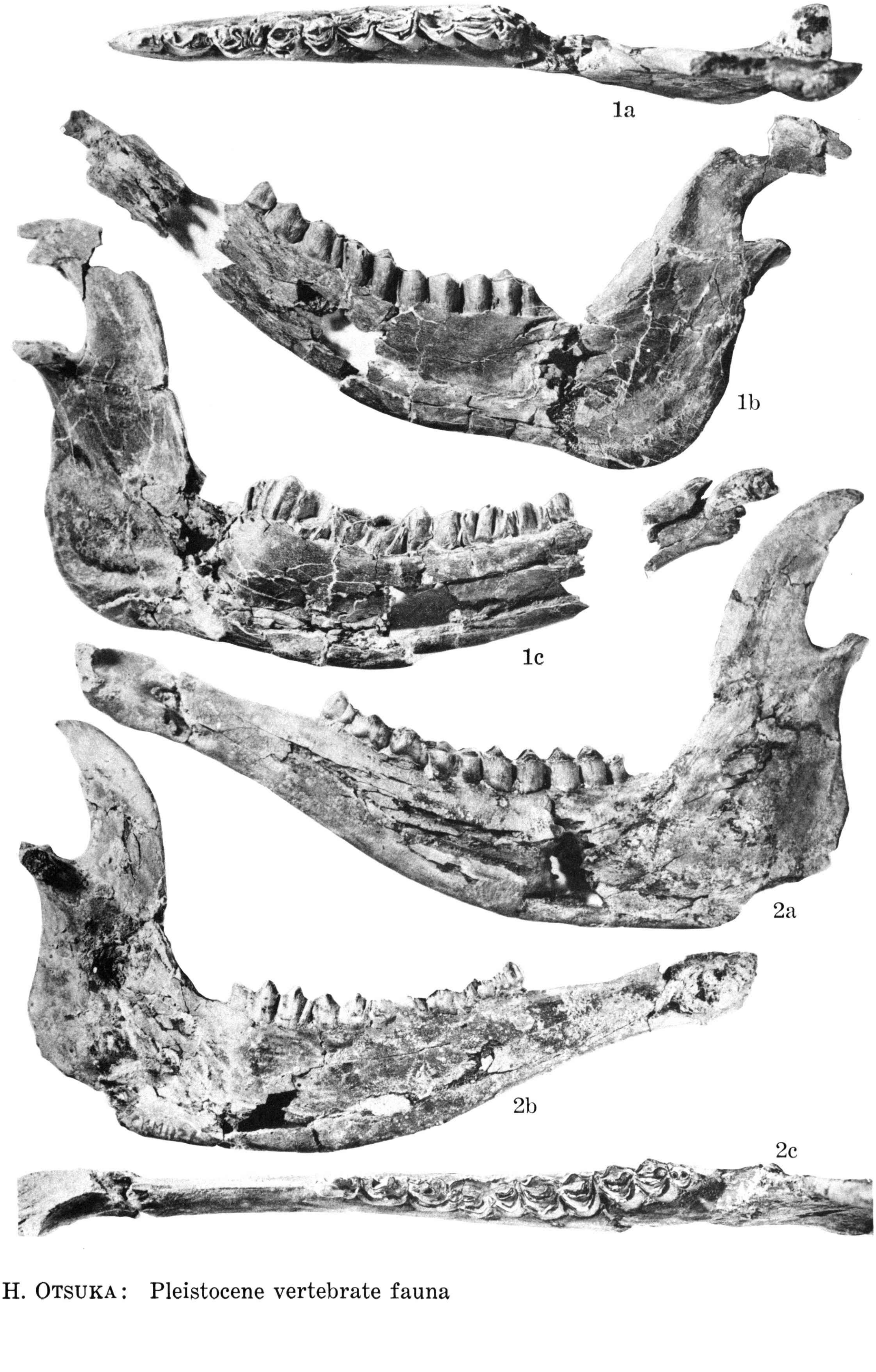

1a
1b
1c
2a
2b
2c

Plate 8

Explanation of Plate 8

Figs. 1–2. *Cervus* (*Axis*) *japonicus* sp. nov. ....Page 277–304

1. GK. M1062, a right lower jaw of paratype. Upper (a), inner (b) and outer (c) views, ×0.3.
2. GK. M1063, a left lower jaw of paratype. Outer view, ×0.3. Deformed specimen.

Fig. 3. *Cervus* (*Deperetia*) *shimabarensis* sp. nov. ....Page 305–310

3. GK. M1173, a right lower jaw of paratype. Outer (a), inner (b) and upper (c) views, ×0.3.

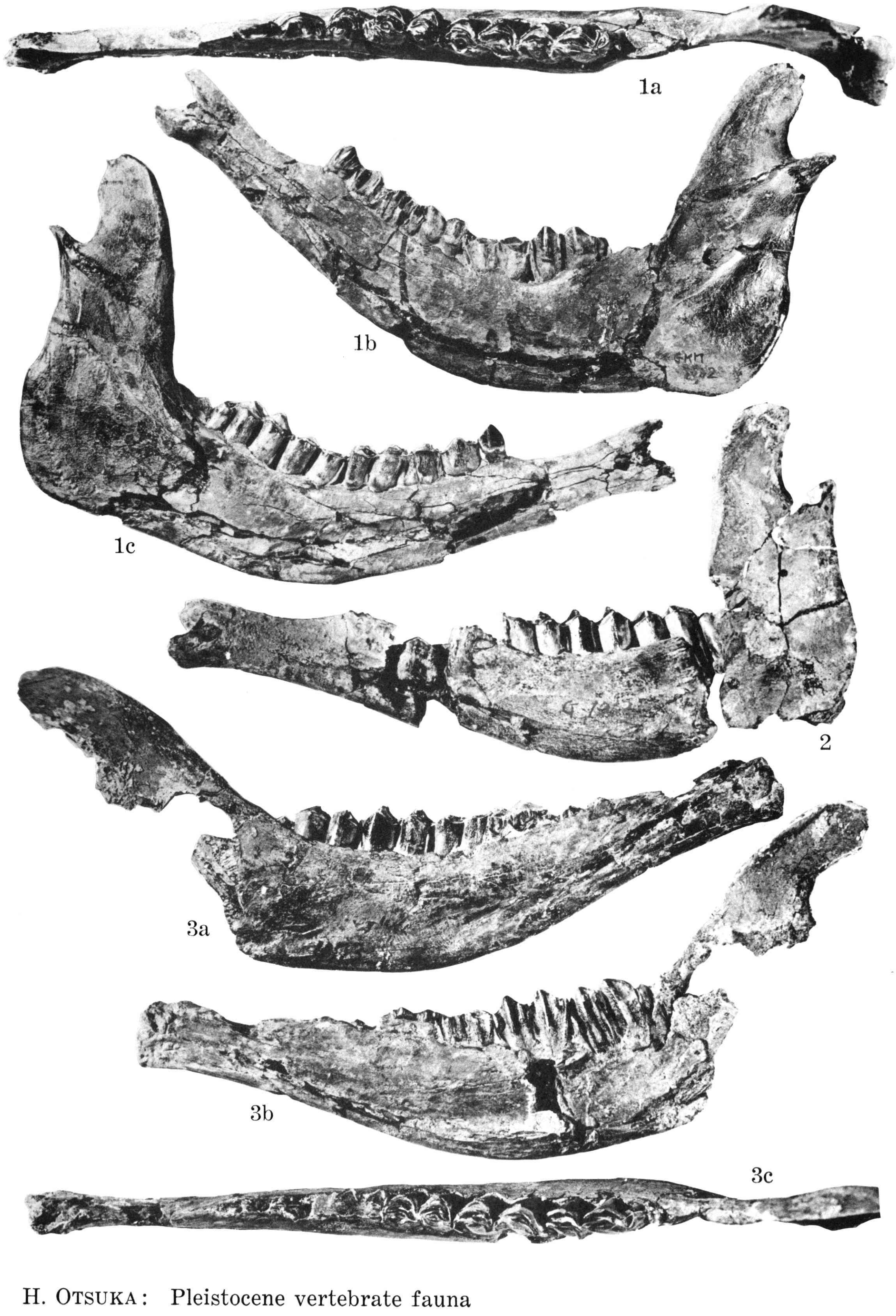

1a
1b
1c
2
3a
3b
3c

Plate 9

Explanation of Plate 9

Fig. 1. *Cervus* (*Deperetia*) *shimabarensis* sp. nov. ....Page 305–310

1. GK. M1118, a frontal bone with right antler of holotype. Lateral (a) and frontal (b) views, ×0.3.

1a

1b

Plate 10

Explanation of Plate 10

Figs. 1–20. The upper teeth and posterior limb bones of *Cervus* (*Axis*) *japonicus* sp. nov. .... Page 277–304

1. GK. M1190, an upper left M1. Upper (a), inner (b), outer (c), posterior (d) and anterior (e) views, ×0.5.
2. GK. M1127, an upper left M3. Upper (a), inner (b), outer (c) and anterior (d) views, ×0.5.
3. GK. M1094, an upper right M2. Upper (a), inner (b), outer (c) and anterior (d) views, ×0.5.
4. GK. M1093, an upper left M3. Upper (a), inner (b), outer (c) and posterior (d) views, ×0.5.
5. GK. M1091, an upper right M3. Upper (a), inner (b), outer (c), posterior (d) and posterior (e) views, ×0.5.
6. GK. M1092, an upper left M3. Upper (a), inner (b), outer (c) and anterior (d) views, ×0.5.
7. GK. M1046, a distal pharange. Lateral (a) and posterior (b) views, ×0.3.
8. GK. M1136, a proximal pharange. Lateral (a), posterior (b), and anterior (c) views, ×0.3.
9. GK. M1151, a proximal pharange. Lateral (a), posterior (b) and anterior (c) views, ×0.3.
10. GK. M1094, a proximal pharange. Anterior (a), posterior (b), and lateral (c) views, ×0.3.
11. GK. M1167, a proximal pharange. Anterior (a), posterior (b) and lateral (c) views, ×0.3.
12. GK. M1150, a middle pharange. Lateral (a), posterior (b) and lateral (c) views, ×0.3.
13. GK. M1086, a middle pharange. Lateral (a), posterior (b) and anterior (c) views, ×0.3.
14. GK. M1132, a left cubo-navicular. Upper view, ×0.3.
15. GK. M1133, a left cubo-navicular. Upper view, ×0.3.
16. GK. M1167, a left cuneiform. Upper (a) and anterior (b) views, ×0.3.
17. GK. M1169, a left trapezoid. Upper (a) and anterior (b) views, ×0.3.
18. GK. M1170, a left lunar. Ventral (a) and anterior (b) views, ×0.3.
19. GK. M1168, a right scaphoid. Upper (a) and anterior (b) views, ×0.3.
20. GK. M1085–M1087, a right carpus. Upper (a) and anterior (b) views, ×0.3.


1a 1b 1c 1d 1e 2a 2b 2c
2d 3a 3b 3c 3d 4a 4b
4c 4d 5a 5b 5c 5d 5e
6a 6b 6c 6d 6e 7a 7b
8a 8b 8c 9a 9b 9c 10a 10b 10c
11a 11b 11c 12a 12b 12c 13a 13b 13c
14 15 16a 17a 18a 19a
20a 20b 16b 17b 18b 19b

Plate 11

Explanation of Plate 11

Figs. 1–11. Vertebrae and limb bones of *Cervus* (*Axis*) *japonicus* sp. nov. ....Page 277–304

1. GK. M1123, a thoracic vertebra. Anterior (a), lateral (b) and upper (c) views, ×0.3.
2. GK. M1051, a lumber vertebra. Lateral (a) and anterior (b) views, ×0.3.
3. GK. M1157, a lumber vertebra. Lateral (a) and ventral (b) views, ×0.3.
4. GK. M1158, a lumber vertebra. Ventral (a) and lateral (b) views, ×0.3.
5. GK. M1124, a sixth cervical vertebra. Dosal (a), anterior (b), ventral (c) and lateral (d) views, ×0.3.
6. GK. M1044, a right calcaneum. Outer (a), inner (b), posterior (c) and anterior (d) views, ×0.3.
7. GK. M1125, a left calcaneum. Outer (a), inner (b), anterior (c) and posterior (d) views, ×0.3.
8. GK. M1085, a right astragalus. Posterior (a), anterior (b) and inner (c) views, ×0.3.
9. GK. M1126, a right astragalus. Posterior (a), anterior (b) and inner (c) views, ×0.3.
10. GK. M1135, a left ulna. Outer (a) and inner (b) views, ×0.3.
11. GK. M1165, a right ulna. Inner (a) and outer (b) views, ×0.3.

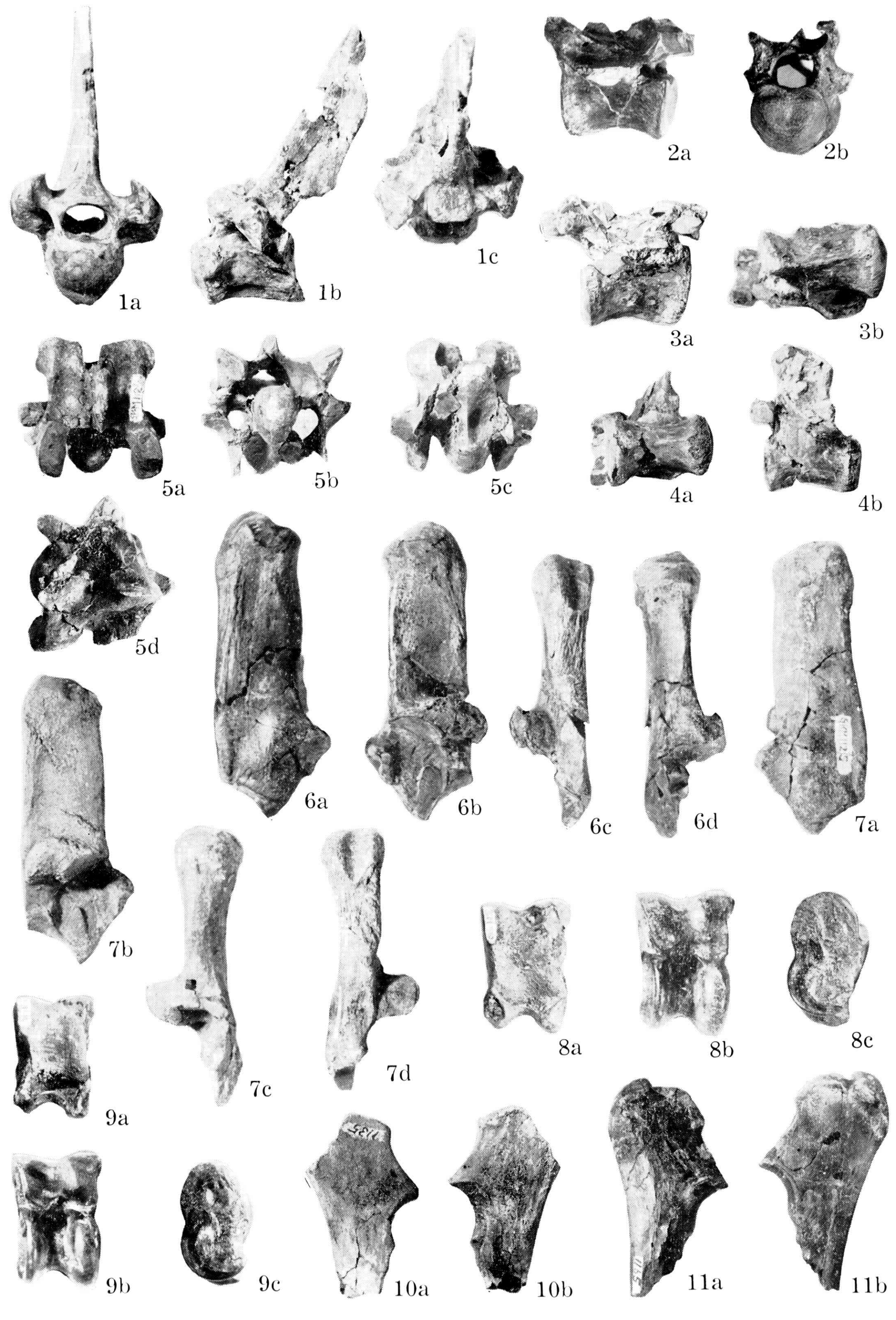

1a
1b
1c
2a
2b
3a
3b
5a
5b
5c
4a
4b
5d
6a
6b
6c
6d
7a
7b
7c
7d
8a
8b
8c
9a
9b
9c
10a
10b
11a
11b

Plate 12

Explanation of Plate 12

Figs. 1–5. Anterior and posterior limb bones of *Cervus* (*Axis*) *japonicus* sp. nov. .... Page 277–304

1. GK. M1057, a right metatarsus of paratype. Two lateral (c, d) and posterior (b) views, ×0.3.
2. GK. M1045, a left metacarpus of paratype. Anterior (a), posterior (b) and lateral (c) views, ×0.3.
3. GK. M1060, a right metacarpus of paratype. Two lateral (a, b), anterior (d) and posterior (c) views, ×0.3.
4. GK. M1078, a right femur of paratype. Anterior (a) and posterior (b) views, ×0.3.
5. GK. M1159, a left femur of paratype. Anterior (a) and posterior (b) views, ×0.3.

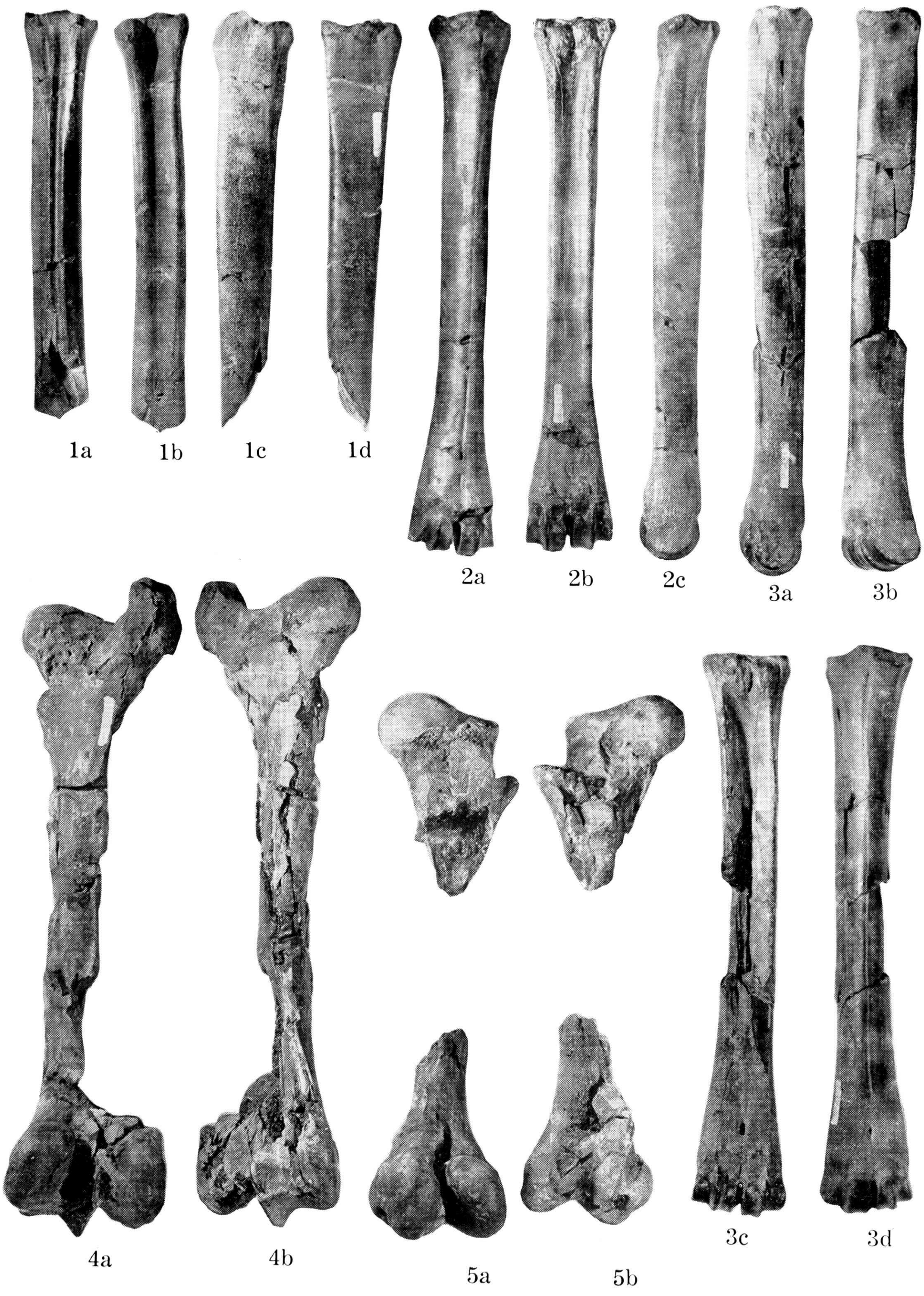

1a
1b
1c
1d
2a
2b
2c
3a
3b
4a
4b
5a
5b
3c
3d

Plate 13

Explanation of Plate 13

Figs. 1–4. Anterior and posterior limb bones of *Cervus* (*Axis*) *japonicus* sp. nov. ....Page 277–304

1. GK. M1059, a left radius of paratype. Anterior (a), posterior (b) and lateral (c) views, ×3.
2. GK. M1130, a right humerus. Two lateral (a, c) and anterior (a) views, ×0.3.
3. GK. M1161, a left tibia. Two lateral (c, d), anterior (a) and posterior (b) views, ×0.3.
4. GK. M1092, a right femur. Posterior (a) and lateral (b) views, ×0.3.


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

Plate 14

Explanation of Plate 14

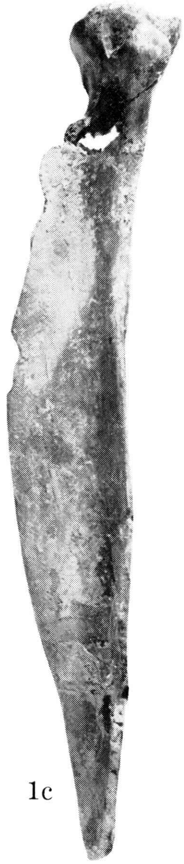
Figs. 1–3. Scapula, cervical vertebrae and sacrum of *Cervus* (*Axis*) *japonicus* sp. nov. ....Page 277–304

1. GK. M1122, a left scapula of paratype. Outer (a), inner (b) and dorsal (c) views, ×0.3.
2. GK. M1176, a fourth cervical vertebra of paratype. Anterior (a), dorsal (b) and lateral (c) views, ×0.3.
3. GK. M1175, a fragmental specimen of sacrum of paratype. Anterior (a) and ventral (b) views, ×0.3.

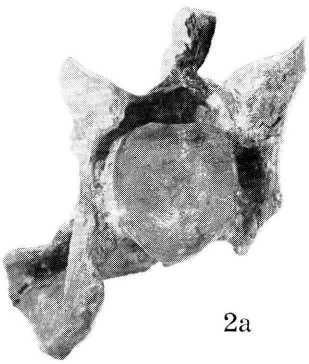
Plate 14

1a

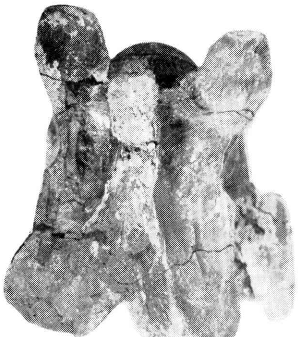
1b



1c



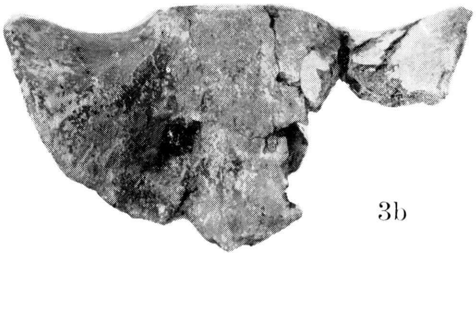
2a



2b

2c

3a



3b