

Quaternary Cave and Fissure Deposits and their Fossils in Akiyosi District, Yamaguti Prefecture

By

Tokio SHIKAMA and Goro OKAFUJI*

I. Preface

Akiyosi limestone plateau in the west-central part of Yamaguti Prefecture is known as indicating the best developed karst topography in Japan. Also the Akiyosi limestone itself is noteworthy as a highly fossiliferous formation of Permo-Carboniferous with complicated structures. On the geology and palaeontology of this limestone, the works of Y. OZAWA, T. KOBAYASHI, T. SUGIYAMA and R. TORIYAMA are most distinguished. Akiyosi-dai, including Zigoku-dai to its north, situated in Syuho and Mito-mati of Mine-gun, is about 7.5 km wide of E-W direction and 9 km wide of N-S, about 300-400 m above sea level, 200-300 m above river floor, and the highest point of it is 425.5 m above sea level. West to the plateau there lie smaller plateaus of Beppu-, Ohuku-, Irimi-, Iwanaga-, Amagoi- and Isa-dai from north to south, and between Akiyosi-dai and these there is a wide valley of Akiyosi-Beppu district where flows the Kôtô river southward.

On the surface of these limestone plateaus, there are many notable places as Karst, we can see abundant dolines, uvaes and sink-holes etc. Stalactite caves are not rare, above 50-60 caves are known, but of them large scaled are the caves of Syuho-dô (Taki-ana), Taisyo-dô, Nakao-dô and Kagekiyo-ana etc. (dô and ana meaning hole). The first of them is most popular and best known as the largest cave in Japan, about 10 km in length, 200 m in maximum width, 70 m in maximum height and from it flows out the river Sôwa, which joins the Kôtô river. At Ryugahuti, which is the widest place of the cave, the subterranean river is about 0.5 m deep and we can see a terraced rocks of several meters above the water level. At some places of the cave, there are found deposits of cave travertine, bat guano and alternation of sand and clay etc. The deepest point has not been explored yet. They say that the subterranean flow named Numa-gawa goes upstreams to Akago area, and from the cave of Hakugyo-dô (white fish hole) to southward it is a subterranean river. It is also said that in flood time leucodermed cave fishes are pushed out-wads from Hakugyo-do. Rimmed pools named Timatida

* Ômine High School, Ômine-mati, Mine City, Yamaguti Prefecture.



Text-fig. 1. Map of Akiyoshi-dai area showing the fossiliferous caves and fissures.

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| 1. Ube-Kōsan's quarry, Isa. | 14. Husen-ana, Akiyoshi. |
| 2. Third quarry of Nippon-Sekkai, Isa. | 15. Maruyamano-ana, Maruyama. |
| 3. Fourth quarry of Nippon-Sekkai, Isa. | 16. Mizusima-kami-ana, Akiyoshi. |
| 4. Fifth quarry of Nippon-Sekkai, Isa. | 17. Mizusimano-ana, Akiyoshi. |
| 5. Tokuyama-Soda's quarry, Yamase. | 18. Awayano-ana, Akiyoshi. |
| 6. Quarry of Onoda-Cement, Sigeyasu. | 19. Coiffait's cave, Ryugamine. |
| 7. Ube-Soda's quarry, Sigeyasu. | 20. Naki-ana, Ono. |
| 8. Koziki-ana, Tyogatubo. | 21. Suzume-ana, Ono. |
| 9. Makurazino-ana, Makurazi. | 22. Nakao-dō. |
| 10. Akabano-ana, Okugawara. | 23. Taisyō-dō. |
| 11. Obaga-ana, Okugawara. | 24. Tanuki-ana. |
| 12. Kagekiyo-ana, Ebara. | 25. Irimino-ana, Irimi. |
| 13. Syuho-dō, Akiyoshi. | |



Text-fig. 2. Karrenfeld of Akiyosi-dai.

(thousand ricefields) and Hyakumaizara (one hundred dishes) are noticeable as cave sinter deposits. After N. NAORA, a left ramus of megacerid with DM_4 , M_1 and M_2 was found from Syuho-dô and now belongs to T. SUZUKI of the Faculty of Agriculture, Tokyo University.

The surface of the karrenfeld of Akiyosi-dai is covered by terra rossa which also overlies the 20 m terrace in the neighbourhood of Akiyosi, accompanying decomposed red clayey deposits. There are twelve quarries of limestone in the neighbourhood of Isa-mati, Mine City, 8.5 km southwest of Akiyosi, namely; Ube-Kôsan Company's quarry, third, fourth and fifth quarries of Nippon-Sekkai Company, quarries belonging to Onoda Cement Company, Ube Soda Company, Sanwa-Sekkai Company, Syowa-Sekkai Company, Tokuyama Soda Company, Umeyama-, Inoue- and Yakusen-Companies. Since 1918, from some fissures of fifth quarry of Nippon-Sekkai fossil bones have been known to occur, and E. TAKAHASHI researched these specimens reserved in many schools in Yamaguti Prefecture, hence in 1949 he and the senior author wrote an article about fossil mammals of Isa. They named the spelean deposits of Kitagawa, Isa, where the fifth quarry lies with fossiliferous deposits, as Isa formation, which is composed of white to light brown travertine, reddish brown porous calcareous clay, grit, gravel of chert pebbles and red clay etc; from the former two sediments, the fossils such as *Cervus (Dépéretia) praenipponicus* SHIK. and *Urusus arctos* L. occurred. In 1949, F. TAKAI and J. WATANABE of Tokyo University made an excavation of cave clay of Kômoriana, lying east of Syuho-dô: this cave is small scaled, 2-3 m wide and on the floor of it is deposited brecciated brown clay of about 1.5 m deep; they could

gain some bones of small sized mammals. In August of 1954, the senior author visited the district of Isa and Akiyosi, and with the junior author, M. KÔNO, I. ETÔ, H. KITAMURA, F. OKAMURA and T. NAKAJIMA explored the Husen-ana cave, from which in 1953 some remains of a large sized animal were found; they could reach the deepest place of a large chamber where they could find fossil bones of megacerid scattered over the floor with fallen limestone boulders. On June 23rd, 1956, moreover, E. TAKAHASHI and the junior author with KÔNO, ETÔ, NAGAO, HIRAOKA, NAKAJIMA and OKAMURA entered this cave, and at the large chamber found a cheek tooth of *Palaeoloxodon amoriensis* and the other remains.

Since 1948, the junior author has been paying his keen attention to fossil bones occurring from fissure deposits of the quarries of Ube-Kôsan, Nippon-Sekkai and others. He could gain tolerable numbers of bones, among which noteworthy may be the human skull, vertebra and jaws of marine fishes. It is very interesting that the fossils of Ube-Kôsan's quarry and that of Husen-ana are well related to each other. In October of 1955 and in January of 1957 he and K. YOSHIMURA could gain much remains of deer from the third quarry of Nippon-Sekkai. From Kozikiana at Tyogatubo, west of Ube-Kôsan's quarry, situating beside a small creek joining to the Asa river, the junior author found abundant remains of fossil *Semisulcospira*; in 1954 the both authors with ETÔ and G. NAITO researched this cave, and then in September of 1955 and in July of 1956, NAITO and the junior author made some excavations of its floor deposits and could gain some remains of *Homo sapiens*, *Sus leucomystax* and fishes with *Meretrix*, *Haliotis* and the other non-marine shells. In June, 1956 the junior author excavated the caves of Tanuki-ana, Suzume-ana, Naki-ana and Obaga-ana (=Okugawarano-ana) of Akiyosi-dai as a member of the systematic survey team of fossiliferous spelean deposits of Akiyosi-dai held by E. TAKAHASHI together with KÔNO, NAITO, ETÔ, NAGAO, SUNAHARA, ANNO and others. They could gain some bones of small sized mammals.

Furthermore, in April and October of 1957 the junior author and Y. HASEGAWA of the Geological Institute of Yokohama National University excavated Koziki-, Makurazi- and Mizusima- caves and could gain exceedingly a great quantity of small bones, shells with some cervid and canid bones. In January of 1958, he found a fossiliferous hard brecciated deposits at the quarry wall of Tokuyama Soda and could gain some micromammals. A continuous survey of many caves has been made by him to this day, and he has reported the occurrence of 68 species of land shells from the caves of Koziki, Makurazi, Irimi, Maruyama, Awaya, Mizusima and Tanuki; these molluscan fauna seem to belong to Holocene.

II. Acknowledgement

Here the authors extend their cordial thanks to Professor E. TAKAHASHI and Assist. Prof. M. KÔNO of Yamaguchi University, Mr. G. NAITO of Ômine High School, Messrs. I. ETÔ, M. FUJIMURA of Akiyosi, Syuho-mati, who ardently collaborated in surveying many caves and donating many valuable materials to the authors for study. Sincere thanks are also due to Messrs. H. MIITO, N. UCHIDA and the other gentlemen of Ube-Kôsan Company, who kindly submitted many specimens to the authors for their researches. Many gentlemen of the quarry of Nippon-Sekki Company, Sigeyasu quarry of Tokuyama Soda Company, Akiyosi-dai Researching Association directed by Prof. M. MATSUYAMA of Yamaguchi University, Akiyosi-dai Cave Researching Members of the Speleological Society of Japan and of the Biological Club of Ômine High School and Dr. T. KURODA of Kyoto University gave the junior author valuable help and advices. Dr. S. ABE of Tôkai Regional Fisheries Research Laboratory gave the senior author valuable suggestion and help in preparing this work. Prof. F. TAKAI of Tokyo University and Mr. H. OZAKI of National Science Museum of Tokyo also gave him invaluable help. Mr. Y. HASEGAWA collaborated them in surveying caves, preparing and photographing specimens. To them the authors express their hearty thanks.

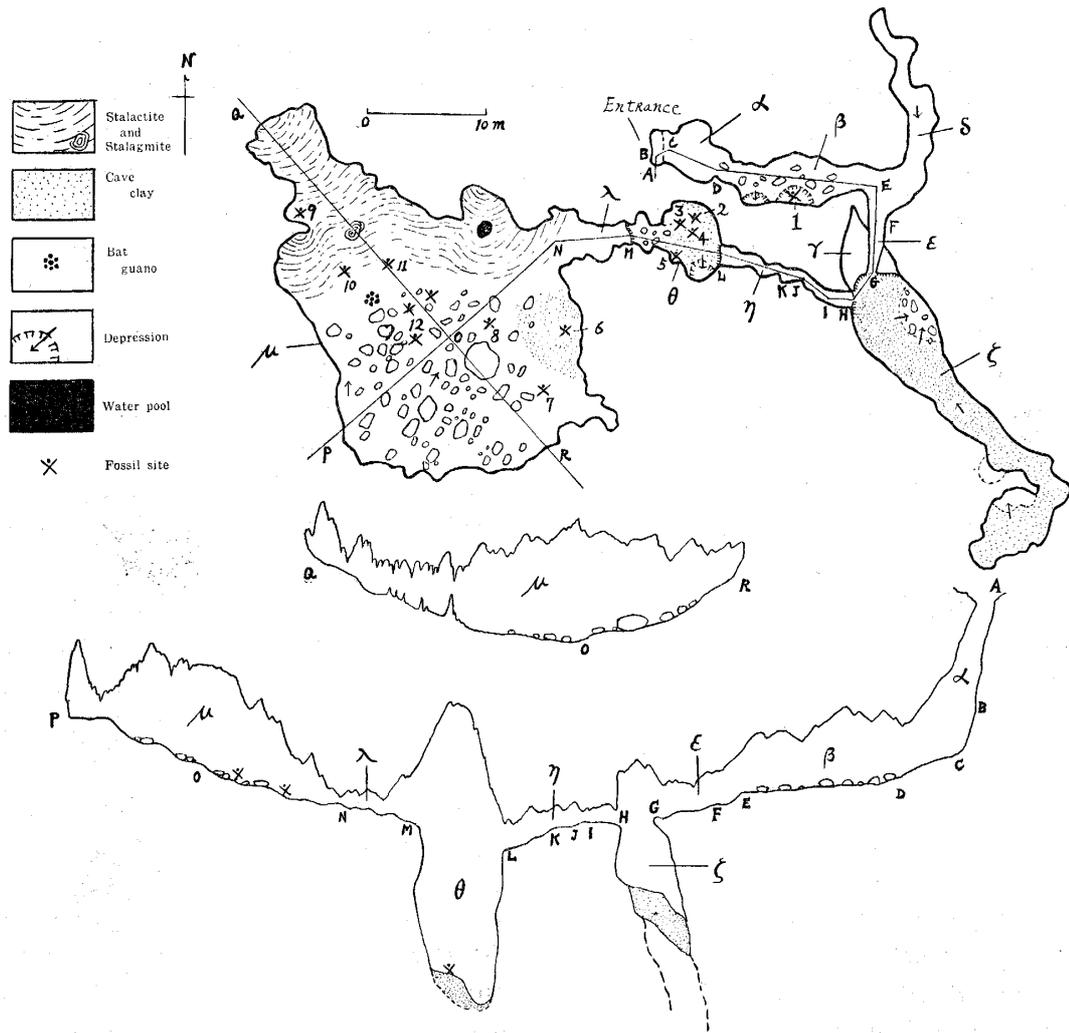
III. Fossiliferous Caves and Fissures

Of eighteen stalactite caves the junior author investigated, twelve caves are fossiliferous, i. e., Husen-, Tanuki-, Maruyama-, Irimi-, Naki-, Suzume-, Obaga-, Koziki-, Akaba-, Mizusima-, Makurazi- and Taisyô- caves; besides these, from Nakao-dô Eto once found a few remains of *Canis* and *Lepus*.

Important caves and fissures are considered in the following paragraphs from geological and palaeontological points of view.

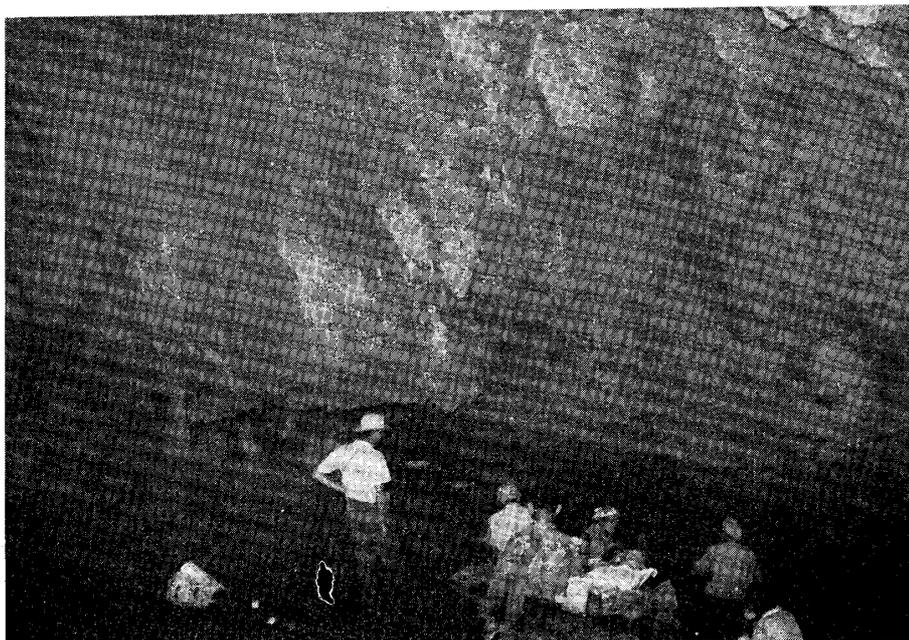
A. Husen-ana (stalactite cave) (Text-figs. 3-7)

The entrance of this cave is situated about 600 m north east of the main entrance of Syuho-dô and opens southward at the western edge of the plateau surface of Akiyosi-dai (Text-fig. 3, A). This cave belongs to the so called "Zibasû" among the natives, meaning a deep pit, but is not a single pit, for it links with horizontal tunnels and chambers. From the small entrance the cave abruptly goes down like a pit (α), and soon becomes a tunnel (β) with east west direction; on the floor of this tunnel there are seen many fallen blocks and at one site (1) were found cervid vertebrates. The tunnel β connects with tunnels δ and ϵ , which run north south direction and slope down from δ to ϵ , the latter of which opens to the middle height of the north wall of a fissure (ξ). This fissure runs and slopes down from northwest to southeast, 6 m wide and 13 m long, and on the floor is deposited brown sticky cave clay 5-6 m thick. At the northern end of this fissure, the floor of it slopes

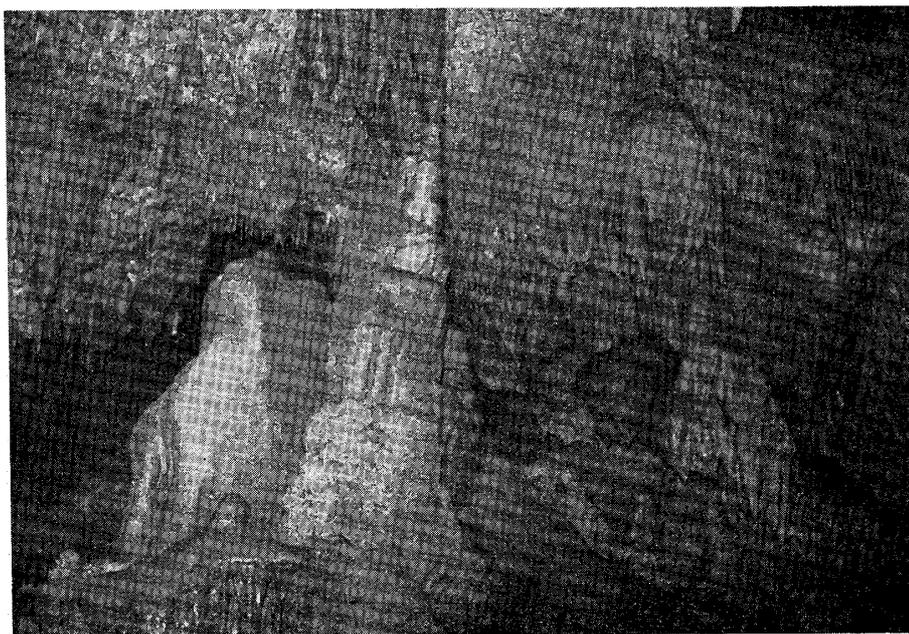


Text-fig. 3. Plan and section of Husen-ana. (after Ero)

down northward, extending beyond the opening point of tunnel ε (G). By a narrow tunnel (η) 1 m wide and 1.5 m high we can reach a deep pit (θ) 7 m wide and 20 m deep; the floor of which is about 15 m deep from the floor of tunnel η , about the same level with the floor or the fissure ξ and carries deposits of brown sticky clay 3 m thick with fossil bones and shells. At the site 2 and 3, the authors gained limb bones and vertebrae of *Nyctereutes viverrinus* and at the site 4 *Trishoplita goodwini* (SMITH). At the middle height of the western wall of the pit θ opens a narrow tunnel (λ) 2-4 m wide and 1.5 m high, going through which we can reach a large chamber (μ): this is the largest, and the western part of this cave is situated just below the plateau edge and the chamber wall seems to be very near to the plateau surface. At the north western part of the chamber we see a well-developed stalagmite-stalactite covering. The floor slopes down from south-west to north-east until it reaches the lowest eastern margin with partial deposition of

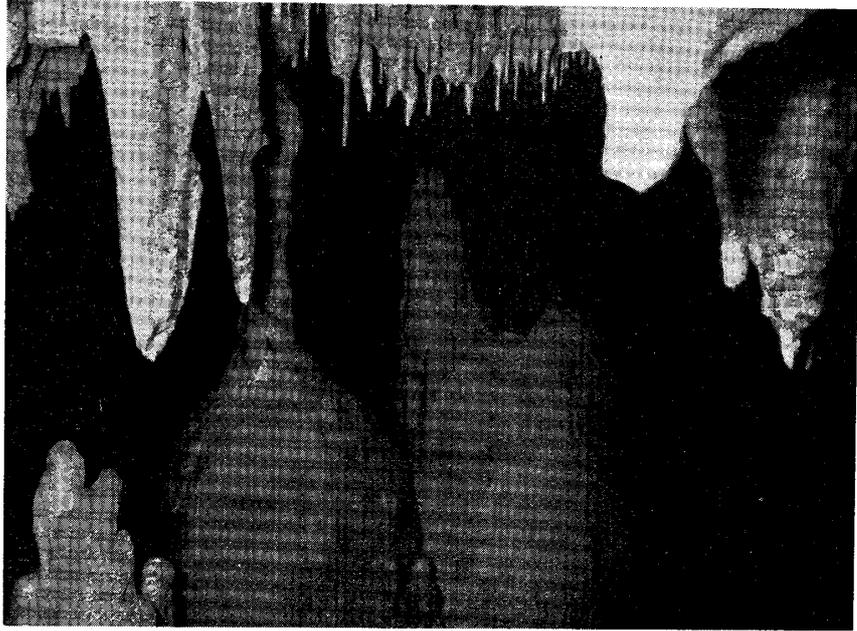


Text-fig. 4. Northern wall of chamber μ of Husen-ana.



Text-fig. 5. Stalactite-stalagmite of chamber μ of Husen-ana.

brown sticky clay. At the site 6, the authors could gain some remains of boar and *canis* sp. aff. *familiaris* L. They are deposited in the surface part of the clay. At the main part of the floor there are seen many fallen blocks, and among them there are scattered many fossil bones and teeth upon the limestone floor. At the site 10, the junior author, TAKAHASHI, KÔNO and others found a molar of *Palaeoloxodon amoriensis*; at the sites 8, 10, 11, 12 the



Text-fig. 6. Stalactite-stalagmite of chamber μ of Husen-ana. (Kôno photo.)



Text-fig. 7. *Palaeoloxodon* tooth found at the floor of chamber of Husen-ana.
(Kôno photo.)

authors gained teeth and limb bones of sinomegacrid; from the site 9 are found remains of boar and *Martes ten* SHIK.; from the site 7 were found teeth of *Canis lupus* L. The condition of these fossils preservation is very interesting, because they are not buried in deposits but exposed to air upon the floor. Thin calcium coating is seen upon them. Even if there had been

any kinds of deposits carrying them in this chamber, they must have been rewashed away. At first the large sized animal remains seem to have run into this chamber from the surface through an unknown tunnel which once may have lain in the southwestern part of the wall but now is closed by the deposition of cave limestone. The authors now call the original deposits with *Palaeoloxodon*, sinomegacerid and others as Husen-ana bed, and the brown sticky clayay bed as Akiyosi brown clay bed. It is noteworthy that the latter is deposited on a lower level than the former in this cave. Near the site 10, there is found a bat guano cone 60 cm high.

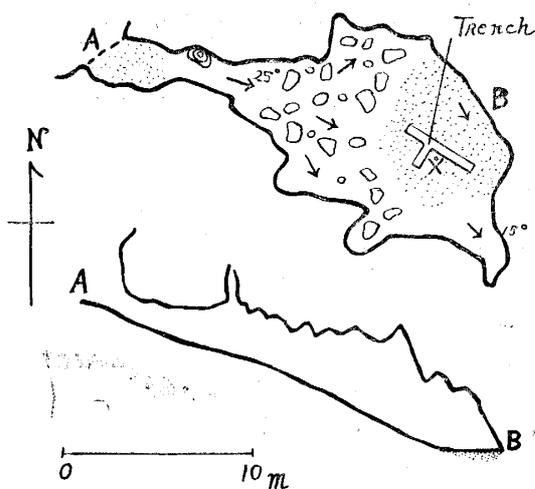
The fossils of Husen-ana are listed below:

- Husen-ana bed (chamber μ)
Palaeoloxodon aomoriensis TOK. & TAK.
Sinomegaceros (Sinomegaceroides) yabei (SHIK.)
Cervus (Depéretia) praenipponicus SHIK.
Sus leucomystax TEM. & SCHL.
Martes ten SHIK.
Canis hodohylax TEM. & SCHL.

- Akiyosi brown clay bed (pit and fissure ξ)
Nyctereutes viverrinus TEM.
Trishoplita goodwini (SMITH)

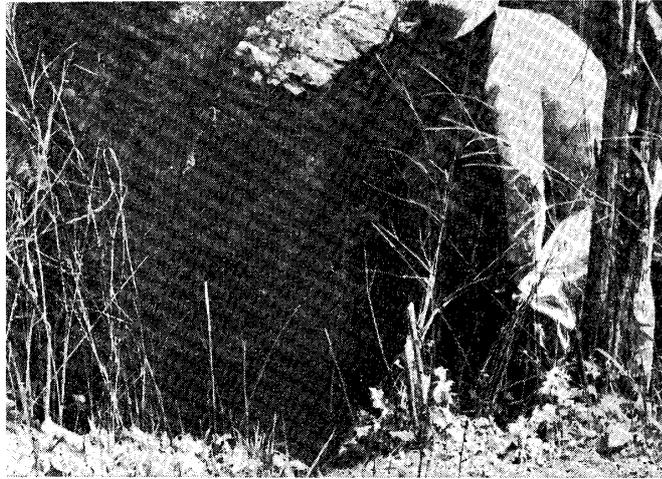
B. Tanuki-ana (stalactite cave) (Text-figs. 8-10).

Small sized horizontal cave of a single chamber. This cave is situated 150 m north-east of the entrance of Syuho-dô and opens to the slope of the eastern wall of uvaes named Hirodani. It is about 23 m in maximum length and 10 m in maximum width; the entrance is about 3 m wide, 1 m high, and at the middle length of the cave suddenly becomes much wider. The floor gently slopes down inwardly, with many fallen blocks at its middle part and brown cave clay at the inside of the entrance and at the deepest point, where



Text-fig 8. Plan and section of Tanuki-ana.

TAKAHASHI and others in 1956 dug a trench 1 m deep and gained some remains of *Nyctereutes viverrinus* TEM. from the surface, and those of *Nyctereutes viverrinus* TEM., *Meles anakuma* TEM., *Cervus (Depéretia) praenipponicus* SHIK., *Lepus brachyurus* TEM., *Apodemus* sp. and *Rhinolophus ferrum-equinum nippon* TEM. from the brown cave clay 5-20 cm below the surface. These bones from the clay are not so much fossilized as those of Husen-ana bed but more fossilized than neolithic bones in general. The cannon bone



Text-fig. 9. Entrance of Tanuki-ana.

of cervid is partially injured before its deposition. The remains gained from the surface may belong to Holocene, but those from the clay, the authors regard, may be fossils of the age of Akiyosi brown clay bed. Associated with the bones, there are found a coprolite 6×6 cm in size, but it is difficult to determine what kind of animal left the coprolite; it is dark grey in colour, porous, rugose, not so light in weight and contains plant remains. Under the cave clay we see some brecciated clay with fallen blocks, but its thickness and deposition base are not known. The cave wall does not carry so good stalactite-stalagmite.



Text-fig. 10. Coprolite from Tanuki-ana. ×0.8 nat. size.

C. Naki-ana and Suzume-ana (stalactite-caves)

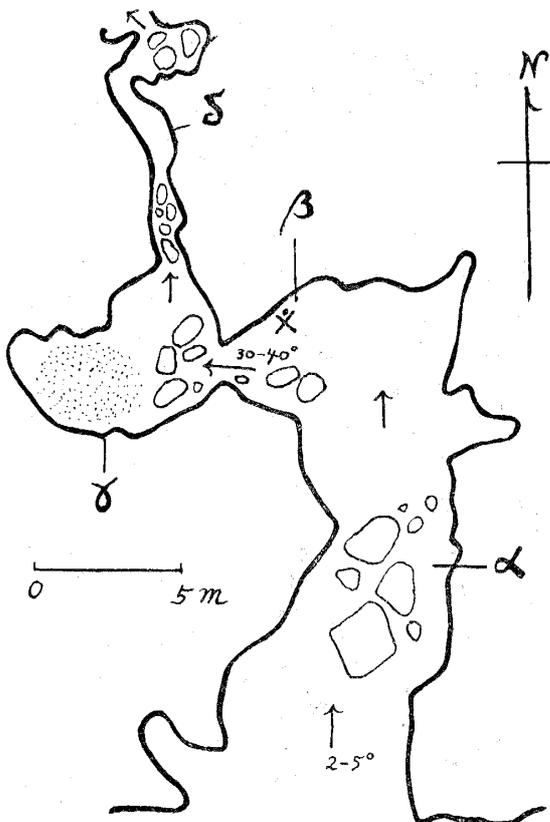
Both lie at the northern part of Akiyosi-dai, 1 km east of Ono, and the former opens eastward while the latter does north-westward. They are very much like Tanuki-ana in general aspects and the manner of deposition. Naki-ana is about 10 m wide and 3-5 m high at its entrance, and 20 m wide and 10-12 m high at its main chamber; the cave floor slopes down inward with a dip of 30°, carrying many fallen blocks at main chamber and dark coloured sandy clay inside the entrance, from which are found remains of *Nyctereutes viverrinus* TEM. and *Cyclophorus herklotsi* MARTENS; they are the same in fossilization as those found from the surface of Tanuki-ana.

Suzume-ana is about 17m wide and 5 m high at its entrance, about 10-

13 m wide and 4-5 m high at the middle length, running with the strike of N 45°E: the cave floor 20 m long, slopes down inward with the strike of 30°, carrying fallen blocks at its middle part and clay inside the entrance and at the terminal part, where the junior author and others dug a trench 1 m deep and gained few land shells such as *Cyclophorus herklotsi* MARTENS, *Spirostoma japonica* (A. ADAMS), *Cyclotus campanulatus* MARTENS, *Megalophaedusa japonica* (CROSSE) and *Euhadra congenita hickonis* (KOBELT) etc. from the horizon 3 cm below the surface.

D. Obaga-ana (=Okugawarano-ana) (stalactite-cave) (Text-fig. 11)

This cave is situated at the south-western corner of Iwanaga-dai plateau, about 400 m east of Okugawara and its entrance opens to the western slope



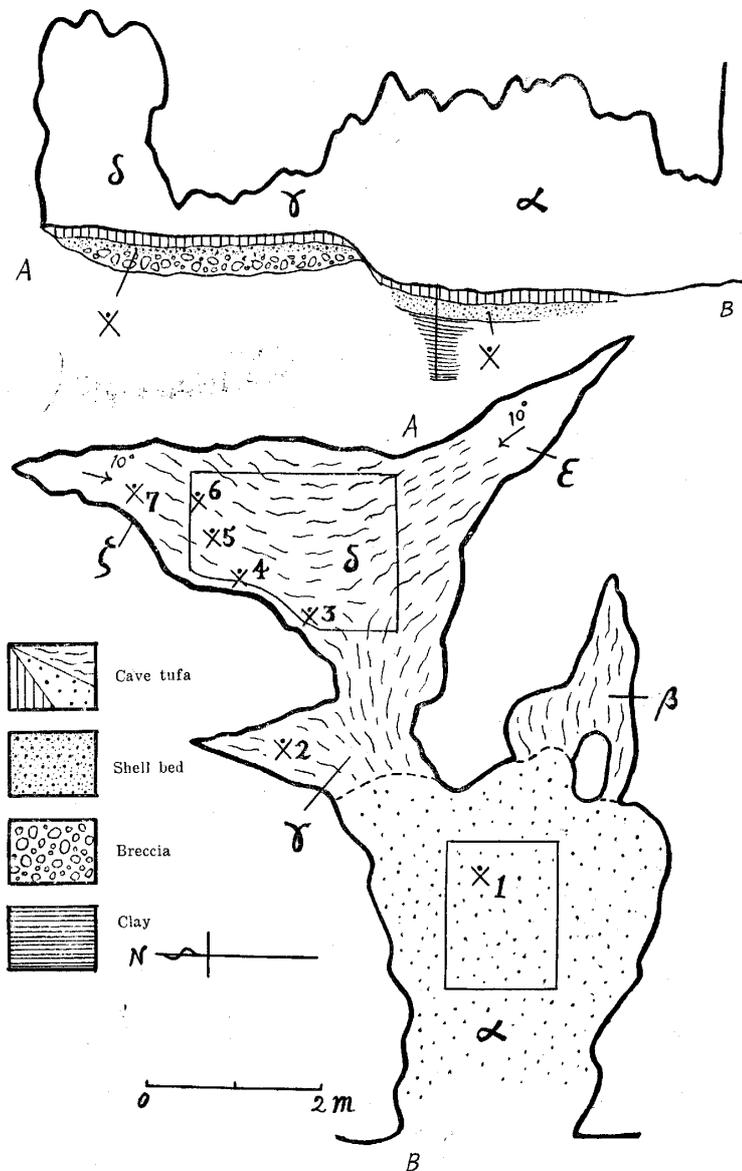
Text-fig. 11. Plan and section of Obaga-ana.

of the plateau. The general aspect is rather like that of Tanuki-ana. From the entrance 8 m wide the cave runs northward, slopes inward with a dip of 2-5°, then turns and slopes down westward with another dip of 30-40°; at this point (β) the junior author gained remains of *Nyctereutes viverrinus* TEM. lying at the surface of small-scaled pit bottom, in the state of fossilization rather like the fossils from Akiyosi brown clay bed. The next chamber (γ) lying west of the main chamber (α) is 7 m long and 5 m wide and on its floor there is found a bed of sandy clay with small pebbles of chert, limestone and slate etc.; the clay carries some land shells. From the chamber γ, furthermore, a narrow tunnel 1 m wide (δ) goes northward and at its northern part of chamberlet runs a ground water stream. The cave wall has no distinct stalactite-stalagmite.

E. Koziki-ana (stalactite cave) (Text-figs. 12-16)

From the left bank of the Asa river at Tyogatubo, Yosinori, Mine City there is a small creek running to Isa-mati and on its left bank just below limestone cliff of Isa-dai, the horizontal cave of Koziki-ana opens its entrance. This cave is small scaled with four branches (β, γ, ε, ξ) of the main chamber

(α and δ), the floor of which is stepped at γ and the inner floor δ is higher than the outer one α . The cave is 8 m long, the chamber α is 4 m long, 3 m wide and 2 m high, while the chamber δ is 4 m long, 1.5–5 m wide and 2.5 m high. At the chamberlet γ , the passage becomes very low, about 0.5 m high. The ground surface before the entrance is about 1 m above the water level of the creek, and the floor α is 0.5 m higher than that, and submerges in flood time. The floor is all covered by thin deposits of cave sinter 4–7 cm thick and underlies a notable shell bed 10 cm thick, consisting of brecciated yellow clay and porous tufa. Among the breccia there are river pebbles of palaeozoic members such as chert, sandstone and slate. At the chamber α , the junior author dug a trench 1 m deep and could not touch the rock floor, but could



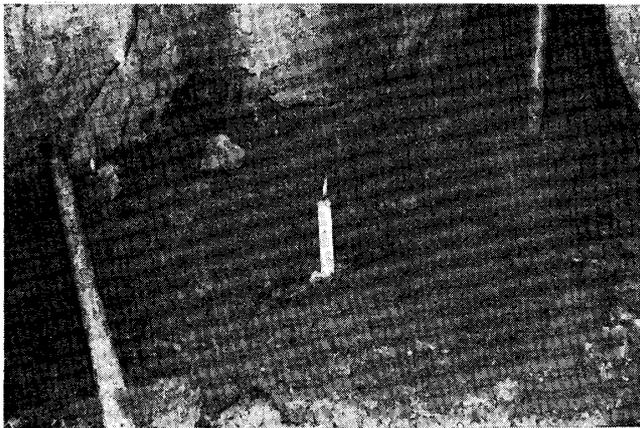
Text-fig. 12. Plan and section of Koziki-ana.



Text-fig. 13. Koziki-ana. Chamber seen from the entrance.



Text-fig. 14. Chamberlet of Koziki-ana seen from chamber.



Text-fig. 15. Floor of chamber, Koziki-ana. Shell bed in excavation.

see a reddish clay with no fossils underlying the shell bed. At the chamber δ , he dug a trench about 50 cm and saw a limestone breccia underlying the shell bed over the rock floor.

It is rather difficult to determine the stratigraphical relationship between the breccia bed and reddish clay bed, but the authors think the former is older than the latter as it lies at a higher level. Hence they assume the stratigraphical succession as follows in ascending order;

- | | |
|--------------------------------|-------------|
| 1. Limestone breccia bed | 35 cm \pm |
| 2. Reddish clay bed..... | 85 " |
| ~~~~~ Submergency ~~~~~ | |
| 3. Shell bed..... | - 10 " |
| 4. Cave sinter | 4-7 " |

The shell bed carries rich fauna; *Semisulcospira libertina nassaeformis* KURODA & KANAMARU is most abundant at northern part of the floor; at the point 5 two human teeth were found and at point 6 marine shells such as *Meretrix lusoria* (RÖDING), *Haliotis* sp. aff. *discus* REEVE, *Cerithidea cingulata*

(GMELIN) and *Tegula argyrostoma turbinata* (A. ADAMS) etc. are gained. At the point 1 non-marine microshells, marine shells and vertebrata have been gained by the authors, HASEGAWA, NAITO and others. They are as follows:

Mollusca (marine)	
<i>Cyclina sinensis</i> (GMELIN)	r
<i>Mastra veneriformis</i> REEVE	r
<i>Haliotis</i> sp. aff. <i>discus</i> REEVE	r
Decapoda	
Gen. & sp. indet.	r
Pisces	
Gen. & sp. indet.	r
Amphibia	
<i>Bufo vulgaris formosus</i> BOULENGER ? ..	c
<i>Rana</i> sp.	c
<i>Hyla</i> sp.	c
Reptilia	
<i>Natrix</i> sp. aff. <i>tigrina</i> (BOIE)	c
<i>Elaphe</i> sp.	c
Scincidae, gen. & sp. indet.	c
Aves	
Gen. & sp. indet.	r
Mammalia	
<i>Mogera wogura</i> (TEM.)	m
<i>Urotrichus talpoides hondonis</i> THOMAS ..	c
<i>Apodemus speciosus</i> (TEM.)	m
<i>A. geisha</i> (THOMAS)	c
<i>Microtus montebelli</i> (MILNE-EDWARDS) ..	m
<i>Rattus</i> sp.	r
<i>Lepus brachyurus</i> TEM.	r
<i>Rhinolophus</i> sp.	r
<i>Sus leucomystax</i> TEM.	c
<i>Homo sapiens</i> L.	r
m: much c: common r: rare	



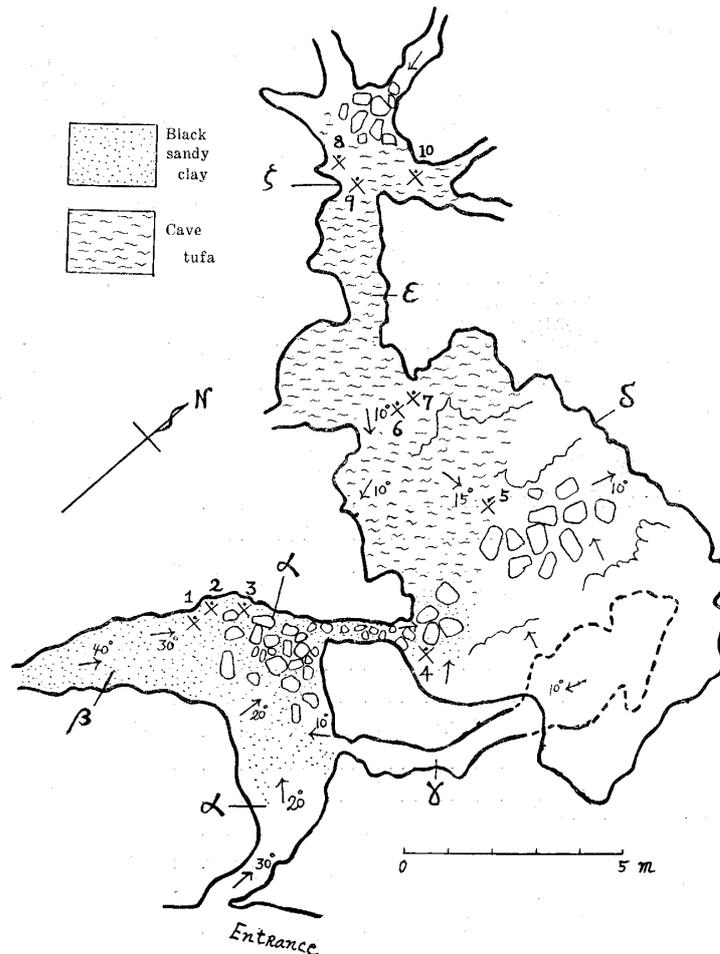
Text-fig. 16. A block of shell bed with a fragment of boar ramus and *Semisulcospira*. $\times 0.6$ nat. size.

Nonmarine shells are listed in the Table 2. It is clear that the marine shells were brought into the cave by men and that the boar may have been left by them; but the other microvertebrata and nonmarine shells are, the authors regard, deposited naturally when the cave floor was often attacked by river waters. Hitherto the authors could not find any artifacts except a bone needle and a few cut bones of boar, and they cannot tell the cultural age of this men. Also it may be noteworthy that there lives not *Semisulcospira libertina nassaeformis* in the neighbourhood of the cave, but only *S. libertina* (GOULD) is living there.

F. Makurazino-ana (stalactite cave) (Text-figs. 17, 18)

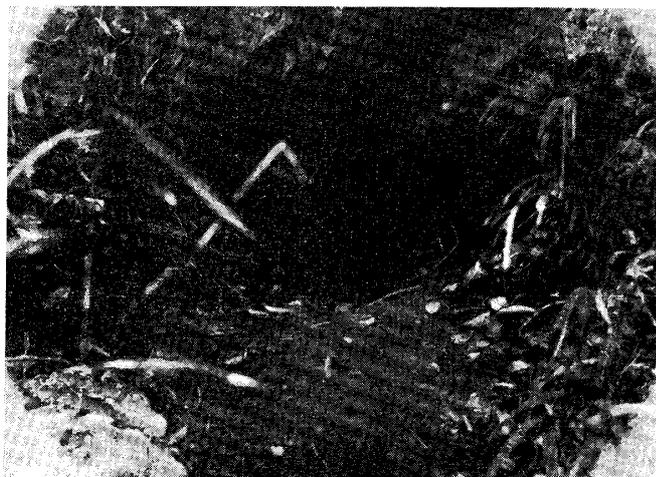
The cave is situated 1 km east south-east of the post office of Isa, opens to the eastern slope of a small hill, and the floor of the entrance is 6-7 m above the brook of Makurazi. The general aspect of its plan is like that of

Koziki-ana but more complicated than that. The entrance is small, about 70 cm wide, and slopes down to a chamber (α) with a dip of 20° ; from this chamber a narrow passage (β) runs to the surface, with another one (γ) running northward. The floor of the chamber α is covered by black sandy clay and fallen boulders, and at the points 1-3 there are found micromammals.



Text-fig. 17. Plan and section of Makurazino-ana.

From this chamber we can go to the large main chamber (δ) about 8 m wide and 8 m long, which occupies the lowest level of the cave, and the eastern half of the floor is barren of deposits except fallen boulders but the western half of it is covered by a tufa bed 3-5 cm thick. Reddish clay about 1 m thick underlies this tufa and at the points 5-7, the junior author and HASEGAWA could find some remains of *Meles anakuma* TEM., *Nyctereutes viverrinus* TEM., *Canis lupus hodopylax* TEM. and *C. sp. aff. familiaris* L. from the clay. At the south-eastern part of this chamber we can see the black sandy clay overlies the tufa. From the chamber, through a passage (ϵ) 30 cm high we can reach the chamber (ξ) which is not high, but the deposits here are like



Text-fig. 18. Entrance of Makurazino-ana.

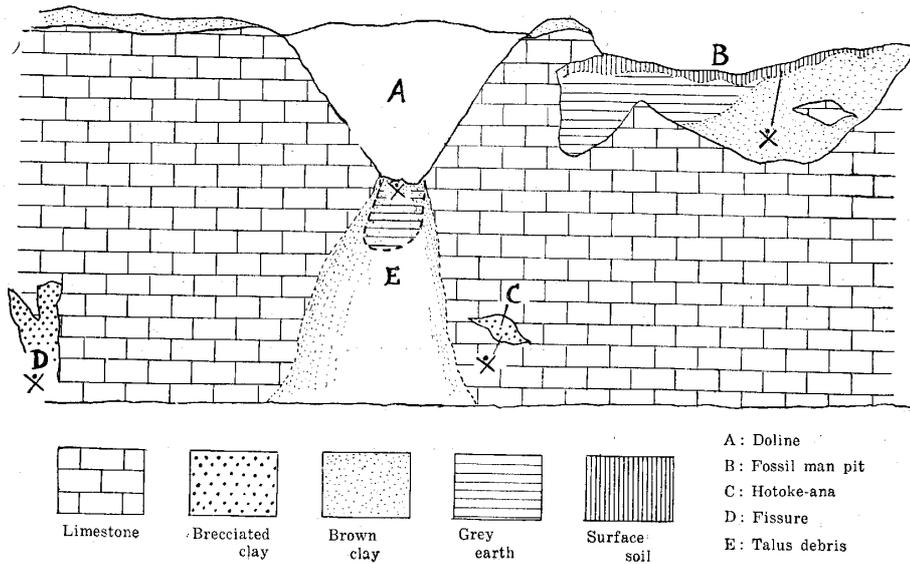
those of the chamber δ , and at the points 8-10, the junior author gained remains of *Canis lupus hodopylax* TEM. The microvertebrates from the chamber α are as follows:

<i>Nyctereutes viverrinus</i> TEM.	m
<i>Mustela itatsi</i> TEM.	r
<i>Petaurista leucogenys</i> TEM.	r
<i>Rattus norvegicus</i> ERXLEBEN	c
<i>Microtus montebelli</i> (MILNE-EDWARDS).....	m
<i>Apodemus speciosus</i> (TEM.)	m
<i>A. geisha</i> (THOMAS)	c
<i>Rhinolophus ferrum-equinum nippon</i> TEM.	m
<i>Pipistrellus</i> (?) sp.	c
<i>Mogera wogura</i> (TEM.)	m
<i>Crocidura dsinezumi chisai</i> THOMAS	r
<i>Urotrichus talpoides hondonis</i> THOMAS	c
Aves, gen. & sp. indet.	c
<i>Elaphe quadrivirgata</i> STAIN.	c
<i>Natrix tigrina</i> BOIE	c
Lacertilia, gen. & sp. indet.	r
<i>Bufo</i> sp.	c

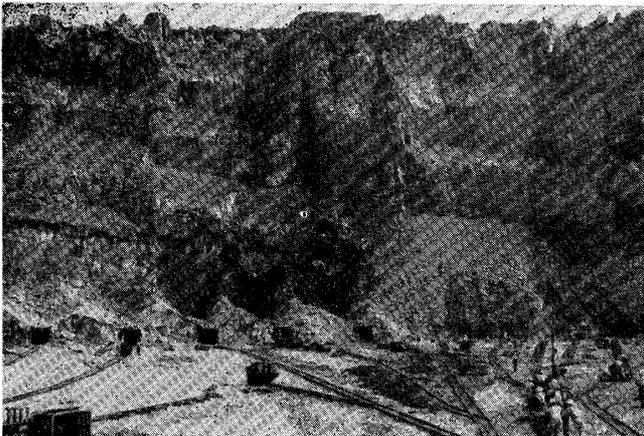
Associating these, a few shells of *Corbicula japonica* PRIME and a seed of *Prunus* sp. cf. *mume* SIEB. & ZUCC. gnawed by *Petaurisia* are gained.

G. Quarry of Ube-Kôsan Company (Text. figs. 19-20)

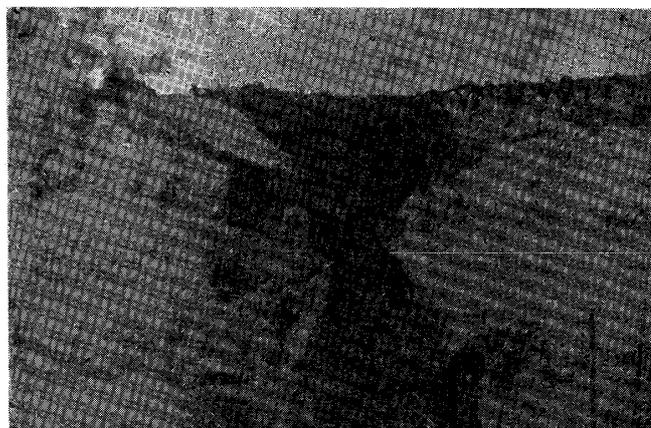
The quarry, working on a large scale, lies just north of Isa-mati, has once exposed a few fissures, a cave named Hotoke-ana and a doline during the course of working. Especially since 1947, tolerable numbers of fossil teeth and bones have occurred from the deposits filling them. The quarry is about 200 m long and 43-45 m high. When the senior author visited it in 1954, the doline 20-30 m deep (A) was still seen at the upper border of the quarry cliff



Text-fig. 19. The diagrammatical figure of the quarry of Ube-Kōsan Company.



Text-fig. 20. The quarry of Ube-Kōsan Company, pictured in August of 1956.



Text-fig. 21. Doline (A) of Ube-Kōsan's quarry, pictured before 1950. Hotoke-ana is seen at the lower right corner.

at its middle length, and at the basal part of the doline there was seen a pit 5-6 m deep running downward, and filling yellowish- to greyish black earth, from which were found some fossil bones. At the eastern corner of the upper border of the cliff, there was exposed a shallow pit 20-25 m wide and 5-6 m deep (B). The junior author observed the following succession of beds in ascending order.

- | | |
|-------------------------------|---------|
| 1. Reddish brown clay | 5-6 m ± |
| 2. Grey earth | 3 m ± |
| 3. Surface soil (humus) | 1 m - |

The last bed also covers the base of a large scaled shallow doline. In 1954 a quarry man engaged in rock explosion work found a fossil human skull fallen from these beds of this pit, and he says that the site where the skull was lying is 4-6 m below the surface, but the authors judge from the materials attached to the skull and from the state of fossilization that it was not derived from the reddish brown clay but from the grey earth. That is to say the depth of 4-6 m is not a true but a false depth and the destroyed land surface was very near to the site. Two vertebrae, fragments of radius and clavicle were found with the skull. Afterward a jaw of pisces was found from the same bed. Here the authors call this pit (B) as the fossil man pit and the grey earth bed as Mukôyama bed. Near the quarry floor there was exposed a stalactite cave named Hotoke-ana (C), and inside of this cave there were found brecciated clay depositing upon the cave floor. From the clay the quarry men and the junior author found the following fossils.

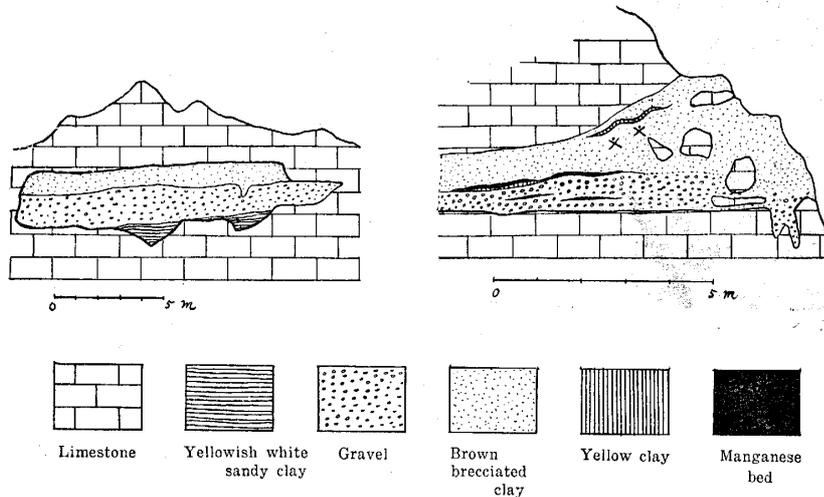
<i>Palaeoloxodon aomoriensis</i> TOK. & TAK.	r	
<i>Sinomegaceros (Sinomegaceroides) yabei</i> SHIK.	r	
<i>Cervus (Dépéretia) praenipponicus</i> SHIK.	m	r: rare
<i>Ursus arctos</i> L.	r	m: much
<i>Felis tigris</i> L.	r	
<i>Thunnus orientalis</i> (TEM. & SCHL.)	r	

From the geographical point of view, it is very curious that in these places, far from coast, there was found a vertebra of *Thunnus*, which must have been thrown away by men if not by *Felis* or *Ursus*. Someone says that there was seen a kind of linear engraving on the cave wall, but nowadays it cannot be confirmed owing to the entire disappearance of the cave by quarry working. At the other site there was seen a fissure (D) with brecciated clay, from which the junior author could gain some fossil bones of cervid. Partially the bones are much calcified and very hard. The senior author has once named these brecciated clayey bed as Isa bed.

H. Third quarry of Nippon-Sekkai Company (Text-figs. 22-27)

This quarry is situated immediately next to the above mentioned quarry and since 1956 at the western wing of the quarry cliff, a part of cave was

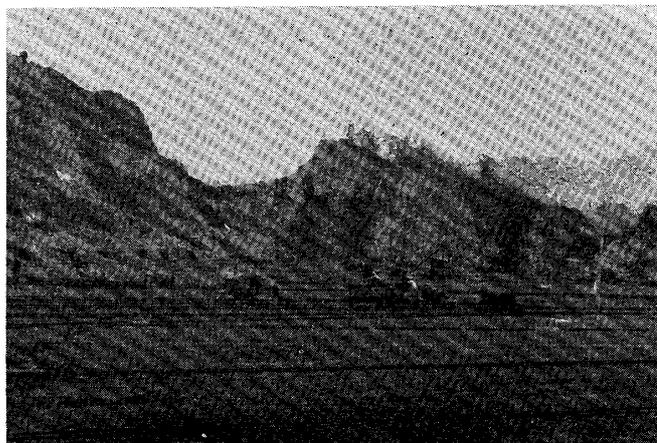
exposed with full of its deposits. In 1957 the junior author and HASEGAWA gained tolerable numbers of fossil bones from the deposits. Also at a part of



Text-fig. 22. The diagrammatical figure of a cave exposed at third quarry of Nippon-Sekkai (right figure) and at right wing of Ube-Kōsan's quarry (left figure).

the eastern wing of the quarry of Ube-Kōsan, a similar cave with the same kinds of deposits was found, and the authors regard the both caves are linked to each other. The deposits are as follows in ascending order:

1. Yellowish white to bluish grey clay 1 m, at Ube-Kōsan.
2. Gravel intercalating manganese bed of 10-15 cm thick
0.8-1 m, at Ube-Kōsan and Nippon-Sekkai.
3. Brown brecciated clay intercalating yellow clay of 5 cm thick
1-1.3 m, ditto.



Text-fig. 23. Right wing of Ube-Kōsan's quarry. A cave in question is seen at the central part.



Text-fig. 24. A cave exposed at right wing of Ube-Kôsan's quarry.



Text-fig. 25. A cave exposed at third quarry of Nippon-Sekkai.

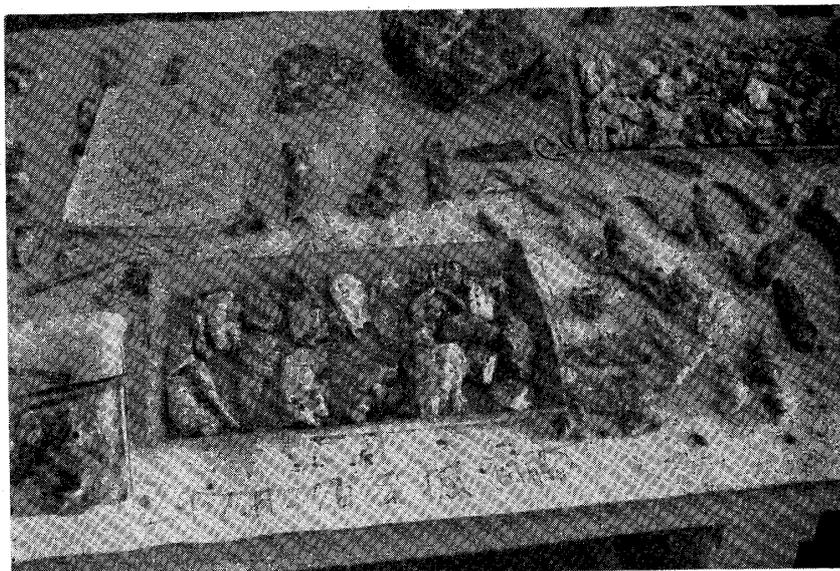
The gravel bed, composed of brown clayey sand with fine round pebbles about 2-3 cm in size, is regarded to have been left by a river; the rocks of pebbles are chert and other palaeozoic members. The brecciated clay is sticky and not hard, with limestone breccia, fragments of cave travertine and fallen blocks. At a part of this clay filling the cave of Nippon-Sekkai, fossil bones were found. Large parts of them are those of *Cervus (Depéretia) praejaponicus* SHIK. and accompanies a few of *Macaca fuscata* (BLYTH).

The fifth quarry of Nippon-Sekkai Company is situated about 1200 m east of the third quarry above mentioned. In 1918 a fossiliferous fissure was exposed while working. Brown calcareous hard clay and white travertine carry fossil bones, and associating these deposits there were seen gravel and brecciated sandstone. The senior author and TAKAHASHI have once reported *Cervus (Depéretia) praejaponicus* SHIK. and *Ursus arctos* L. and named these deposits with fossils as Isa bed. According to TAKAHASHI there was an empty stalactite cave exposed in the same quarry cliff, so that it may be said that the opening of the stalactite cave is younger than the deposition of Isa bed in age.

Here the authors refer the gravel bed at Ube-Kôsan's quarry and third quarry of Nippon-Sekkai to the same age as that of fifth quarry of it, and perhaps there may be two horizons of fossil faunae, i. e. the upper is that of brecciated clay and the lower is that of travertine and calcareous hard clay, although both are included in the Isa bed.



Text-gg. 26. Gravel (lower) and brecciated clay (upper) of a cave exposed at third quarry of Nippon-Sekkai.



Text-fig. 27. Cervid fossils excavated from the third quarry of Nippon-Sekkai Company.

I. Quarry of Tokuyama Soda Company (Text-fig. 28)

This quarry is situated about 3 km north of Isa, and 2 km east of the Sigeyasu railway station. It is about 40 m high and at the end of 1957, at the site 20 m high a fissure was exposed while working. From this fissure the junior author could gain some travertine carrying some microvertebrae as follows, although its thickness is unknown:



Text-fig. 28. Quarry of Tokuyama Soda Company, Yamase. The fossiliferous fissure is shown with cross mark.

- Cervus (Depéretia) praenipponicus* SHIK. r
- Microtus montebelli* (MILNE-EDWARDS) c
- Mustela erminea* L. r
- Sorex shinto* THOMAS (?) r
- Crocidura dsinezumi chisai* THOMAS r
- Urotrichus talpoides hondonis* THOMAS r
- Mogera wogura* (TEM.) c
- Anourosorex japonicus* SHIK. & HASEGAWA. r
- Rana* sp. r

Lower left M_1 of *Cervus (Depéretia) praenipponicus* SHIK. is clearly water worn. From the quarry of Ube Soda Company, just west of the Sigeyasu railway station, tolerable numbers of *Cervus (Depéretia) praenipponicus* SHIK. were found, but the speleostratigraphy of the quarry is not known at present.

IV. General Stratigraphy

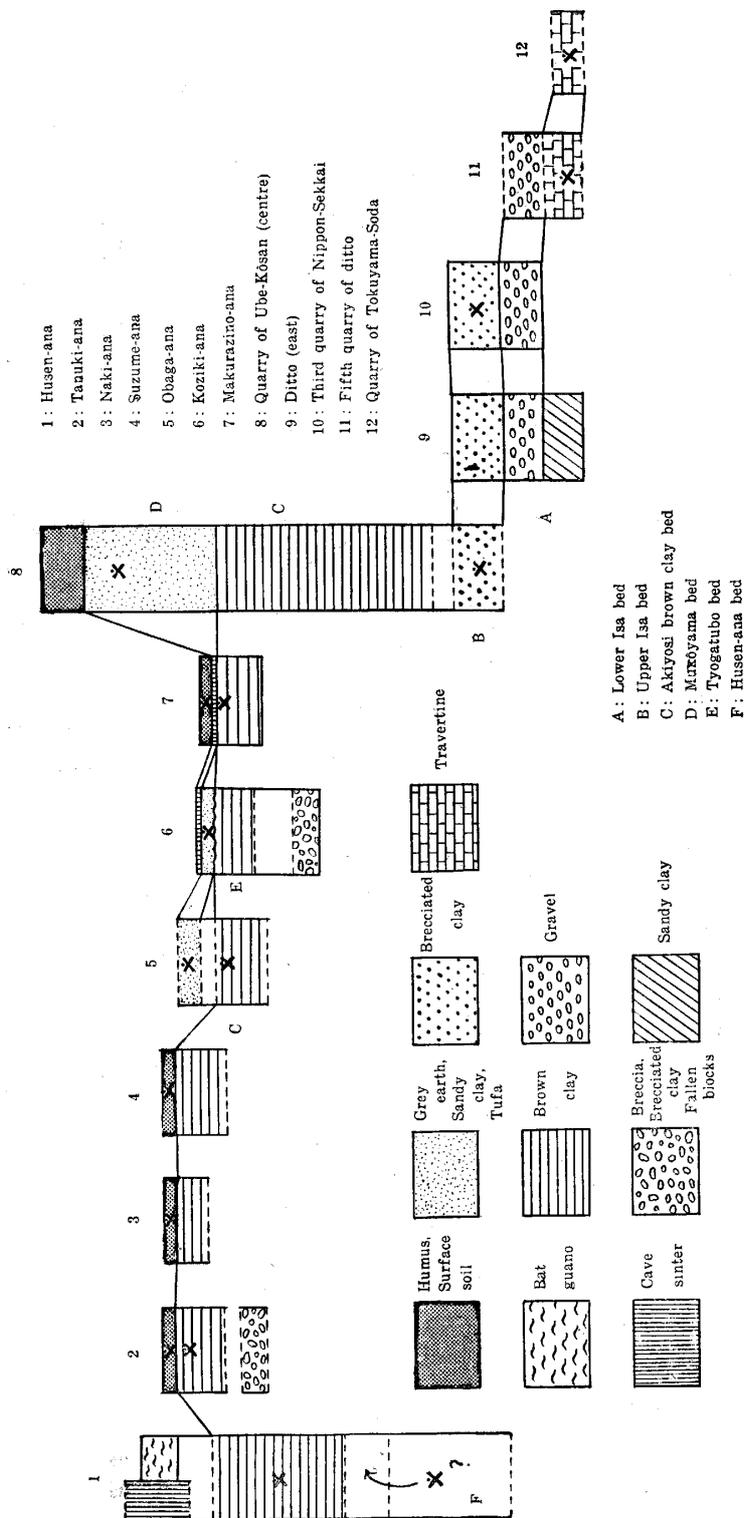
From the above mentioned twelve localities, we may note, of the spelean deposits of Akiyosi area, that in the simple shaped stalactite cave as Tanuki-ana, there is always seen brown clay overlain by humuseous soil or sandy clayey bed. At Koziki- and Makurazino-ana we can see the following succession in descending order.

1. Humus
2. Cave sinter
3. Sandy clay with shelly fauna
4. Brown clay

This succession seen in stalactite caves is also visible at the quarry of Ube-Kôsan where the beds are thick partially in bottom of doline. The sandy clay bed is named as Tyogatubo bed at Koziki-ana and Mukôyama bed at Ube-Kôsan's quarry. At present it is rather difficult to make clear the relationship between the brown clay bed (Akiyosi brown clay bed) and the brown brecciated clayey bed (Upper Isa bed), although they are both fossiliferous. At the quarry of Ube-Kôsan and third quarry of Nippon-Sekkai, Upper Isa bed is underlain by gravel and travertine beds, which the authors call Lower Isa bed. At any rate, the general columnar section of the spelean deposits are shown in Text-fig. 29.

The gravel of Lower Isa bed and Tyogatubo bed are left by rivers, may belong to a phase when a part of the Akiyosi-dai is submerged. It may be important that in the stalactite cave we can't see any existence of Isa bed and that at the fifth quarry of Nippon-Sekkai a stalactite cave was made after the deposition of Lower Isa bed. So that we may say that the present system of stalactite caves were made after the Lower Isa bed, but reenlargement might have occurred after the Upper Isa bed as seen in Husen-ana. Perhaps it may be said that generally in a submerged phase of the plateau or in humid phase from climatic point of view the ground water level became high, causing the cave making rather extensive and vigorous. On the contrary the Akiyosi brown clay bed or Upper Isa bed may have been deposited in a rather arid phase. We can gain the speleo-history of the Akiyosi-dai as follows in ascending order:

1. Cave and fissure making submergence
2. Lower Isa bed ”
3. Arid phase, open fissure, Upper Isa bed Emergence
4. Cave and fissure making submergence
5. Arid phase, open of cave and fissure, breccia and Akiyosi
brown clay bed Emergence
6. Humid phase, Tyogatubo- and Mukôyama beds Submergence
7. Deposition of cave sinter, bat guano and humus etc.



Text-fig. 29. Columnar sections of spelean deposits.

Table 1. Speleo-stratigraphy of Akiyosi-dai.

Holocene	K ₂	Humus		↑ ↓	
	K ₁	Tyogatubo bed	Mukôyama bed		
Pleistocene	Upper	J ₃	Akiyosi brown clay bed		↑ ↓ Karrenfeld of plateau, 20 m terrace of Akiyosi
		J ₂	Isa bed	Upper	
	Lower	J ₁	Isa bed	Lower	↓
		I			

~~~~~ Cave and fissure making    ↓ Submergence    ↑ Emergence

### V. Fossil Fauna

Hitherto known species of fauna are listed below: extinct elements are shown with asterisks.

#### A. Fauna with extinct elements (J<sub>2</sub>).

| Localities                                                       | Husen-ana | Ube-Kôsan's quarry | Thirs quarry Nippon-Sekkai | Fourth quarry Nippon-Sekkai | Fifth quarry Nippon-Sekkai | Syowa Sekkai quarry | Tokuyama Soda's quarry | Ube Soda's quarry |
|------------------------------------------------------------------|-----------|--------------------|----------------------------|-----------------------------|----------------------------|---------------------|------------------------|-------------------|
| Beds<br>U: Upper Isa bed<br>L: Lower Isa bed<br>H: Husen-ana bed | H         | U                  | U                          | ?                           | L                          | ?                   | L                      | ?                 |
| Cave and fissure<br>C: Cave<br>F: Fissure                        | C         | F                  | F                          |                             | F                          |                     | F                      |                   |
| Mammalia                                                         |           |                    |                            |                             |                            |                     |                        |                   |
| * <i>Sinomegaceros (Sinomegaceroides) yabei</i> (SHIK.) .....    | *         | *                  |                            |                             |                            |                     |                        |                   |
| * <i>Cervus (Depéretia) Praenipponicus</i> SHIK. ....            | *         | *                  | *                          | *                           | *                          | *                   | *                      | *                 |
| △△ <i>Cervus nippon</i> TEM. ....                                |           |                    | *                          |                             |                            |                     |                        |                   |
| <i>Sus leucomystax</i> TEM. ....                                 | *         |                    |                            |                             |                            |                     |                        |                   |
| * <i>Palaeoloxodon aomoriensis</i> TOK. & TAK. ....              | *         | *                  |                            |                             |                            |                     |                        |                   |
| <i>Nyctereutes viverrinus</i> TEM. ....                          |           | *                  |                            |                             |                            |                     |                        |                   |
| △ <i>Canis lupus</i> L. ....                                     | *         |                    |                            |                             |                            |                     |                        |                   |
| △ <i>Felis tigris</i> L. ....                                    |           | *                  |                            |                             |                            |                     |                        |                   |

|                                                  |   |   |  |  |  |  |   |  |
|--------------------------------------------------|---|---|--|--|--|--|---|--|
| △ <i>Ursus arctos</i> L. ....                    | * | * |  |  |  |  |   |  |
| * <i>Martes ten</i> SHIK. ....                   | * |   |  |  |  |  |   |  |
| △△ <i>Mustela erminea</i> L. ....                |   |   |  |  |  |  | * |  |
| <i>Macaca fuscata</i> (BLYTH) .....              |   |   |  |  |  |  |   |  |
| <i>Microtus montebelli</i> (MILNE-EDWARD) ..     |   | * |  |  |  |  | * |  |
| <i>Sorex shinto</i> THOMAS (?) .....             |   |   |  |  |  |  | * |  |
| * <i>Anourosorex japonicus</i> SHIK. & HAS. .... |   |   |  |  |  |  | * |  |
| <i>Crocidura dsinezumi chisai</i> THOMAS         |   |   |  |  |  |  | * |  |
| <i>Urotricus talpoides hondonis</i> THOMAS ..... |   |   |  |  |  |  | * |  |
| <i>Mogera wogura</i> (TEM.) .....                |   |   |  |  |  |  | * |  |
| Aves                                             |   |   |  |  |  |  |   |  |
| Gen. & sp. indet. ....                           | * |   |  |  |  |  |   |  |
| Amphibia                                         |   |   |  |  |  |  |   |  |
| <i>Rana</i> sp. ....                             |   |   |  |  |  |  | * |  |
| Pisces                                           |   |   |  |  |  |  |   |  |
| △△ <i>Thunnus orientalis</i> (TEM. & SCHL.)      |   | * |  |  |  |  |   |  |

 B. Fauna of Akiyosi brown clay bed (all in caves) (J<sub>3</sub>).

|                                                       | Husen-ana | Tanuki-ana | Obaga-ana | Makurazino-ana | Maruyamano-ana | Mizusimano-ana | Nakao-dô |
|-------------------------------------------------------|-----------|------------|-----------|----------------|----------------|----------------|----------|
| Mammalia                                              |           |            |           |                |                |                |          |
| * <i>Cervus (Dépéretia) praenipponicus</i> SHIK. .... |           | *          |           |                |                |                |          |
| <i>Sus leucomystax</i> TEM. ....                      | *         |            |           |                |                |                |          |
| <i>Meles anakuma</i> TEM. ....                        |           |            |           | *              |                |                |          |
| * <i>Canis lupus hodopylax</i> TEM. ....              |           |            |           | *              |                |                |          |
| <i>Canis</i> sp. aff. <i>familiaris</i> L. ....       | *         |            |           | *              | *              |                | *        |
| <i>Nyctereutes viverrinus</i> TEM. ....               | *         | *          | *         | *              | *              |                |          |
| <i>Lepus brachyurus</i> TEM. ....                     |           | *          |           | *              |                | *              | *        |
| <i>Macaca fuscata</i> (BLYTH) .....                   |           |            |           |                |                | *              |          |
| <i>Microtus montebelli</i> (MILNE-EDWARD) .....       |           |            |           |                |                | *              |          |
| <i>Apodemus speciosus</i> (TEM.) .....                |           |            |           |                |                | *              |          |
| <i>A. geisha</i> (THOMAS).....                        |           |            |           |                |                | *              |          |
| <i>A.</i> sp. ....                                    |           | *          |           |                |                |                |          |
| <i>Rhinolophus ferrum-equinum nippon</i> TEM. ....    | *         | *          |           |                |                |                |          |
| <i>R.</i> sp. ....                                    |           |            |           | *              |                |                |          |
| Amphibia                                              |           |            |           |                |                |                |          |
| <i>Bufo vulgaris formosus</i> BOULENGER .....         | *         |            |           | *              |                |                |          |

C. Faunae of Tyogatubo and Mukôyama beds (K<sub>1</sub>).

|                                                   | Koziki-ana<br>(cave) | Ube-Kôsan's<br>quarry<br>Mukôyama<br>bed (pit) |
|---------------------------------------------------|----------------------|------------------------------------------------|
| Mammalia                                          |                      |                                                |
| <i>Sus leucomystax</i> TEM. ....                  | *                    |                                                |
| <i>Homo sapiens</i> L. ....                       |                      | *                                              |
| <i>Lepus brachyurus</i> TEM. ....                 | *                    |                                                |
| <i>Rattus</i> sp. ....                            | *                    |                                                |
| <i>Apodemus geisha</i> (THOMAS) ....              | *                    |                                                |
| <i>A. speciosus</i> (TEM.) ....                   | *                    |                                                |
| <i>Microtus montebelli</i> (MILNE-EDWARD) ....    | *                    |                                                |
| <i>Rhinolophus</i> sp. ....                       | *                    |                                                |
| <i>Mogera wogura</i> (TEM.) ....                  | *                    |                                                |
| <i>Urotrichus talpoides hondonis</i> THOMAS ....  | *                    |                                                |
| Aves                                              |                      |                                                |
| Gen. & sp. indet. ....                            | *                    |                                                |
| Reptilia                                          |                      |                                                |
| <i>Natrix</i> sp. aff. <i>tigrina</i> (BOIE) .... | *                    |                                                |
| <i>Elaphe</i> sp. ....                            | *                    |                                                |
| Scincidae, gen. & sp. indet. ....                 | *                    |                                                |
| Amphibia                                          |                      |                                                |
| <i>Bufo vulgaris formosus</i> BOULENGER ? ....    | *                    |                                                |
| <i>Rana</i> sp. ....                              | *                    |                                                |
| <i>Hyla</i> sp. ....                              | *                    |                                                |
| Pisces                                            |                      |                                                |
| Gen. & sp. indet. ....                            | *                    | *                                              |

D. Fauna of surface soil (or sandy clay) (K<sub>2</sub>).

|                                                 | Makurazino-<br>ana | Naki-ana | Irimino-ana | Tanuki-ana | COIFFAIT'S<br>cave |
|-------------------------------------------------|--------------------|----------|-------------|------------|--------------------|
| Mammalia                                        |                    |          |             |            |                    |
| <i>Sus leucomystax</i> TEM. ....                |                    |          |             |            | *                  |
| <i>Canis</i> sp. aff. <i>familiaris</i> L. .... |                    |          |             |            | *                  |
| <i>Nyctereutes viverrinus</i> TEM. ....         |                    |          |             |            | *                  |
| <i>Meles anakuma</i> TEM. ....                  |                    |          |             | *          | *                  |
| <i>Mustela itatsi</i> TEM. ....                 | *                  |          |             |            | *                  |
| <i>Macaca fuscata</i> (BLYTH) ....              |                    |          |             |            | *                  |
| <i>Lepus brachyurus</i> TEM. ....               |                    | *        |             |            |                    |
| <i>Petaurista leucogenys</i> TEM. ....          | *                  |          |             |            |                    |
| <i>Rattus norvegicus</i> ERXLEBEN. ....         | *                  |          |             |            |                    |

|                                                    |   |  |   |  |   |
|----------------------------------------------------|---|--|---|--|---|
| <i>Apodemus speciosus</i> (TEM.) .....             | * |  |   |  |   |
| <i>A. geisha</i> (THOMAS) .....                    | * |  | * |  |   |
| <i>Microtus montebelli</i> (MILNE-EDWARD) .....    | * |  | * |  |   |
| <i>Rhinolophus ferrum-equinum nippon</i> TEM. .... | * |  |   |  |   |
| <i>Pipistrellus</i> (?) sp. ....                   | * |  |   |  |   |
| <i>Mogera wogura</i> (TEM.) .....                  | * |  | * |  |   |
| <i>Crocidura dsinezumi chisai</i> THOMAS .....     | * |  |   |  |   |
| <i>Urotrichus talpoides hondonis</i> THOMAS .....  | * |  |   |  |   |
| Aves                                               |   |  |   |  |   |
| Gen. & sp- indet. ....                             | * |  |   |  | * |
| Reptilia                                           |   |  |   |  |   |
| <i>Elaphe quadrivirgata</i> STEIND. ....           | * |  |   |  |   |
| <i>Natrix tigrina</i> (BOIE) .....                 | * |  |   |  |   |
| Lacertilia, gne. & sp. indet. ....                 | * |  |   |  |   |
| Amphibia                                           |   |  |   |  |   |
| <i>Bufo</i> sp. ....                               | * |  |   |  |   |
| <i>Rana</i> sp. ....                               | * |  | * |  |   |

Furthermore, the junior author reported 58 species of land shells from the caves of Koziki, Makurazi, Irimi, Maruyama, Awaya, Mizusima, Mizusimakami and Tanuki as follows:

Table 2. Land shells from surface soil of different caves.

|                                                           | Koziki | Makurazi | Irimi | Maruyama | Awaya | Mizusima-kami | Mizusima | Tanuki |
|-----------------------------------------------------------|--------|----------|-------|----------|-------|---------------|----------|--------|
| <i>Georissa japonica</i> PILSBRY .....                    |        | *        |       |          |       |               |          |        |
| <i>G. shikokuensis</i> (PILS. & HIRASE) AMANO .....       | *      | *        | *     | *        | *     | *             | *        | *      |
| <i>Pupinella rufa</i> (SOWERBY) .....                     | *      | *        |       |          | *     |               | *        |        |
| <i>Chamalycaneus pilsbryana</i> (KOBELT) .....            | *      |          |       |          |       |               | *        |        |
| <i>Nakadaella micron</i> (PILSBRY) .....                  | *      |          |       |          |       |               | *        |        |
| <i>Cyclophorus herklotsi</i> MARTENS .....                | *      | *        | *     | *        | *     | *             | *        | *      |
| <i>Spirostoma japonica</i> (A. ADAMS) .....               | *      | *        | *     | *        | *     |               | *        | *      |
| <i>Cyclotus (Procyctotus) campanulatus</i> MARTENS ....   | *      | *        |       | *        | *     | *             | *        | *      |
| <i>Palaina pusilla</i> (MARTENS) .....                    | *      |          |       |          |       |               |          |        |
| <i>Diplommatina tanegashimae kyushuensis</i> PILSBRY ..   | *      |          |       |          |       |               | *        |        |
| <i>D. collarifera tenuiplica</i> PILSBRY .....            | *      |          |       |          |       |               | *        |        |
| <i>Akiyoshia uenoi</i> KURODA & HABE .....                |        |          |       |          | *     |               |          |        |
| <i>Paludinella (Cavernmacmella) kuzuensis</i> SUZUKI .... | *      | *        | *     | *        | *     |               | *        | *      |
| <i>Carychium pessinum</i> PILSBRY .....                   | *      |          |       |          |       |               |          |        |
| <i>C. nipponense</i> PILSBRY & HIRASE .....               | *      | *        | *     | *        | *     |               | *        |        |
| <i>Fossaria ollula</i> (GOULD) .....                      |        |          | *     |          |       |               |          |        |
| <i>Gyraulus pulcher</i> (MORI) .....                      |        |          | *     |          |       |               |          |        |

|                                                                |    |    |    |    |    |   |    |    |
|----------------------------------------------------------------|----|----|----|----|----|---|----|----|
| <i>Boysidia (Bersonella) plicidens</i> (BENSON) .....          | *  | *  |    | *  | *  |   | *  | *  |
| <i>Vertigo japonica</i> PILSBRY & HIRASE .....                 | *  |    |    |    |    |   |    |    |
| <i>Ena reiniana</i> (KOBELT) .....                             | *  | *  |    | *  | *  |   | *  | *  |
| <i>Paganizaptyx subaurantiaca</i> (PILSBRY) .....              | *  |    | *  |    |    |   | *  |    |
| <i>Tyrannophaedusa pilsbryana kawamotoi</i> KURODA & TAKI..... | *  |    |    |    |    |   | *  |    |
| <i>T. bilabrata</i> (SMITH) .....                              | *  |    |    |    |    |   | *  |    |
| <i>Megalophaedusa (Vastina) vasta</i> (FOETTGEN) ....          | *  |    |    |    |    |   | *  |    |
| <i>M. japonica</i> (CROSSE) .....                              | *  | *  | *  | *  | *  |   | *  | *  |
| <i>Allopeas pyrgula</i> (SCHMACHER & FOETT.) .....             | *  |    | *  |    |    |   |    |    |
| <i>A. satsumense</i> (PILSBRY).....                            | *  |    |    | *  |    |   |    |    |
| <i>A. clavulinum kyotoense</i> (PILS. & HIRASE) .....          | *  |    |    |    |    |   |    |    |
| <i>Punctum japonicum</i> PILSBRY .....                         | *  |    |    | *  | *  |   |    | *  |
| <i>P. amblygonum</i> (REINHARDT) ..                            | *  |    |    | *  |    |   |    | *  |
| <i>Hawaiiia minuscula</i> (BINNEY) .....                       | *  |    |    |    |    |   |    | *  |
| <i>Petalochlamys</i> sp. KURODA.....                           |    |    |    | *  |    |   |    |    |
| <i>Sitalina japonica</i> (HIRASE).....                         | *  |    |    |    |    |   | *  |    |
| <i>S. circumcincta</i> (REINHARDT) .....                       | *  |    |    | *  |    |   |    |    |
| <i>Parakaliella harimensis</i> (PILSBRY) .....                 | *  |    |    |    |    |   |    | *  |
| <i>P. pagoduloides</i> (GUDE) .....                            | *  |    |    | *  | *  |   | *  | *  |
| <i>Trochochlamys fraterna</i> (PILSBRY).....                   | *  |    |    | *  |    |   |    |    |
| <i>T. praealta</i> (PILSBRY) .....                             |    |    |    | *  |    |   |    |    |
| <i>T. crenulata</i> (GUDE).....                                | *  |    |    | *  |    |   |    | *  |
| <i>Gastrodontella multivolvis</i> (PILSBRY) .....              | *  |    |    |    |    |   | *  |    |
| <i>Discoconulus sinapidium</i> (REINHARDT) .....               | *  |    |    | *  | *  |   | *  |    |
| <i>D. hilgendorfi</i> (REINHARDT) .....                        | *  |    |    | *  | *  |   |    |    |
| <i>Parasitula nanodes</i> (GUDE).....                          | *  |    |    |    |    |   |    |    |
| <i>Yamatochlamys vaga</i> (PILSBRY & HIRASE) .....             |    |    |    |    |    |   | *  |    |
| <i>Urazirochlamys doenitzii</i> (REINHARDT) .....              | *  |    |    |    |    |   |    |    |
| <i>Ceratochlamys ceratodes</i> (GUDE) .....                    | *  |    |    |    |    |   | *  |    |
| <i>Satsuma myonphola</i> (MARTENS) .....                       | *  | *  | *  | *  | *  | * | *  | *  |
| <i>Aegista friedeliiana aperta</i> PILSBRY .....               | *  |    |    |    |    |   | *  | *  |
| <i>A. kobensis</i> (SCHMACHER & BÖTTGER).....                  | *  |    |    |    |    |   |    | *  |
| <i>A. (Plectotropsis) aemula</i> (GUDE) .....                  | *  | *  | *  | *  | *  | * | *  | *  |
| <i>Trishoplita eumenes</i> (WESTERLUND) .....                  | *  |    |    |    |    |   | *  |    |
| <i>T. goodwini</i> (SMITH) .....                               | *  |    |    |    |    |   |    |    |
| <i>Fruticicola (Acusta) despecta sieboldiana</i> (PFEIFFER)    | *  |    |    |    |    |   |    |    |
| <i>Euhadra herklotsi</i> (MARTENS) .....                       | *  | *  | *  | *  | *  | * | *  | *  |
| <i>E. dixonii</i> (PILSBRY) .....                              | *  |    |    |    | *  |   | *  |    |
| <i>E. congenita hickonis</i> (KOBELT) .....                    | *  | *  | *  | *  | *  | * | *  | *  |
| <i>Gulella (Sinoennea) iwakawa</i> (PILSBRY) .....             | *  | *  |    | *  | *  |   | *  | *  |
| Total specific numbers .....                                   | 51 | 16 | 14 | 26 | 21 | 7 | 33 | 20 |

He picked up the small shells from the surface soil by sieving it with water. Nextly the authors will show the geological range in Akiyosi-dai of each species of vertebrate fauna as follows:

Table 3. Geological range of each species.

| Geological Age                                            | Late Pleistocene               |                | Holocene       |                |
|-----------------------------------------------------------|--------------------------------|----------------|----------------|----------------|
|                                                           | J <sub>1</sub> -J <sub>2</sub> | J <sub>3</sub> | Low.           | UP.            |
|                                                           | A                              | B              | K <sub>1</sub> | K <sub>2</sub> |
| Fauna                                                     | A                              | B              | C              | D              |
| Numbers of localities                                     | 8                              | 7              | 2              | 5              |
| Mammalia                                                  |                                |                |                |                |
| * <i>Sinomegaceros (Sinomegaceroides) yabei</i> (SHIK.).. |                                |                |                |                |
| * <i>Cervus (Depéretia) praenipponicus</i> SHIK. ....     |                                |                |                |                |
| △△ <i>Cervus (Sika) nippon</i> TEM. ....                  |                                |                |                | .....          |
| <i>Sus leucomystax</i> TEM. ....                          |                                |                |                |                |
| △ <i>Felis tigris</i> L. ....                             |                                |                |                |                |
| * <i>Martes ten</i> SHIK. ....                            |                                |                |                |                |
| △△ <i>Mustela erminea</i> L. ....                         |                                |                |                |                |
| <i>M. itatsi</i> TEM. ....                                |                                |                |                |                |
| <i>Meles anakuma</i> TEM. ....                            |                                |                |                | .....          |
| △ <i>Ursus arctos</i> L. ....                             |                                |                |                |                |
| <i>Nyctereutes viverrinus</i> TEM. ....                   |                                |                |                |                |
| △ <i>Canis lupus</i> L. ....                              |                                |                |                |                |
| ** <i>C. lupus hodopylax</i> TEM. ....                    |                                |                |                |                |
| <i>C. sp. aff. familiaris</i> L. ....                     |                                |                |                | .....          |
| <i>Homo sapiens</i> L. ....                               |                                |                |                |                |
| <i>Macaca fuscata</i> (BLYTH) ....                        |                                |                |                | .....          |
| * <i>Palaeoloxodon aomoriensis</i> TOK. & TAK. ....       |                                |                |                |                |
| <i>Lepus brachyurus</i> TEM. ....                         |                                |                |                |                |
| <i>Petaurista leucogenys</i> TEM. ....                    |                                |                |                |                |
| <i>Rattus norvegicus</i> ERXL. ....                       |                                |                |                |                |
| <i>R. sp.</i> ....                                        |                                |                |                |                |
| <i>Apodemus speciosus</i> (TEM.) ....                     |                                |                |                |                |
| <i>A. geisha</i> (THOMAS) ....                            |                                |                |                |                |
| <i>A. sp.</i> ....                                        |                                |                |                |                |
| <i>Microtus montebelli</i> (MILNE-EDWARDS) ....           |                                |                |                |                |
| <i>Rhinolophus ferrum-equinum nippon</i> TEM. ....        |                                |                |                | .....          |
| <i>R. sp.</i> ....                                        |                                |                |                |                |
| <i>Pipistrellus</i> (?) sp. ....                          |                                |                |                |                |
| △△ <i>Sorex shinto</i> THOMAS ....                        |                                |                |                |                |
| * <i>Anourosorex japonicus</i> SHIK. & HASEGAWA ....      |                                |                |                |                |
| <i>Crociodura dsinezumi chisai</i> THOMAS ....            |                                |                |                | .....          |
| <i>Urotrichus talpoides hondonis</i> THOMAS ....          |                                |                |                | .....          |

|                                                                                                       |     |      |    |     |
|-------------------------------------------------------------------------------------------------------|-----|------|----|-----|
| <i>Mogera wogura</i> (TEM.) .....                                                                     |     |      |    |     |
| The other vertebrate                                                                                  |     |      |    |     |
| Aves, gen. & sp. indet. ....                                                                          |     |      |    |     |
| <i>Elaphe quadrivirgata</i> STEIN. ....                                                               |     |      |    |     |
| <i>E. sp.</i> .....                                                                                   |     |      |    |     |
| <i>Natrix tigrina</i> (BOIE) .....                                                                    |     |      |    |     |
| <i>N. sp. aff. tigrina</i> (BOIE).....                                                                |     |      |    |     |
| Scincidae, gen. & sp. indet. ....                                                                     |     |      |    |     |
| Lacertilia, gen. & sp. indet. ....                                                                    |     |      |    |     |
| <i>Bufo vulgaris formosus</i> BOULENGER ? .....                                                       |     |      |    |     |
| <i>B. sp.</i> .....                                                                                   |     |      |    |     |
| <i>Rana</i> spp. ....                                                                                 |     |      |    |     |
| <i>Hyla</i> sp. ....                                                                                  |     |      |    |     |
| △△ <i>Thunnus orientalis</i> (TEM. & SCHL.) .....                                                     |     |      |    |     |
| Pisces, gen. & sp. indet. ....                                                                        |     |      |    |     |
| Total specific numbers                                                                                | 20  | 14   | 18 | 23  |
| Index of richness $\left( \frac{\text{total specific numbers}}{\text{numbers of localities}} \right)$ | 2.5 | 2    | 9  | 4.6 |
| Numbers of extinct species                                                                            | 5   | 1    | 0  | 0   |
| Ratio of extinct species to total                                                                     | 25% | 7%   | 0% | 0%  |
| Ratio of extinct species to total mammalia                                                            | 28% | 7.6% | 0% | 0%  |

\* Extinct \*\* Almost extinct △ Exotic to Japan △△ Exotic to Akiyosi-dai area.

It is very clear that the fauna of Isa bed (A) is much like and can be correlated in age to that of Upper Kuzuü which the senior author regarded to be late Pleistocene in age ( $J_2$ ) and to be the same age with the *Sinomegacerooides-Bison* fauna of Syodosima, Inland Sea or with the Kushiangtung bed in North Manchuria. We can say such a kind of fauna as of Isa bed is not so rare in Japan, but those of Akiyosi brown clay bed ( $J_3$ ) is rather rare, so that the discovery of this fossil bed may be very important. Another interesting thing is the possibility of the existence of men in Isa bed, as can be deduced from the find of *Thunnus* bone, supporting the opinion of NAORA that the fossil men are gained from the Upper Kuzuü bed\*. Nowadays the non-ceramic culture from the red earth bed of Tatikawian ( $J_3$ ) is said to have some aspect resembling somewhat the culture of Aurignacian from the typological points of view. The Upper Kuzuüian is older than Tatikawian and at present we cannot gain any valid materials of cultural remains from spelean deposits of this stage in Japan.

\* In 1957, T. ONO reported the occurrence of an end scraper and other stone implements from Kita Umakorobi of Akiyosi-dai and regarded them belonging to non ceramic culture. The authors think, it may belong to the Akiyosi brown clay.

## VI. Description of Selected Species

Mammalia

Order Ungulata

Family Suidae

*Sus leucomystax* TEMMINCK, 1845

(Pl. IV, Figs. 1-13, Pl. V, Figs. 1-4)

- 1845 *Sus leucomystax* TEMMINCK. In SIEBOLD'S Faun. Jap., p. 57.  
 1924 *Sus leucomystax* TEM., KISHIDA. Mon. Jap. Mamm., pp. 348-350.  
 1936 *Sus leucomystax* TEM., SHIKAMA. Jour. Geol. Soc. Jap., vol. 42, no. 516, pp. 647-659.  
 1938 *Sus leucomystax leucomystax* TEM., KURODA. List Jap. Mam., p. 2.  
 1938 *Sus leucomystax leucomystax* TEM., OKADA. Cat. Vert. Jap., p. 23.  
 1940 *Sus leucomystax* TEM., KURODA. Mon. Jap. Mam., pp. 5-6.  
 1949 *Sus scrofa leucomystax* TEM., IMAIZUMI. Nat. Hist. Jap. Mam., pp. 280-284.

**Specimens:** Upper left jaw with P<sup>4</sup>, M<sup>1</sup>, M<sup>2</sup>, upper right jaw with P<sup>3</sup>-M<sup>3</sup> and lower right DM<sub>3</sub> from Koziki-ana; a part of cranium, upper left jaw with M<sup>1</sup>, M<sup>2</sup>, upper right jaw with P<sup>4</sup>-M<sup>2</sup>, lower symphysis with right I<sub>1</sub>, left I<sub>1</sub>, I<sub>2</sub>, upper left I<sub>2</sub>, upper right P<sup>3</sup>, left P<sup>3</sup>, lower right C, lower left P<sub>4</sub>, distal part of right tibia, right and left calcaneum, right third metacarpus, left second, third and fourth metatarsus, proximal and middle phalanges of pes from Husen-ana.

**Description:** Specimens from Koziki-ana.

The both upper jaws belong to one fully grown adult individual and of large size; all teeth ground except hypocone, metacone and talon of M<sup>3</sup>. Parastyle of it well developed, thick and consists of six tubercles. In palatal view, M<sup>3</sup> elongate-trigonal, becoming much broader anteriorly and with distinct talon, which projects backward; paracone and metacone more eminent than protocone and hypocone: lingual side of the latter two steeper than buccal side of the former two. M<sup>2</sup> subquadrate in palatal view with eminent parastyle which consists of four to five tubercles; paracone and metacone more distinct than protocone and hypocone respectively. M<sup>1</sup> much smaller than M<sup>2</sup>, subquadrate, protocone and hypocone much broader than paracone and metacone respectively. P<sup>4</sup> subquadrate, a little broader than long, with eminent protocone and paracone; median valley tolerably deep. P<sup>3</sup> longer than broad with eminent ectoloph. Lower right DM<sub>3</sub> relatively short antero-posteriorly, with small sized talonid; dimensions are as follows:

|                 | Specimens in question |      | Adult specimen from  |         |
|-----------------|-----------------------|------|----------------------|---------|
|                 | Right                 | Left | Akaisi Mts.<br>Right |         |
| P <sup>3</sup>  | L.....                | 13.6 | —                    | 13.7 mm |
|                 | W.....                | 10.5 | —                    | 11.0    |
| P <sup>4</sup>  | L.....                | 12.9 | 12.8                 | 12.5    |
|                 | W.....                | 14.7 | 15.1                 | 14.1    |
| M <sup>1</sup>  | L.....                | 17.0 | 16.8                 | 18.2    |
|                 | W.....                | 14.2 | 14.3                 | 16.0    |
| M <sup>2</sup>  | L.....                | 22.0 | 22.7                 | 22.7    |
|                 | W.....                | 17.8 | 18.3                 | 18.2    |
| M <sup>3</sup>  | L.....                | —    | 37.8                 | 32.0    |
|                 | W.....                | —    | 20.5                 | 22.0    |
| DM <sub>3</sub> | L.....                | 29.3 | —                    | —       |
|                 | W.....                | 15.2 | —                    | —       |

L: Length    W: Width

Specimens from Husen-ana. Cranium consists of a part of right frontal, parietal and large parts of left frontal and parietal; it belongs to a young individual of small size. Anterior part of frontal anterior to supra-orbital foramen unpreserved. Contraction of parietal rather distinct, about 22.5 mm wide. Dorsal surface of cranium 111.2 mm long along median longitudinal suture, and left frontal 46.6 mm in maximum width. Right upper cheek teeth much ground, while those of left not much worn; the former small sized, especially M<sup>2</sup> is so, not long. Left M<sup>2</sup> eminent, larger and stouter than those from Koziki-ana; parastyle and metastyle consist of six tubercles. Lower symphysis carries right I<sub>1</sub>, left I<sub>1</sub> and I<sub>2</sub>; left I<sub>2</sub> almost complete in preservation while crowns of right and left I<sub>1</sub> broken off; crowns of I nearly triangular in cross section. Upper left I<sup>2</sup> worn anteriorly, longer than broad and with spatulate crown. All P<sup>3</sup> much ground, broader posteriorly than anteriorly. Lower right C large, stout, gently curved and tip of it tolerably ground; enamel surface partly worn; distance from tip to base 117 mm and diameters at middle height 27×14 mm.

**Remarks:** In size and shape, these specimens above mentioned just closely coincide with the fully grown adult male animal of the recent wild boar of Japan.

#### Family Cervidae

##### *Cervus (Sika) nippon* TEMMINCK, 1837

- 1842 *Cervus sika* TEMMINCK. In SIEBOLD'S Faun. Jap., pp. 54-55.  
 1898 *Cervus nippon typicus* LYDEKKER. Deer of All Lands, pp. 112-114.  
 1915 *Cervus nippon nippon* TEM., LYDEKKER. Cat. Ung. Mamm. Brit. Mus., vol. 4, pp. 108-110.  
 1932 *Cervus (Sika) nippon nippon* TEM., NAGASAWA. Jour. Geol. Soc. Jap., vol. 39, no. 461, pp. 71-84.  
 1941 *Cervus (Sika) nippon nippon* TEM., SHIKAMA. Jub. Pub. Comm. Prof. YABE, vol. 2, pp. 1150-1151.

- 1949 *Cervus (Sika) nippon nippon* TEM., SHIKAMA. Sci. Rep. Tôhoku Imp. Univ., ser. 21, vol. 23, pp. 103-104.  
1949 *Cervus nippon* TEM., IMAIZUMI. Nat. Hist. Jap. Mamm., pp. 285-293.

**Specimens:** Three right upper jaw fragments, a left upper jaw fragment, a right ramus, five right upper cheek teeth, twelve left upper cheek teeth and a right lower  $M_3$  from the third quarry of Nippon-Sekikai.

*Cervus (Depéretia) praenipponicus* SHIKAMA, 1936

(Pl. V, Figs. 5-26, Pl. VI, Figs. 1-17)

- 1936 *Cervus (Anoglochis) praenipponicus* SHIKAMA. Jour. Geol. Soc. Jap., vol. 43, no. 510, pp. 168-176.  
1937 *Cervus (Depéretia) praenipponicus* SHIKAMA. Sci. Rep. Tôhoku Imp. Univ., ser. 2, vol. 19, no. 1, p. 89.  
1941 *Cervus (Depéretia) praenipponicus* SHIKAMA. Jub. Pub. Comm. Prof. YABE, vol. 2, pp. 1147-1148.  
1949 *Cervus (Depéretia) praenipponicus* SHIKAMA. Sci. Rep. Tôhoku Imp. Univ., ser. 2, vol. 23, pp. 85-99.  
1949 *Cervus (Depéretia) praenipponicus* SHIKAMA, SHIK. & TAKAHASHI. Min. Geol., vol. 3, no. 3, p. 106.

**Specimens:** Two upper right jaw fragments, eight upper left jaw fragments, fourteen right rami including fragments, ten left rami including fragments, thirty-one isolated upper right cheek teeth, thirty seven isolated upper left cheek teeth, forty three isolated lower right cheek teeth, four isolated lower left I, a cranium, three right antler pedestals, a left antler pedestal, thirty four antler fragments, eight axis, three cervic vertebrae, a lumbar vertebra, eight scapulae (proximal parts), three fragments of innominate bone, twelve distal ends of humerus, a head of humerus, four proximal parts of radius, two distal parts of radius, an olecranon of ulna, three fragments of cannon bone, two distal parts of femur, a proximal end of tibia, a calcaneum, seven astragalus, two cubonavicular and thirteen phalnges from third quarry of Nippon-Sekikai. Judged from the numbers of rami, above fifteen individuals are deposited in the fissure of the quarry.

Besides these, two upper left jaws, right and left rami from fifth quarry of Nippon-Sekikai, which in 1949 described by the senior author and TAKAHASHI; three antler fragments, an upper right  $M^1$ , a left ramus, a lumbar vertebra, a left innominate bone, a fragment of radius, a proximal part of femur, a proximal end of tibia and a fragment of cannon bone from the quarry of Ube-Kôsan; of these innominate bone, femur and tibia are highly fossilized; left ramus, eight fragments of humerus, radius, femur, calcaneum, astragalus and phalanges from Husen-ana bed of Husen-ana; two antlers, a left upper jaw, right and left rami, detached upper cheek teeth, two supraocciput, atlas, axis, sacrum and right femur from Mizusimano-ana; a lower left  $M_1$  from



## Left upper teeth.

|                | No. 16 | No. 17 | No. 18 | No. 19 | No. 20 | No. 21  |      |
|----------------|--------|--------|--------|--------|--------|---------|------|
| P <sup>2</sup> | L      | —      | —      | —      | —      | 14.8 mm |      |
|                | W      | —      | —      | —      | —      | 13.8    |      |
| P <sup>3</sup> | L      | —      | —      | —      | —      | 13.3    |      |
|                | W      | —      | —      | —      | —      | 13.8    |      |
| P <sup>4</sup> | L      | —      | —      | —      | —      | 13.3    |      |
|                | W      | —      | —      | —      | —      | 13.5    |      |
| M <sup>1</sup> | L      | —      | 17.0   | —      | 18.8   | 18.0    | 17.7 |
|                | W      | —      | 17.2   | —      | 19.0   | 16.8    | 17.0 |
| M <sup>2</sup> | L      | 20.8   | 20.7   | 20.2   | —      | —       | 19.8 |
|                | W      | —      | 17.0   | 19.0   | —      | —       | 17.8 |
| M <sup>3</sup> | L      | 20.2   | —      | —      | —      | —       | 20.0 |
|                | W      | —      | —      | —      | —      | —       | 17.1 |

## Left lower teeth

|                | No. 1 | No. 2 | No. 3 | No. 21 | No. 22 | No. 23 | No. 24 | No. 25 | No. 26 | No. 32 |
|----------------|-------|-------|-------|--------|--------|--------|--------|--------|--------|--------|
| P <sub>2</sub> | L     | —     | —     | —      | —      | —      | —      | —      | 10.2   | 9.0 mm |
|                | W     | —     | —     | —      | —      | —      | —      | —      | 6.7    | 7.2    |
| P <sub>3</sub> | L     | —     | 11.5  | —      | —      | —      | —      | 13.2   | —      | 13.5   |
|                | W     | —     | 7.2   | —      | —      | —      | —      | 7.8    | —      | 8.3    |
| P <sub>4</sub> | L     | —     | 13.3  | —      | —      | —      | 14.0   | —      | —      | 14.2   |
|                | W     | —     | 8.7   | —      | —      | —      | 8.8    | —      | —      | 9.6    |
| M <sub>1</sub> | L     | 13.2  | 14.2  | —      | 13.7   | —      | —      | —      | —      | 15.7   |
|                | W     | 10.8  | 10.0  | 10.7   | 11.2   | —      | —      | —      | —      | 10.2   |
| M <sub>2</sub> | L     | 17.1  | 16.5  | 16.4   | 17.3   | 21.2*  | 20.0   | —      | —      | 18.9   |
|                | W     | 11.8  | 10.7  | 12.0   | 11.0   | 11.8   | 11.6   | —      | —      | 12.0   |
| M <sub>3</sub> | L     | 25.2  | —     | 23.5   | 24.3   | —      | —      | —      | —      | 23.9   |
|                | W     | 11.0  | 10.4  | 11.8   | 10.8   | —      | —      | —      | —      | 12.8   |

\* Unworn

## Right lower teeth

|                | No. 4 | No. 27 | No. 28 | No. 29 | No. 30 | No. 31 | No. 33  |
|----------------|-------|--------|--------|--------|--------|--------|---------|
| M <sub>1</sub> | L     | 13.0   | —      | —      | —      | —      | 15.8 mm |
|                | W     | 11.0   | —      | —      | —      | —      | 10.8    |
| M <sub>2</sub> | L     | 16.5   | 17.2   | —      | —      | —      | 19.0    |
|                | W     | 11.8   | 11.8   | —      | —      | —      | 11.8    |
| M <sub>3</sub> | L     | 24.2   | 24.8   | 25.7   | 24.0   | 26.8   | 22.8    |
|                | W     | 11.4   | 12.0   | 10.8   | 10.5   | 11.7   | 11.0    |

No. 1 from Husen-ana, Nos. 32 and 33 from Mizusimano-ana and others from third quarry of Nippon-Sekkai.

|                | Maximum and Minimum values | Ditto of <i>praenipponicus</i> from Kuzuü | <i>nippon</i> (NAGASAWA) |           |
|----------------|----------------------------|-------------------------------------------|--------------------------|-----------|
| M <sup>1</sup> | L                          | 16.9—18.8                                 | 15.4—17.2                |           |
|                | W                          | 16.8—18.7                                 | 16.3—18.0                |           |
| M <sup>2</sup> | L                          | 19.5—21.2                                 | 17.0—19.0                |           |
|                | W                          | 17.0—19.0                                 | 17.5—20.0                |           |
| M <sup>3</sup> | L                          | 19.2—20.2                                 | 17.4—21.0                |           |
|                | W                          | 17.1—18.6                                 | 17.0—19.5                |           |
| M <sub>1</sub> | L                          | 13.0—15.8                                 | 14.5—17.7                | 14.0—15.4 |
|                | W                          | 10.0—11.2                                 | 10.7—11.8                | 10.0—10.6 |
| M <sub>2</sub> | L                          | 16.4—21.2                                 | 18.5—20.7                | 16.8—17.8 |
|                | W                          | 10.7—12.0                                 | 11.2—13.7                | 11.0—11.6 |
| M <sub>3</sub> | L                          | 23.5—26.8                                 | 23.6—27.8                | 22.9—23.9 |
|                | W                          | 10.4—12.8                                 | 11.5—14.5                | 11.1—11.5 |

A left innominate bone retaining proximal portion of ilium of about 114 mm long; acetabulum subtriangular in outline, about 38×40 mm in diameters; ischial border rather acute but pubic border obtuse in running. A left metatarsus with distinct longitudinal groove on anterior surface; posterior surface of shaft concave backward, especially in proximal part; in lateral view shaft tapering distally. Dimensions follow.

|                                   |           |    |
|-----------------------------------|-----------|----|
| Length as preserved .....         | 228.0     | mm |
| Diameters of proximal end .....   | 25.6×24.2 |    |
| Ditto of shaft below middle ..... | 21.2×20.2 |    |

**Remarks:** It may be said that upper  $M^1$  and  $M^2$  are a little longer and lower  $M_1$  and  $M_3$  are a little shorter than those of *praenipponicus* from Kuzui, hence there may be a tolerable degree of variation within the species of *praenipponicus*.

*Sinomegaceros (Sinomegaceroides) yabei* (SHIKAMA), 1938

(Pl. VII, Figs. 1-12, Pl. VIII, Figs. 1-9)

- 1937 *Cervus (Megaceros)* sp. SHIKAMA. Jour. Geol. Soc. Jap., vol. 44, no. 524, p. 409.  
 1938 *Cervus (Sinomegaceros) yabei* SHIKAMA. Jap. Jour. Geol. Geogr., vol. 16, no. 1-2, pp. 115-122.  
 1941 *Cervus (Sinomegaceros) yabei* SHIKAMA. Jub. Pub. Comm. Prof. YABE, vol. 2, p. 1157.  
 1942 *Megaceros* sp. YAGI. Jour. Geogr., vol. 54, no. 635, p. 32.  
 1949 *Cervus (Sinomegaceros) yabei* SHIKAMA. Sci. Rep. Tôhoku Imp. Univ., ser. 2, vol. 23, pp. 107-111.  
 1954 *Euryceros* sp. NAORA. Old Stone Age Jap., pp. 95-96, 197-200.  
 1954 *Megaceros* sp. NAORA. Ibid., pp. 132-134.  
 1956 *Megaceros kinryuensis* MATSUMOTO & MORI. Dobutsugaku Zasshi, vol. 65, no. 6, pp. 17-21.

**Specimens:** A right tibia from Ube-Kôsan's quarry. The others from Husen-ana are as follows: Upper left  $P^3$ , upper right  $M^3$ , lower left  $M_2$  and  $M_3$ , piece of antler crown, two thoracic and lumbar vertebrae, two proximal parts of right and left scapula, two pieces of coracoid region of right and left scapula, large part of right humerus, left radius, distal end of left radius, right acetabulum, proximal part of right femur, entocondyle of left femur, two right tibia, right calcaneum, distal end of right (?) metatarsus, third and fourth proximal phalanges of right (?) pes, third middle phalange of right (?) pes: surfaces of scapulae, humeri, radii and femora are partly coated with calcium carbonate.

**Description:** Teeth. Upper teeth of this species have firstly been described here. Left  $P^3$  moderately worn, with high crown strongly bent backward; posterior outer fold much projected; median fold distinct; valley large and outer crescent narrower than inner interiorly, but longer anteriorly. Right  $M^3$  much worn and its accessory inner column worn; a

little broader than long; anterior fold and costa rather strong; median fold and accessory inner column very strong; anterior inner fold obsolete and antecrochet developed; cingulum moderately developed, enamel wall rather smooth. Dimensions are as follows:

|                                             | P <sup>3</sup> | M <sup>3</sup> |
|---------------------------------------------|----------------|----------------|
| Maximum length of crown .....               | 18.8           | 24.5 mm        |
| Length at crown base of outer lobe .....    | 14.8           | 22.0           |
| Maximum breadth of crown as preserved ..... | 15.9           | 25.0           |



Text-fig. 30. *Sinomegaceros* (*Sinomegaceroides*) *yabei* (SHIKAMA). Crown tip from Sionoiri, Urasato-mura, Tiisagata-gun, Nagano Prefecture.  $\times 0.5$ .

Lower left M<sub>2</sub> a little worn, with stout crown; inner costae strong and a small tubercle seen at base of median inner costa; accessory outer column very eminent; outer crescent larger than inner; in inner view, posterior costa of anterior and posterior lobes expanding upward; median fold of anterior lobe thick but abruptly tapering upward; posterior end of inner crescent of posterior lobe eminently keeled. Lower left M<sub>3</sub> unworn, retaining only crown; third lobe not large, semi-circular in upper view; median inner fold of first lobe thick and tapering upward; upper margin of inner lobe gently convex upward in inner view; posterior border of third lobe much bent forward; accessory inner column very distinct between first and second lobes; a small inner column very distinct between first and second lobes; a small posterior outer fold seen at base of posterior wall of second lobe. Dimensions follow.

|                                          | M <sub>2</sub> | M <sub>3</sub> |
|------------------------------------------|----------------|----------------|
| Maximum length of crown..                | 32.7           | 42.4 mm        |
| Length at crown base of inner lobe ..... | 27.8           | 41.9           |
| Maximum breadth of crown                 | 21.9           | 21.7           |

Antler fragment. A piece of crown tip preserved, which is 92.8 mm long and 36.7 $\times$ 19.0 mm in diameter of proximal end. Surface of crown rather

rugose. Crown tip of this species is also reported by T. YAGI from the Late Pleistocene bed of Sionoiri, Urasato-mura, Tiisa-gata-gun, Nagano Prefecture (Text. fig. 30). It is rather flat and like the palmated portion of *flabellatus* TEILHARD: two prongs preserved and their surface black coloured and rugose; one side of it strongly eroded; it is 311 mm in maximum length and 97.3 mm in width at base of prong.

Anterior thoracic vertebra broken in its neural spine, right half of neural arch, transverse process and in its prezygapophysis. Epiphysis is detached. Centrum 49.2 mm long and  $42.3 \times 34.6$  mm in diameter at anterior end. Lumbar vertebra preserved in its centrum which is partly broken and epiphysis detached. Centrum 51.6 mm long and  $43.0 \times 56.0$  mm in diameter.

Distal part of scapula unknown; coracoid process moderate in development; acromion unpreserved; anterior margin very straight while posterior much curved. Dimensions of two proximal parts are as follows:

|                                   | Right              | Left               |    |
|-----------------------------------|--------------------|--------------------|----|
| Maximum length as preserved ..... | 187±               | 185±               | mm |
| Diameters of glenoid cavity ..... | $58.5 \times 76.8$ | $51.8 \times 69.4$ |    |

Right humerus is tolerably well known. Shaft not long, proximal part of which broader antero-posteriorly than transversally: caput of head relatively large sized, near to circular in upper view: external insertion process not eminent. Internal condyle very broad, and supra-trochlea fossae deep and narrow. Dimensions of humeri follow:

|                                      |                    |      |
|--------------------------------------|--------------------|------|
| Maximum length as preserved.....     | 264                | mm   |
| Diameters of head .....              | $102 \times 132$   |      |
| Ditto of shaft below head .....      | $82.2 \times 52.4$ |      |
| Ditto of middle part of shaft .....  | $44.8 \times 41.3$ |      |
| Transverse length of trochlea .....  | 75.8               | 73.2 |
| Ditto of supra-trochlea fossae ..... | 25.5               |      |

Left radius is fully known although its epiphysis of distal end is detached and surface of shaft cracked longitudinally. Head projects outward, with rather deep articular depression that lies exteriorly. Small fossae lie at posterior part of articular depression. Shaft flat, thickening downward, and in distal part bearing two strong longitudinal ridges. Dimensions are as follows:

|                                     |                    |                 |
|-------------------------------------|--------------------|-----------------|
| Maximum length as preserved.....    | 339                | mm              |
| Diameters of head .....             | $84.2 \times 43.3$ | $— \times 42.5$ |
| Ditto of middle part of shaft ..... | $50.2 \times 30.8$ |                 |
| Ditto of distal part .....          | $75.0 \times 54.7$ |                 |

Right acetabulum preserved with outer surface of innominate bone enclosing the acetabulum, which near to oval, longer antero-posteriorly than transversally and  $68.2 \times 38.8$  mm in diameters.

Head of right femur round and relatively large in size. Trochanteric

fossa moderate in depression; surface below small trochanter very flat; great trochanter unpreserved and small trochanter broken. Entocondyle and distal inner surface of left femur preserved, the interior broken surface of which eroded and covered by calcite crystals. Dimensions follow:

|                                                 |           |    |
|-------------------------------------------------|-----------|----|
| Anterio-posterior diameter of head .....        | 56.1      | mm |
| Ditto below head.....                           | 38.5      |    |
| Diameters of shaft below small trochanter ..... | 53.0×49.5 |    |
| Ditto of entocondyle .....                      | 64.0×34.4 |    |

One right tibia almost completely preserved but epiphysis of its upper articulating surface detached, while another right tibia broken both in its proximal and distal parts; the broken one is larger than the other. Cnemial crest distinct, but longer than one third the total length of shaft. Outer side of the crest strongly concave. Upper articular surface irregularly triangular in upper view. Shaft nearly triangular in cross section; posterior surface largest and antero-inner surface a little smaller than antero-outer surface. Antero-inner side of distal end expanded to a considerable extent; median longitudinal groove seen at outer surface of distal end; in lower view, outer articulating surface broader than inner. Dimensions are as follows:

|                                   |           |           |
|-----------------------------------|-----------|-----------|
| Maximum length as preserved ..... | 332       | mm        |
| Diameters of proximal end .....   | 80.0×61.5 |           |
| Ditto of shaft at middle .....    | 42.8×29.0 | 49.8×38.2 |
| Ditto at distal end .....         | 68.0×49.8 |           |

Posterior surface of proximal part of right calcaneum broken; distal end coated with calcium carbonate. Tuber calcis long and stout: inner surface curved proximally; sustentacular facet for astragalus relatively small and round. Dimensions follow.

|                                                 |           |    |
|-------------------------------------------------|-----------|----|
| Maximum length as preserved.....                | 131.3     | mm |
| Diameters of distal end .....                   | 44.2×36.2 |    |
| Transverse diameter through sustentacular ..... | 56.5      |    |
| Diameters of tuber calcis at middle .....       | 43.2×27.0 |    |

Distal end of right(?) metatarsus about 86.5 mm long as preserved, 67.2 mm in maximum transverse diameter of distal end and 42.0 mm in fore- and- aft diameter of inner condyle. Median distal cleft narrow and deep. Median foramen of postero-distal surface oval shaped, deep and 11.0×4.0 mm in diameter.

Third proximal phalange of right(?) pes broken proximo-posteriorly, but fourth proximal phalange of it completely preserved. Anterior border in lateral view nearly straight, while posterior bent to it and lateral surface becomes much broader proximally. Articulating surface with condyle of metatarsus higher exteriorly than interiorly. Dimensions are as follows:

|                                                | Third     | Fourth    |
|------------------------------------------------|-----------|-----------|
| Maximum length along anterior border . . . . . | 84.2      | 84.2 mm   |
| Diameters of proximal end . . . . .            | 41.0×34.2 | 40.7×34.0 |

Third middle phalange relatively broad antero-posteriorly, with much expanded distal end; anterior and posterior tips of it much projected; interior distal surface bearing oval shaped depression and posterior distal surface bearing deep triangular depression: anterior and posterior borders tolerably curved in lateral view; maximum length along anterior border 49.7 mm and diameter of proximal end 37.0×29.8 mm.

**Remarks:** In the description of the new species *yabei* SHIKAMA, 1938, he touched the phylogenetic interrelations of megacerid group of the world. After that, in 1941, P. TEILHARD DE CHARDIN and W.C. PEI fully described the important species of *flabellatus* and *ordosianus*. In 1932, the new name of *ordosianus* was proposed by YOUNG, but it was invalid for the lack illustration and definite designation. The real description and definition of the species *flabellatus* was in 1936 given by TEILHARD DE CHARDIN, but more detailed description of it was given in 1941. As pointed out in the paper of the senior author above mentioned, the generic name of *Euryceros* GRAY, 1850 cannot be used, as it was preoccupied by *Euryceros* LESSON, 1832 given for Aves, hence for the Choukoutien megacerid, the generic name of *Sinomegaceros* DIETRICH, 1933 given by him for *pachyosteus* YOUNG of Choukoutien is to be used, regardless of his generic designation. TEILHARD and PEI, 1941 indicated the following synopsis of the Chinese megacerid (their Euryceroid deer).

1. Brow tine expanding transversally to the skull.
  - A. Brow tine enormous, pachyostosis moderate ..... *flabellatus*
    - a. Cylindrical portion of beam long, plane of palmature at 45° of plane of brow tine ..... type 1
    - b. Cylindrical portion of beam relatively short, plane of palmature subparallel to plane of brow tine ..... type 2
  - B. Brow tine moderate and subparallel to palmature, pachyostosis extreme ..... *pachyosteus*
    - a. Cylindrical portion of beam relatively short ..... type A-B
    - b. Cylindrical portion of beam extremely short or inexistent... type C
    - c. Brow tine moderate and practically fused with palmature, pachyostosis distinct but slight..... " *Euryceros* " sp. of Choukoutien
2. Brow tine expanding sagittally to the skull (and transversally to the palmature), not pachyostosed (?) ..... *ordosianus*

According to this synopsis, the species *yabei* belongs safely to the group A of *flabellatus*; in the outline of lower jaw and basal portion of antelr, the both species seem to be conspecific, but they may be distinct, as *yabei* of Late Pleistocene is much larger than *flabellatus* of Farly Pleistocene. For the A type, the senior author in 1949 gave the new subgeneric name *Sinomegaceroides*.



- 1936 *Palaeoloxodon aomoriensis* TOKUNAGA & TAKAI. Jour. Geol. Soc. Jap., vol. 43, no. 511, pp. 254-258.
- 1938 *Palaeoloxodon aomoriensis* TOKUNAGA & TAKAI. Jap. Jour. Geol. Geogr., vol. 15, no. 1-2, pp. 77-79.
- 1938 *Elephas namadicus aomoriensis* (TOK. & TAK.) MAKIYAMA. Mem. Coll. Sci. Kyoto Imp. Univ., ser. b, vol. 14, no. 1, p. 54.
- 1939 *Palaeoloxodon namadicus aomoriensis* TOK. & TAK., TAKAI. Jour. Geol. Soc. Jap., vol. 46, no. 552, p. 487.
- 1949 *Palaeoloxodon aomoriensis* TOK. & TAK., SHIKAMA. Sci. Rep. Tôhoku Imp. Univ., ser. 2, vol. 23, p. 74.

**Specimens:** Lower right  $M_2$  from Husen-ana; a piece of limb bone from Ube-Kôsan's quarry; a fragment of ramus from unknown locality of Akiyosidai.

**Description:** Molar. Lower right  $M_2$  not so good in preservation, small sized, stenocoronine, with fourteen ridges and hind talon; anterior end worn off and ridges formula probably  $\times 14 \times$ ; anterior five to six ridges coated with calcium carbonate; crown 167 mm long and 57 mm wide at middle height of ninth ridge, where it is broadest. Cement well developed and posterior three ridges unworn at grinding surface; cement of posterior part broken off and posterior three ridges separated from anterior ones. Dentine islets of anterior three ridges closely set to each other. Crown elongate-elliptical, with outer and inner borders converging backward, the former of which slightly concave and the latter convex. Anterior five ridges parallel to one another, also posterior eight ridges parallel to one another, but fifth, sixth and seventh ridges converge outward. Mesial expansion distinct, especially at from sixth to ninth ridges. Crenulation of enamel wall rather fine; wall not so thick as lower  $M_1$  of the type specimen, i.e. about 1.5 mm. Weak longitudinal cleft seen at both inner and outer portions of posterior ridges. Seventh ridge divided into two dentine islets, eighth and tenth ridges into three islets and ninth ridge into four islets respectively. Outer ends of fourth to sixth ridges turned forward; median portion of fore wall feebly convex forward while that of aft wall nearly straight. Last ridge carries five mammillae and hind talon two mammillae. Ridge frequency in 100 mm about nine at base and on grinding surface. In lateral view, anterior four ridges expanding upwardly; fifth to ninth ridges much concave posteriorly; last four ridges gently wavy. First five ridges converge to one root, which in cross section near to oval and its enamel wall very thick, about 7-10.3 mm; to next one root converge sixth to eighth ridges and enamel wall of the root 4-6 mm thick; succeeding ridges carry their roots respectively and root of ninth ridge triangular in cross section; root enamel wall of ninth and tenth ridges rather thick, 3.0-5.3 mm; that of eleventh and succeeding ridges rather thin. Dimensions of ridges follow.

| Ridge number ..  | 1     | 2     | 3      | 4      | 5      | 6     | 7       | 8    |
|------------------|-------|-------|--------|--------|--------|-------|---------|------|
| Maximum width    | 26.4  | 38.0± | 48.0   | 52.0±  | 52.0±  | 50.9  | 51.1    | 51.0 |
| Thickness*.....  | 8.8   | 6.7   | 9.8    | 10.2   | 11.8   | 12.2  | 11.3    | 11.7 |
| Outer height* .. | 77.4± | 64.2± | 58.8±  | 59.7±  | 61.2   | 67.6  | 71.8    | 83.2 |
| Inner height**.. | 70.5± |       | 58.9±  | 55.3±  | 60.7   | 64.5  | 77.2    | 84.8 |
|                  | 9     | 10    | 11     | 12     | 13     | 14    | Talon   |      |
|                  | 56.0± | 57.0  | 53.0   | 52.2   | 50.8   | 46.5  | 18.7 mm |      |
|                  | 11.0  | 9.9   | 8.8±   | 9.0    | 9.0    | 9.0   | 7.0     |      |
|                  | 91.6  | 101.2 | 106.2± | 105.8± | 97.2±  | 79.7± | 55.0    |      |
|                  | 94.3  | 100.5 | 104.0± | 103.8± | 103.0± | 80.8± | 50.9    |      |

\* First to eleventh ridges measured at median line of grinding surface; twelveth to fourteenth ridges measured at outer side of middle height; talon measured at inner side of middle height.

\*\* Measured in direct line from tip to basal cingula.

**Remarks:** Compared with the type specimen of *aomoriensis*, enamel layer of this specimen is rather thinner. Ridge frequency in 100 mm of the former is 9.5, hence a little differences are seen between them, but they may be due to individual variation.

This species is reported from Upper Kuzuü formation, Inland Sea of Off Syodo Island and from Hitinohe bed of Lower Noheji Group. The formations above mentioned have hitherto been regarded to be Late Pleistocene, deducing the dwarf of this species, but the senior author is now inclined to regard the Hitinohe bed not to be Late but older Pleistocene.

#### Order Carnivora

#### Family Canidae

#### *Canis lupus* L., 1758

(Pl. IX, Figs. 5-10)

- 1758 *Canis lupus* L. Sys. Nat., 10th ed., p. 39.  
 1912 *Canis lupus* L., MILLER. Cat. Mamm. West Europe, pp. 305-315.  
 1924 *Canis lupus lupus* L., KISHIDA. Mon. Jap. Mamm., pp. 233-235.  
 1934 *Ganis lupus* L., TOK. & NAORA. Rep. Ist Sci. Exp. Manch., sec. 2, pt. 1, p. 46.  
 1939 *Canis lupus* L., SAITO. Ibid., pt. 4, pp. 7-9.  
 1949 *Canis lupus* L., SHIKAMA. Sci. Rep. Tôhoku Imp. Univ., ser. 2, vol. 23, pp. 122-127.  
 1954 *Canis lupus* L., NAORA. Old Stone Age Jap., p. 233.

**Specimens:** Lower right and left C, right and left P<sub>2</sub>, left P<sub>4</sub> and right M<sub>1</sub> from Husen-ana bed of Husen-ana.

**Description:** All specimens detached from jaw, broken in roots and very fragile. Canines preserved only in tip portions and M<sub>1</sub> broken in both crown walls of blade. M<sub>1</sub> large sized, about 29.9 mm long and 14.5± mm wide; protoconid very strong and metaconid not obsolete: hypoconid rather eminent in talonid; anterior blade not high. Left P<sub>2</sub> 12.3 mm long, 7.0 mm wide and with

abruptly bending fore margin. Left  $P_4$  14.4 mm long,  $7.0 \pm$  mm wide with no distinct characteristics.

**Remarks:** In size and shape of  $M_1$ , these specimens may belong to the species *lupus*, corresponding to Siberian wolf. The lower left  $M_1$  described by the senior author as *lupus* from the Upper Kuzuü formation is  $29.5 \pm \times 11.5$  mm, hence the Akiyasi wolf is a little larger than the Kuzuü wolf mentioned above.

*Canis lupus hodopylax* TEM., 1845

(Pl. IX, Figs. 11-23)

- 1845 *Canis hodopylax* TEM. In SIEBOLD'S Faun. Jap., pp. 38-39.  
 1924 *Canis lupus hodopylax*, KISHIDA. Mon. Jap. Mamm., pp. 235-238.  
 1934 *Canis lupus* var. *variabilis* PEI. Pal. Sin., ser. c, vol. 8, fasc. 1, pp. 13-18.  
 1938 *Canis lupus hodopylax* TEM., KURODA. List. Jap. Mamm., p. 36.  
 1938 *Canis lupus hodopylax* TEM., OKADA. Cat. Vert. Jap., p. 16.  
 1940 *Canis lupus hodopylax* TEM., KURODA. Mon. Jap. Mamm., pp. 52-53.  
 1949 *Canis lupus hodopylax* TEM., IMAIZUMI. Nat. Hist. Jap. Mamm., p. 149.

**Specimens:** Upper left jaw and left ramus, atlas, axis, three cervic vertebrae, proximal part of right scapula, distal part of right humerus, proximal part of right ulan, right and left tibia and right calcaneum from Mizusimanoana.

**Description:** Upper jaw preserved from fore end of  $P^2$  to aft border of  $M^2$ : nasal unpreserved but anterior end of jugal preserved. Teeth entirely broken off except  $P^2$ , which is 13.2 mm long and 6.2 mm wide. Alveol of  $P^4$  and  $M^1$  are  $21.8 \times 12.7$  mm and  $11.4 \times 19.0$  mm respectively.

Ramus broken off upper border of coronoid process, angular process and symphyial region including C.  $M_3$  appeared but unpreserved:  $P_4$  entirely disappeared in living time, also there is seen a diastema between  $P_2$  and  $P_3$ : these indicate the ramus belonging to a fully grown adult animal. Horizontal ramus relatively thick and high especially at the region posterior to  $M_1$ . Fore border of ascending ramus much bent to horizontal ramus. Inferior dental foramen bears two exterior openings below  $P_1$ .  $P_1$  much worn, and with blunt crown. Crown of  $P_2$  broken.  $P_3$  relatively broad and high, with much ground crown tip. Tips of trigonid cusps and exterior surface of talonid much worn in  $M_1$ , which is stout and strong.  $M_2$  oval in upper view and much worn. Dimensions follow.

|                                              |         |
|----------------------------------------------|---------|
| Length of ramus as preserved.....            | 55.5 mm |
| Depth of it at $P_1$ ..                      | 24.7    |
| Ditto at fore end of $M_1$ .....             | 27.0    |
| Ditto at aft end of $M_1$ .....              | 30.5    |
| Height of ascending ramus as preserved ..... | 54.3    |
| Maximum width of ascending ramus .....       | 42.9    |

|                                                                 |                              |                              |
|-----------------------------------------------------------------|------------------------------|------------------------------|
| Thickness of ramus at P <sub>2</sub> .....                      | 12.5                         |                              |
| Ditto at posterior of M <sub>1</sub> .....                      | 12.8                         |                              |
| Length of tooth row from P <sub>1</sub> to M <sub>3</sub> ..... | 58.2                         |                              |
| P <sub>1</sub> { L..... 5.5                                     | P <sub>3</sub> { L..... 12.9 | M <sub>1</sub> { L..... 27.0 |
| { W..... 4.0                                                    | { W..... 6.8                 | { W..... 10.8                |
| P <sub>2</sub> { L..... 10.4±                                   |                              | M <sub>2</sub> { L..... 9.4  |
| { W..... 5.9±                                                   |                              | { W..... 8.2                 |

Vertebrae. Atlas broken in its both exterior borders of transverse processes. Ring a little high vertically; anterior margin of neural arch thick and rugose, while posterior one of it acute; antero-inner corner of transverse process bears strong notch; hypophysis projecting a little strongly backward; ventral surface of arch very short antero-posterioly along its median line; ring at its anterior opening 44.0×30.5 mm and at its posterior opening 36.8×28.8 mm. Atlas about 80.0 mm in maximum width as preserved, 18.9 mm in median length of dorsal arch and 11.9 mm in median length of ventral arch including hypophysis. Axis good in preservation except dorsal margin of neural spine which is 51.2 mm long; ring tolerably narrow and centrum long; it is about 45.2 mm long and 28.0 mm in middle width; odontoid process very eminently projected postero-upwardly. Three cervic vertebrae precisely unknown in their position, broken in their transverse processes; the largest one carries eminent dorsal arch and strong prezygapophysis; dorsal surface very flat, 21.8 mm long and 34.2 mm in middle width; centrum much projects postero-downwardly.

Distal part of right humerus 116.8 mm long as preserved and 42.2 mm in width of trochlea; exterior condyle longer than broad, with strong backward projection; supra-trochlea foramen large and posterior depression just above trochlea very deep; in upper view of trochlea seen a groove running in crescent shape behind the foramen. Proximal part of right ulna 83.9 mm long as preserved and 25.5 mm in middle width of head, which, not high, carries strong upper border. Right tibia broken in its distal end, while left tibia preserved perfectly; the former 197 mm long as preserved and the latter 210 mm long; cnemial crest rather eminent; head in upper view subtriangular, longer than broad, 47.0×38.7 mm in left dimensions; interio-posterior corner projects backward; distal end 28.7×20.2 mm in left dimensions.

Right calcaneum 53.5 mm long, 21.2 mm wide at above sustentacular facet and 10.5 mm thick at middle of tuber clacis, which tapers distalward; sustentacular facet for astragalus broad, shallow and carries a distinct groove running in antero-posterior direction at inner region.

**Remarks:** In size of teeth, the specimens above described just belong to the Japanese hondo wolf, *lupus hodopylax* TEM., which has nowadays almost disappeared from the mainland of Japan and is rather noteworthy as a small sized wolf. Hitherto we could not gain any fossil *hodopylax* from Pleistocene of Japan, so that those specimens may be the first record of it. *Canis lupus*

*variabilis* PEI reported from the *Sinanthropus* bed of Choukoutien is a smaller sized wolf and in size and shape closely allies to *hodopylax*, probably synonymic to it, hence it becomes probable that *hodopylax* migrated from continent to Japan in geologic time.

*Canis* sp. aff. *familiaris* L., 1758

(Pl. IX, Figs. 24, 25, Pl. X, Figs. 1-5)

**Specimens:** Right and left rami belonged to ETO's collection from Nakao-do; cranium and left ramus from Makurazino-ana; rostrum and two right rami from Akiyosi brown clay bed of Husen-ana.

**Description:** Cranium unpreserved in zygomatic arch, occipital condyles, tympanic bullae and in fore border of postorbital process. It has no different characteristics compared with that of the recent dog. Rostrum unpreserved in nasal region and in posterior portion of frontal; palate preserved but all teeth unpreserved except left P<sup>2</sup> and P<sup>3</sup>. Dimensions are as follows:

|                                                      | Cranium                          | Rostrum |
|------------------------------------------------------|----------------------------------|---------|
| Maximum width of cranium.....                        | 52.0                             | — mm    |
| Distance between tips of postorbital processes ..... | —                                | 38.0+   |
| Height of occipt along median line .....             | 49.0                             | —       |
| Width of occipt at base .....                        | 62.8                             | —       |
| Width of palate including P <sup>4</sup> .....       | —                                | 53.5    |
| P <sup>2</sup> {Length..... 9.4                      | P <sup>3</sup> {Length..... 11.2 |         |
| {Width..... 4.2                                      |                                  |         |

Five rami all correspond in size and shape to that of the recent dog, but the following may be noted; anterior portion of horizontal ramus not low relatively. Ramus from Maruyama unpreserved in upper border of coronoid process, angular process and symphysial region including P<sub>1</sub>: all teeth unpreserved except M<sub>2</sub>: M<sub>3</sub> appeared as alveol. Rami from Nakao-do unpreserved in horizontal ramus, but all teeth preserved except I. Two fragmental rami from Makurazino-ana especially small sized; one preserved from the region below M<sub>1</sub> to anterior portion of ascending ramus; another preserved from the region below P<sub>2</sub> to that below M<sub>1</sub>. Dimensions are as follows:

|                                                                | Maruyama | Nakao |       | Makurazi |         |
|----------------------------------------------------------------|----------|-------|-------|----------|---------|
|                                                                | Left     | Right | Left  | Right A  | Right B |
| Length of ramus as preserved .....                             | 121.2    | 105.0 | 85.0  | 58.3     | 57.8 mm |
| Depth of ramus at P <sub>1</sub> .....                         | —        | 18.9  | 18.7  | —        | —       |
| Ditto at fore end of M <sub>1</sub> .....                      | 21.9     | 20.2  | 19.8  | —        | 19.7    |
| Ditto at aft end of M <sub>1</sub> .....                       | 23.0     | 22.8  | 20.9+ | 19.5     | —       |
| Height of ascending ramus as preserved                         | 40.0     | —     | —     | —        | —       |
| Maximum width of ascending ramus....                           | 31.8     | —     | —     | —        | —       |
| Thickness of ramus at P <sub>2</sub> .....                     | 11.0     | 10.0  | 9.8   | —        | —       |
| Ditto at posterior of M <sub>1</sub> .....                     | 11.7     | 10.8  | 11.2  | 9.0      | —       |
| Length of tooth row from P <sub>1</sub> to M <sub>2</sub> .... | —        | 62.8  | —     | —        | —       |

|                |   |      |      |      |      |      |
|----------------|---|------|------|------|------|------|
| C              | L | —    | 10.7 | 10.7 | —    | —    |
|                | W | —    | 5.9  | 6.0  | —    | —    |
| P <sub>1</sub> | L | —    | 4.2  | 4.5  | —    | —    |
|                | W | —    | 3.5  | 3.5  | —    | —    |
| P <sub>2</sub> | L | —    | 7.7  | 7.0  | —    | —    |
|                | W | —    | 4.0  | 4.3  | —    | —    |
| P <sub>3</sub> | L | 11.5 | 9.5  | 9.4  | —    | 9.8  |
|                | W | —    | 4.5  | 4.8  | —    | 4.8  |
| P <sub>4</sub> | L | 13.2 | 11.2 | 11.0 | —    | 10.9 |
|                | W | —    | 5.8  | 5.3  | —    | 6.3  |
| M <sub>1</sub> | L | 22.2 | 19.2 | 19.6 | 18.8 | 19.0 |
|                | W | —    | 8.2  | 7.8  | 7.8  | 7.8  |
| M <sub>2</sub> | L | 9.2  | 7.8  | —    | 8.0  | —    |
|                | W | 7.8  | 6.2  | —    | 6.5  | —    |

Lower right M<sub>1</sub> from Husen-ana about 19.8×8.8 mm in dimensions. It may be noted that the teeth from Maruyamano-ana are larger than the others but smaller than that of *hodopylax*. Anterior blade of M<sub>1</sub> from Makurazino-ana is relatively large and low but those from Nakao-do and Husen-ana are small and high.

**Remarks:** The authors cannot find any different characteristics of these specimens from that of recent dog, so that it may be interesting to note from the view point of the history of the Japanese wild dog, that in the Latest Pleistocene wild dog was living in Japan.

#### *Nyctereutes viverrinus* TEM., 1844

(Pl. X, Figs. 6-22, Pl. XI, Figs. 1-3)

- 1844 *Nyctereutes viverrinus* TEM. In SIEBOLD'S Faun. Jap., pp. 40-43.  
 1924 *Nyctereutes viverrinus* TEM., KISHIDA. Mon. Jap. Mamm., pp. 239-242.  
 1940 *Nyctereutes procyonoides viverrinus* TEM., KURODA. Mon. Jap. Mamm., pp. 51-52.  
 1949 *Nyctereutes procyonoides viverrinus* TEM., IMAIZUMI. Nat. Hist. Jap. Mamm., pp. 152-153.

**Specimens:** A lower right jaw from Ube-Kôsan's quarry; skull, both right and left rami, lower left M<sub>1</sub>, four vertebrae, fragment of innominate bone and phalange from Akiyosi brown clay bed of Husen-ana; three vertebrae, distal part of right humerus and right femur from Akiyosi brown clay bed of Tanuki-ana; supraoccipital, right ramus, lower left C, vertebra, fragment of innominate bone, proximal part of right ulna, both right and left femur, head of left femur, proximal part of left tibia and metacarpus from surface soil of Tanuki-ana; a skelton from Obaga-ana; right ramus, part of innominate bone and left ulna from Maruyamano-ana; right upper jaw, four right rami, two left rami, twelve vertebrae, proximal part of right ulna, right tibia and three left tibiae from Akiyosi brown clay bed of Makurazino-ana; four fragments of skull from surface soil of Makurozino-ana; sacrum and vertebra from Naki-ana; right upper jaw, three right rami, left ramus, five vertebrae,

right humerus, left ulna, left femur, right tibia and proximal part of left tibia from COIFFAIT'S cave.

### Family Ursidae

#### *Ursus arctos* L., 1766

(Pl. XI, Figs. 4-6)

- 1912 *Ursus arctos* L., MILLER. Cat. Mamm. West Eur., pp. 285-297.  
 1934 *Ursus arctos* L., PEI. Pal. Sin, ser. c, vol. 8, fasc. 1, pp. 53-63.  
 1934 *Ursus arctos yesoensis* LYDEKKER, INUKAI & MUKASA. Fol. Anat. Jap., bd. 12, heft. 4, pp. 291-300.  
 1937 *Ursus arctos yesoensis* LYDEKKER, MUKASA. Trans. Sapporo Nat. Hist. Soc., vol. 15, pt. 2, pp. 96-110.  
 1949 *Ursus arctos* L., SHIKAMA & TAKAHASHI. Min. Geol., vol. 3, no. 3, pp. 105-106.

**Specimens:** Anterior part of lower right jaw from fifth quarry of Nippon-Sekai; right humerus and right ulna from Ube-Kôsan's quarry.

**Description:** Ramus. Anterior part of horizontal ramus bears  $I_1$ ,  $I_2$ ,  $C$   $P_4$  but crowns of incisors are all broken off and also canine crown largely broken away. Ramus, large sized, relatively high and symphysis well developed.  $P_1$  just behind  $C$  obsolete, indicating a fully grown adult animal. Most posterior one of three inferior dental foramina lies behind  $P_4$ : anterior two inferior dental foramina oval in outline, occupy middle height of jaw. Lower margin of ramus nearly straight, while upper margin slightly curved. Anterior margin of symphysis in lateral view slightly convex forward. Tip and posterior surface of crown of  $P_4$  ground; in upper view crown nearly quadrate in general outline. Alveole of  $I_1$  smallest and that of  $I_3$  largest of all incisors. Dimensions are as follows:

|                                               | <i>arctos</i> *         |               |               | <i>angustidens speleaeus</i> |                           |
|-----------------------------------------------|-------------------------|---------------|---------------|------------------------------|---------------------------|
|                                               | Isa Choukoutien Loc. 1. | Recent        |               | Choukou-tien Loc. 1.         | Choukou-tien Upper cave   |
| Length of symphysis .....                     | 47.0                    | 46.0          | 41.0 ±        | 34.0 ±                       | 54.0 mm                   |
| Distance between C and $P_4$ .....            | 41.0                    | —             | 28.5          | —                            | —                         |
| Maximum thickness of ramus at symphysis ..... | 28.6                    | —             | 17.0          | —                            | —                         |
| Depth of ramus in front of $P_4$ ..           | 51.0                    | 54.2          | 41.0          | 46.5                         | 54.0-63.0                 |
| Height of C as preserved.....                 | 63.0                    | —             | —             | —                            | —                         |
| Length and width of C .....                   | 21.8 ×<br>14.7          | —             | 19.0 ×        | —                            | —                         |
| Ditto of $P_4$ .....                          | 12.3 ×<br>8.0           | 15.0 ×<br>9.4 | 13.0 ×<br>6.5 | 11.6 ×<br>7.0                | 15.0 × 7.6-<br>17.2 × 9.1 |

\* Specimen stored in the National Science Museum in Tokyo.

Right humerus perfectly preserved. Head in upper view nearly oval in general outline, a little longer than broad with weak bicipital groove, anterior notch of which distinct. Deltoid ridge not distinct, with two eminent lower

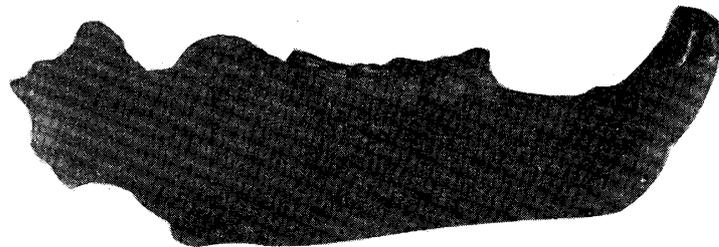
crests which are parallel to one another and obliquely running to shaft; surface of deltoid ridge rather flat. Shaft running nearly straight, uninflated upward, in lateral view turned backward at just below deltoid ridge and above ectocondylar ridge, the last of which not long. Trochlea relatively broad and without ent-epicondylar foramen. Supra-trochlea foramen broad and deep. Surface of internal condyle rugose. Dimensions of humerus follow.

|                                              |           |    |
|----------------------------------------------|-----------|----|
| Maximum length from head to trochlea .....   | 296.5     | mm |
| Diameter of head .....                       | 67.4×58.0 |    |
| Ditto of shaft below head .....              | 38.2×36.2 |    |
| Ditto at just above ectocondylar ridge ..... | 33.0×26.2 |    |
| Ditto at above supra-trochlea fossae .....   | 55.2×23.5 |    |
| Transverse length of trochlea .....          | 84.8      |    |
| Ditto of supra-trochlea fossae .....         | 31.8      |    |

Right ulna almost completely preserved. Shaft much curved inward and inflates upward. Olecranon small sized and very low, while articulating processes of sigmoid notch very stout. Sigmoid fossa in anterior view irregularly triangular with elongate and constricted fossa lunaris; inner margin of sigmoid fossa strongly curved. Inner surface of shaft much concave at its proximal median portion and outer surface of it with two distinct longitudinal sharp ridges. Anterior surface just below sigmoid fossa very rugose. Dimensions follow.

|                                                     |           |    |
|-----------------------------------------------------|-----------|----|
| Maximum length .....                                | 265.8     | mm |
| Length of olecranon at anterior border.....         | 13.6      |    |
| Minimum longitudinal distance of sigmoid notch..... | 25.3      |    |
| Diameters of olecranon .....                        | 31.6×23.5 |    |
| Ditto of shaft below sigmoid fossa .....            | 38.7×16.5 |    |
| Ditto at distal portion .....                       | 18.0×15.7 |    |

**Remarks:** General size of the ramus is rather larger than the mean size of *arctos*, corresponding to the huge sized form of *arctos* from Choukuotien Loc. 1. This may coincide with the ramus of fully grown adult animal. In size, this form may occupy the intermediate position of *arctos* and *spelaeus*. The Choukuotien *arctos* is rather noteworthy for its large size. NAORA reported the occurrence of *arctos yessoensis* from Ogano quarry, Kuzuü-mati,



Text-fig. 31. *Ursus japonicus* SCHLEGEL. Right ramus from off Syodo Island (gypsum model). ×0.3.

but he has not described it fully. *Ursus tanakai* SHIKAMA from the Upper Kuzuü formation belongs to *japonicus-thibetanus* group. *Ursus japonicus* SCHLEGLE from the sea floor of off Syodo Island of Inland Sea represented by its right lower jaw stored in Waseda University, was destroyed in the War, but its figure by NAORA and gypsum model of which (Text-fig. 31) are reserved. The crown of teeth fully ground and the general size and shape of the ramus perfectly referred to *japonicus*. Incisors are all unpreserved, anterior end of the ramus is broken off, and coronoid process is also broken away.  $P_4$  is unpreserved. Dimensions are as follows:

|                                            |           | Specimen from<br>Akaisi Mts. |
|--------------------------------------------|-----------|------------------------------|
| Length of ramus as preserved .....         | 175.0     | 194.0 mm                     |
| Maximum basal length of coronoid process.. | 56.0      | 51.7                         |
| Distance between C and $M_1$ .....         | 38.2      | 46.0                         |
| Depth of ramus in front of $M_1$ .....     | 35.5      | 33.2                         |
| Ditto posterior to $M_3$ .....             | 43.8      | 42.4                         |
| United length of molars at alveol .....    | 57.8      | 59.8                         |
| Length and width of C at crown base .....  | 21.2×14.0 | 17.0×11.2                    |
| Ditto of $M_1$ at crown base .....         | 18.9×12.8 | 21.0×10.8                    |
| Ditto of $M_2$ at crown base .....         | 19.8×11.7 | 22.2×13.8                    |
| Ditto of $M_3$ at crown base .....         | 18.9×13.2 | 17.2×13.0                    |

#### Family Mustelidae

##### *Mustela erminea* L., 1758

(Pl. XI, Fig. 13)

- 1758 *Mustela erminea* L. Syst. Nat., 10th ed., p. 46.  
 1924 *Mustela erminea* L., KISHIDA. Mon. Jap. Mamm., pp. 266-267.  
 1948 *Mustela erminea* L., SHIKAMA. Sci. Rep. Tôhoku Imp. Univ., ser. 2, vol. 23, pp. 162-164.  
 1949 *Mustela erminea* L., IMAIZUMI. Nat. Hist. Jap. Mamm., pp. 176-178.

**Specimen:** A right ramus from Tokuyama-Soda's quarry, Yamase.

**Description:** Ramus 20.8 mm long as preserved, retaining carnassial and  $P_2$ ;  $M_1$  elongate quadrate in upper view and posterior blade a little higher than anterior; trigonid much higher than talonid;  $P_2$  very small, with edge like simple crown. Dimensions follow.

|                                            |        |
|--------------------------------------------|--------|
| Width of ascending ramus .....             | 5.8 mm |
| Depth of ramus at posterior of $M_1$ ..... | 4.3    |
| Height of ascending ramus .....            | 9.6    |
| Length of tooth row (I- $M_2$ ) .....      | 13.2   |

**Remarks:** The specimen now at hand is slightly larger than the fossil mink from the Upper Kuzuü formation but in shape almost indistinguishable from it. It is still a question whether the specimen belongs to one of the subspecies of *erminea nippon* CABRERA (hondo mink) or to *erminea kanei* BAIRD (Ezo mink).

*Mustela itatsi* TEM., 1844

(Pl. XI, Figs. 10-12)

- 1844 *Mustela itatsi* TEM. In SIEBOLD'S FAUN. Jap., pp. 34-35.  
 1924 *Mustela (Lutreola) itatsi itatsi* TEM., KISHIDA. Mon. Jap. Mamm., pp. 271-273.  
 1940 *Mustela itatsi itatsi* TEM., KURODA. Mon Jap. Mamm., p. 40.  
 1949 *Mustela sibirica itatsi* TEM., IMAIZUMI. Nat. Hist. Jap. Mamm., pp. 169-170.

**Specimens:** Rostrum and right ramus from COIFFAIT'S cave; left ramus from surface soil of Makurazino-ana.

**Description:** Rostrum. Frontal, nasal, maxilla and large part of palate preserved, retaining all teeth except left P<sup>2</sup>. Rostrum relatively short, broad, high, about 28.9 mm long as preserved and 21.0 mm in maximum width as preserved; in lateral view, upper border of nasal a little swelling upward; infraorbital foramen subtriangular in outline; palatal width including M<sup>1</sup> 18.2 mm and tooth row from C to M<sup>1</sup> 15.2 mm long. A left ramus broken in upper part of ascending ramus and a right broken in symphyseal part anterior to P<sub>3</sub> and in a part of coronoid process. Ramus relatively high and thick and anterior border of ascending ramus gently bent backward. Right ramus retaining all teeth except I and left one retains P<sub>3</sub>-M<sub>2</sub>; left tooth row from C to M<sub>2</sub> 18.9 mm long. Dimensions are as follows:

|                                                                   | Right | Left    |
|-------------------------------------------------------------------|-------|---------|
| Length as preserved .....                                         | 27.7  | 30.4 mm |
| Ditto at symphysis .....                                          | —     | 9.0     |
| Basal width of ascending ramus .....                              | 9.6   | 9.5     |
| Height of ramus at posterior to P <sub>3</sub> on inner side .... | 5.8   | 5.8     |
| Ditto to M <sub>1</sub> on inner side .....                       | 6.0   | 5.9     |
| Height of ascending ramus as preserved .....                      | 11.9  | 10.2    |

Upper C relatively long and curved backward; P<sub>2-3</sub> sectoral in lateral view, with acute cusps and in general aspect not differing from that of the recent Japanese weasel; M<sup>1</sup> irregularly pendulate in palatal view and median constriction eminent; deuterocone large sized and opposed to protocone; internal cingula rim very strong. All cusps of lower P bent forward and that of P<sub>4</sub> very acute. Trigonid of M<sub>1</sub> low and long, while talonid relatively small. M<sub>2</sub> very small, rudimentary and nearly circular in upper view. Dimensions of teeth follow:

|    | Upper      |      | Lower |      |    |
|----|------------|------|-------|------|----|
|    | Right      | Left | Right | Left |    |
| I1 | L..... 1.2 | 1.2  | —     | —    | mm |
|    | W..... 0.6 | 0.6  | —     | —    |    |
| I2 | L..... 1.3 | 1.3  | —     | —    |    |
|    | W..... 0.8 | 0.7  | —     | —    |    |
| I3 | L..... 2.2 | 2.2  | —     | —    |    |
|    | W..... 1.1 | 1.2  | —     | —    |    |
| C  | L..... 3.0 | 3.0  | —     | 4.2  |    |
|    | W..... 2.7 | 2.6  | —     | 3.0  |    |

|    |          |     |     |     |     |
|----|----------|-----|-----|-----|-----|
| P2 | { L..... | 2.1 | —   | —   | 2.8 |
|    | { W..... | 1.5 | —   | —   | 1.3 |
| P3 | { L..... | 4.2 | 4.0 | 3.3 | 3.8 |
|    | { W..... | 2.5 | 2.4 | 2.3 | 2.0 |
| P4 | { L..... | 6.1 | 6.0 | 3.8 | 3.8 |
|    | { W..... | 3.7 | 3.7 | 2.3 | 2.4 |
| M1 | { L..... | 3.8 | 3.2 | 6.7 | 6.8 |
|    | { W..... | 5.0 | 5.0 | 3.2 | 3.2 |
| M2 | { L..... | —   | —   | 1.4 | 1.3 |
|    | { W..... | —   | —   | 1.5 | 1.3 |

**Remarks:** The Akiyosidai weasel is not distinct in size and shape from the common type of Japanese weasel (hondo weasel), *M. itatsi* TEM. and larger than the small weasel, *M. sho* KURODA.

*Martes ten* SHIKAMA, 1949

1949 *Martes ten* SHIKAMA. Sci. Rep. Tôhoku Imp. Univ., ser. 2, vol. 23, pp. 156-158.

**Specimen:** Right ramus from Husen-ana bed of Husen-ana.

**Description:** Rather poor in preservation, broken in its inner side, synphysial region and in posterior border; all teeth are unpreserved and ramus is 69 mm long as preserved.

*Meles anakuma* TEM., 1842

(Pl. X, Figs. 23-25, Pl. XI, Figs. 7-9)

1842 *Meles anakuma* TEM. In SIEBOLD'S Faun. Jap., p. 30.

1924 *Meles anakuma* TEM., KISHIDA. Mon. Jap. Mamm., p. 256.

1940 *Meles anakuma* TEM., KURODA. Mon. Jap. Mamm., pp. 32-33.

1949 *Meles anakuma* TEM., SHIKAMA. Sci. Rep. Tôhoku Imp. Univ., ser. 2, vol. 23, pp. 146-152.

1949 *Meles meles* (L.), IMAIZUMI. Nat. Hist. Jap. Mamm., pp. 178-181.

**Specimens:** A skull, left humerus and distal part of left humerus from COIFFAIT'S cave; atlas, right ramus, distal part of right humerus, left ulna and right femur from Makurazino-ana; right ramus from Tanuki-ana.

**Description:** Skull relatively small sized, retaining rostral portion; P<sup>4</sup> and M<sup>1</sup> preserved; sagittal crest not obsolete, brow smooth and slightly inflated upward. Dimensions follow.

|                                                    |         |
|----------------------------------------------------|---------|
| Length along palate as preserved .....             | 72.0 mm |
| Ditto of palate along median suture.....           | 55.0    |
| Width of rostrum at postorbital constriction ..... | 21.2    |
| Ditto over C .....                                 | 25.8    |
| Width of palate including M <sup>1</sup> .....     | 23.9    |
| Height of rostrum behind M <sup>1</sup> .....      | 31.0    |
| Ditto behind C .....                               | 23.0    |

Rami relatively small and short; horizontal ramus low and not stout; ascending ramus relatively low and acutely pointed upward; posterior border straight and bent forward. Dimensions of rami are as follows:

|                                                 | Makurazino-ana | Tanuki-ana |
|-------------------------------------------------|----------------|------------|
| Length as preserved .....                       | 53.8           | 68.2mm     |
| Width of ascending ramus .....                  | —              | 21.0       |
| Depth of ramus at posterior end of symphysis .. | —              | 10.3       |
| Ditto at posterior part of M <sub>1</sub> ..... | 12.2           | 10.7       |
| Height of ascending ramus .....                 | —              | 32.3       |

Upper P<sup>4</sup> longer than broad; antero-inner and postero-inner borders slightly concave inward; inner corner projected. M<sup>1</sup> rhomboidal in palatal view; posterior-inner and postero-outer borders longest and antero-outer border shortest; intermediate longitudinal ridge not acute; deuterocone eminent and projected anteriorly. Dimensions are as follows:

|                          | Right | Left   |
|--------------------------|-------|--------|
| P <sup>4</sup> { L ..... | 7.2   | 7.0 mm |
| { W .....                | 5.2   | 5.2    |
| M <sup>1</sup> { L ..... | 11.2  | 10.8   |
| { W .....                | 9.2   | 9.3    |

Lower M<sub>1</sub> irregularly quadrate in upper view, with both lateral margins crenulated; that from Makurazi tolerably worn and talonid almost flat: protoconid eminent. Dimensions of lower teeth follow.

|                          | Tanuki-ana | Makurazino-ana |
|--------------------------|------------|----------------|
| C { L .....              | 5.7        | — mm           |
| { W .....                | 3.8        | —              |
| P <sub>2</sub> { L ..... | 2.8        | —              |
| { W .....                | 2.0        | —              |
| P <sub>3</sub> { L ..... | 4.8        | 5.0            |
| { W .....                | 3.2        | 3.0            |
| P <sub>4</sub> { L ..... | 5.7        | 6.1            |
| { W .....                | 3.6        | 3.5            |
| M <sub>1</sub> { L ..... | 13.0       | 11.8           |
| { W .....                | 6.0        | 5.8            |

### Felidae

#### *Felis tigris* L., 1766

(Pl. XII, Figs. 1-3)

- 1934 *Felis* sp. cf. *tigris* L., PEI. Pal. Sin., ser. c, vol. 8, fasc. 1, pp. 130-133.  
 1949 *Felis* sp. (*tigris* type) SHIKAMA. Sci. Rep. Tôhoku Imp. Univ., ser. 2, vol. 23, p. 116.  
 1953 *Felis tigris* L., COLBERT & HOOIJER. Bull. Amer. Mus. Nat. Hist., vol. 102, art. 1, pp. 67-70.  
 1954 *Felis* sp. NAORA. Old Stone Age Jap., p. 136.

**Specimens:** Upper right C, left humerus and proximal end of right ulna from Ube-Kôsan's quarry.

**Description:** Right upper C long, slender, 100.8 mm long, 44.5 mm in crown length, 23.3×15.8 mm in diameter of crown base and 25.5×18.2 mm in ditto of middle of C. Posterior border of root nearly straight in lateral view, while that of crown gently curved; anterior border more strongly curved than posterior. Posterior margin of crown with sharp edge, while anterior obtuse. Anterio-outer corner of crown with a little sharp edge. Enamel wall of crown damaged at anterior- and posterior basal portions. Root bears many minute longitudinal striations.

Left humerus completely preserved, but epiphysis of head detached. Head in upper view longer than broad, with much curved antero-inner margin, longest and irregularly curved outer margin and with projected posterior margin; bicipital groove not so distinct. Shaft stout and inflating upward; deltoid ridge well developed; ectocondylar ridge not strong. External condyle narrow and internal condyle relatively narrow compared with trochlea; supra-trochlea foramen narrow and deep; outer crest of trochlea sharp, obliquely running to shaft and much projected distally. In distal view, trochlea relatively thick antero- posteriorly and posterior margin much depressed. Dimensions of humerus are as follows:

|                                              |           |    |
|----------------------------------------------|-----------|----|
| Maximum length from head to trochlea .....   | 319.0     | mm |
| Diameters of head .....                      | 96.4×78.0 |    |
| Ditto of shaft below head .....              | 73.7×38.0 |    |
| Ditto of just above ectocondylar ridge ..... | 46.0×31.3 |    |
| Ditto at above supra-trochlea fossae .....   | 55.3×30.8 |    |
| Transverse length of trochlea .....          | 82.8      |    |
| Ditto of supra-trochlea fossae .....         | 31.0      |    |

Proximal part of right ulna preserved with olecranon and sigmoid notch, which in anterior view, is irregularly quadrangular, with longest and gently curved inner margin; fossa lunaris narrow and small. Olecranon relatively small compared with shaft; head rugose. Inner surface of proximal end tolerably depressed. Dimensions follow.

|                                                      |           |    |
|------------------------------------------------------|-----------|----|
| Length of olecranon along anterior margin.....       | 47.8      | mm |
| Maximum longitudinal distance of sigmoid notch ..... | 45.8      |    |
| Diameters of olecranon .....                         | 51.1×27.0 |    |
| Ditto of shaft below sigmoid notch .....             | 53.3×25.5 |    |

**Remarks:** In 1949, the senior author described a proximal part of right ulna and third right metatarsus from the Upper Kuzuü formation under the name of *Felis* sp. (*tigris* type): the former is well allied to the present material in shape and size. NAORA reported a fragment of left femur from the Inland Sea under the name of *Felis* sp., but the specimen was destroyed in the War. The canine now at hand is a little larger than that from the Upper Kuzuü formation, described by the writer under the name of *pardus*, and much smaller than the Yenckingkou tiger described by E. COLBERT and D. HOOIJER.

In the latter the fore-and-aft diameter of upper canine is 29.4–32.7 mm, much exceeding the specimen now in question, although the Yenchingkou tiger is characterized by its large size and some of it are larger than *Felis youngi* PERI from Choukoutien. The humerus now at hand generally resembles that of *Felis palaeojavanica* (STREMMER) and *Felis* sp. cf. *pardus* L. described by G. KOENIGSWALD from Java. Although the authors are not supported by plenty materials, they are inclined to regard these specimens to be tigers than to panthers. In 1954, NAORA and Y. NAKAZAWA and T. SHIMIZU found some remains (lower jaws and limb bones) of a tiger from fissure of Isinomaki, Yanagun, Aiti Prefecture; after them, the jaw bearing C, P<sub>3</sub>, P<sub>4</sub> and M<sub>1</sub> is rather small sized as the tiger's, but these materials are not described.

### Order Lagomorpha

#### Family Leporidae

##### *Lepus brachyurus* TEM., 1845

(Pl. IX, Figs. 1–4, Pl. XIII, Figs. 19–22)

- 1845 *Lepus brachyurus* TEM. In SIEBOLD'S Faun. Jap., p. 44.  
 1924 *Lepus brachyurus brachyurus* TEM., KISHIDA. Mon. Jap. Mamm., pp. 93–94.  
 1940 *Lepus brachyurus brachyurus* TEM., KURODA. Mon. Jap. Mamm., pp. 73, 74.  
 1949 *Lepus timidus brachyurus* TEM., IMAIZUMI. Nat. Hist. Jap. Mamm., pp. 201–205.

**Specimens:** Two upper jaws, part of cranium, right ramus, four vertebrae, two right- and left scapulae, six innominate bones, three right humeri, two right ulna and radii, three right- and three left femora, two right- and two left tibiae, two calcaneum and astragalus and four metatarsi from Mizusimano-ana; left femur from Tanuki-ana; distal part of left humerus from Makurazino-ana; three upper cheek teeth and a proximal part of left scapula from Koziki-ana; vertebra, right innominate bone, right femur, distal part of right femur, right tibia, and distal part of left tibia from Nakao-dô; both right and left rami, eight vertebrae, sacrum, left femur, left tibia, three metatarsi and five phalanges from Naki-ana.

**Description:** It is very difficult to give the subspecific determination for these fossils, owing to the shortage of osteological materials of the living Japanese wild hare which has exceedingly many varieties, hence the authors are going to treat them under the name of *brachyurus* TEM.; the subspecies *brachyurus* TEM.—Kyusyu hare—is rather common in Yamaguti Prefecture.

Posterior part of frontal, parietal and right squamosal preserved, not differ from that of the living Japanese wild hare; parietal 21.2 mm long and 23.8 mm wide; supraorbital constriction of frontal 12.7 mm wide. Posterior margin of anterior palatal foramen lies at middle of or behind P<sup>1</sup>. A jaw (B) retains all cheek teeth while another (A) does P<sup>2</sup> to M<sup>3</sup>. Dimensions of upper jaws follow.

|                                                                                                   | A    | B       |
|---------------------------------------------------------------------------------------------------|------|---------|
| Zygomatic breadth.....                                                                            | 44.9 | 46.2 mm |
| Palatal width at P <sup>3</sup> .....                                                             | 29.4 | 28.5    |
| Right tooth row (P <sup>1</sup> -M <sup>3</sup> ) .....                                           | 20.8 | 19.3    |
| Median longitudinal length of palate posterior to aft margin<br>of anterior palatal foramen ..... | 10.2 | 12.5    |

Ramus has no characteristics; cheek tooth row 20.1 mm long and height of ramus at M<sub>3</sub> on inner side 18.0 mm. General aspect of upper cheek teeth well allied to that of the living Japanese wild hare, but may be a little larger. Dimensions of teeth follow.

|                         | Upper right (A) | „ (B) | Lower right |
|-------------------------|-----------------|-------|-------------|
| P <sub>1</sub> { L..... | 2.0             | 2.9   | 5.0 mm      |
| W.....                  | —               | 4.9   | 4.2         |
| P <sub>2</sub> { L..... | 3.4             | 3.6   | 4.0         |
| W.....                  | 5.8             | 6.2   | 4.3         |
| P <sub>3</sub> { L..... | 3.5             | 3.7   | —           |
| W.....                  | 6.0             | 6.1   | —           |
| M <sub>1</sub> { L..... | 3.0             | 3.7   | 4.2         |
| W.....                  | 5.7             | 6.0   | 4.1         |
| M <sub>2</sub> { L..... | 2.8             | 3.0   | 4.4         |
| W.....                  | 5.5             | 5.9   | 4.5         |
| M <sub>3</sub> { L..... | 1.5             | 1.5   | 2.5         |
| W.....                  | 2.0             | 2.0   | 2.4         |

Humerus relatively short and rugose as that of hare; deltoid ridge strong and short and trochlea eminent; one of humeri 86.8 mm long, diameter of head 15.8×14.5 mm and ditto of distal end 11.5×8.6 mm. Distal part of ulna un-preserved; olecranon broader than long in lateral view. Radius long and gently curved, about 96.5 mm long. Femur long, stout and gently curved; proximal end expanded laterally and with strong great trochanter; head relatively small; one of femora 119.7 mm long, and proximal end, middle of shaft and distal end of it 23.0, 10.2 and 18.0 mm in lateral width respectively. Tibia has no characteristics compared with that of the living Japanese wild hare; one of tibia 124.5 mm long.

## Order Primates

### Family Cercopithecidae

#### *Macaca fuscata* (BLYTH), 1875

(Pl. XIII, Figs. 8-13)

- 1837 *Inuus speciosus* TEM. In SIEBOLD'S Faun. Jap., p. 6.  
 1875 *Macacus fuscatus* Blyth. Jour. As. Soc. Bengal, vol. 44, extra num., p. 6.  
 1924 *Macaca (Inuus) fuscata* (BLYTH), KISHIDA. Mon. Jap. Mamm., pp. 213-215.  
 1938 *Macaca fuscata* (BLYTH), KURODA. List. Jap. Mamm., p. 112.  
 1949 *Macaca cf. fuscata* (BLYTH), SHIKAMA. Sci. Rep. Tôhoku Imp. Univ., ser. 2, vol. 23, pp. 67-71.  
 1949 *Lyssodes fuscata* (BLYTH), IMAIZUMI. Nat. Hist. Jap. Mamm., pp. 125-128.

**Specimens:** Upper left jaw from Mizusimano-ana; upper left jaw fragment with C, upper left C, two upper left  $M^3$ , lower right jaw fragment with  $M_1$ , lower left jaw fragment with  $M_2$ , three right and left  $M_2$  and lower right  $M_3$  from third quarry of Nippon-Sekkai.

**Description:** Upper left jaw from Mizusimano-ana retains only maxilla which is broken in its upper portion, about 47.4 mm long and 28 mm high as preserved and only  $M^3$  is preserved; a part of anterior palate is preserved;  $M^3$  large, tolerably ground, becomes slightly narrower backward and 10.5 mm long and 9.2 mm wide. Upper jaw with C very small, 22.2 mm long as preserved, retaining unworn C and roots of  $P^1$  and  $P^2$ ; C eminent, about 10.0 mm long and 6.4 mm wide; crown 14.6 mm high, with strongly curved posterior margin; in inner view, alveolar margin much curved. Isolated C a little smaller than C above described, a little worn,  $8.9 \times 5.7$  mm in dimensions and crown height 12.8 mm.

Upper left  $M^3$  and milk tooth of it large, stout, unground and with strong fore basal cingulum; the former  $10 \times 9.8$  mm and the latter  $9.7 \times 9.2$  mm. Left ramus about 21 mm long as preserved with unground  $M_2$  which is subquadrate in upper view and  $10.0 \times 8.4$  mm in dimensions. Isolated right and left  $M_2$  a little worn and  $9.5 \times 7.4$  mm and  $8.7 \times 8.5$  mm in dimensions. Two of the isolated right  $M_2$  moderately worn but one almost unworn, subquadrate in upper view, about  $9.5 \times 7.4$ ,  $9.2 \times 7.8$  and  $8.7 \times 6.2$  mm in dimensions respectively. Right ramus 18.0 mm long as preserved, with ground  $M_1$  and root of  $M_2$ ; the former  $8.8 \times 6.8$  mm in dimensions. Isolated lower right  $M_3$  unworn, with eminent cusps and deep valleys and  $12.2 \times 7.2$  mm in dimensions.

**Remarks:** The authors cannot see any difference of the Akiyosi fossil ape from the Japanese recent ape which is now not living in the Akiyosi area.

#### Family Hominidae

*Homo sapiens* L.

(Pl. XIII, Figs. 1-7)

**Specimens:** Right half of cranium, fourth (?) cervic and sixth (?) thoracic vertebrae, distal part of left radius and distal part of right clavicle from Mukoyama bed of Ube-Kôsan's quarry; lower P and upper right  $M^1$  from Koziki-ana.

**Description:** Cranium. Right half preserved; parietal, large part of frontal, temporal, posterior part of maxilla and basioccipital retained, but fronto-temporal region and zygomatic arch broken off; auriculare, porion and auditory foramen preserved. In upper view, cranium sphenoid in outline and maximum breadth lies posteriorly to oterion. In lateral view, cranium very flat, near to ellipsoid in outline; border between bregma and oterion not strongly curved but nearly straight in running; border passing through bregma

not projected; euryon situated rather near to stephanion; distance between them 26.2 mm. In posterior view, upper border of parietal sloping gently downward. Dimensions are as follows:

|                                                      |          |
|------------------------------------------------------|----------|
| Maximum longitudinal length as preserved .....       | 152.0 mm |
| Maximum width as preserved .....                     | 65.0     |
| Maximum width of cranium in original condition ..... | 130.0±   |
| Height of cranium at bregma .....                    | 103.5    |
| Length-width index .....                             | 85.5     |
| Length-height index .....                            | 68.1     |
| Width-height index .....                             | 79.6     |

At any rate, it may be said that the cranium is highly brachycephalic.

Lower P probably of right second, tolerably worn, with single and high root; buccal side of crown worn but lingual side of it unworn; grinding surface with shallow median valley. Upper right M<sup>2</sup> also tolerably worn and with two roots not high; crown semiquadrate in palatal view, anterior-buccal corner highest; grinding surface nearly flat and with shallow median valley. Dimensions follow.

|                                             | Lower P <sub>2</sub> (?) | Upper right M <sup>2</sup> |
|---------------------------------------------|--------------------------|----------------------------|
| Length of crown.....                        | 7.0                      | 11.1                       |
| Width of crown (Linguo-buccal) .....        | 8.6                      | 10.5                       |
| Height of crown at buccal side .....        | 6.4                      | 5.0                        |
| Maximum height of tooth including root .... | 21.7                     | 16.8                       |

Fourth cervic vertebra broken in neural spine, small sized and wider than long; transverse process very short and bent backward: pre- and postzygapophysis semicircular in outline; dorsal surface of centrum flat and both anterior and posterior surfaces concave; vertebrarterial canal relatively large and oval in outline. Sixth(?) thoracic vertebra broken in distal part of neural spine; epiphysis largely detached: centrum irregularly circular in anterior- and posterior view; dorsal surface of it concave; demifacet rugose and stout; pre- and postzygapophysis flat. Dimensions are as follows:

|                                               | Fourth (?) cervic | Sixth (?) thoracic |
|-----------------------------------------------|-------------------|--------------------|
| Length along ventral surface of centrum ....  | 13.2              | 16.8 mm            |
| Transverse width of it at middle .....        | 19.3              | 26.0               |
| Ditto of neural arch.....                     | 44.7              | 50.0               |
| Median length of it .....                     | 8.9               | 20.8±              |
| Diameters of centrum at anterior surface .... | 21.2×11.8         | 28.7×24.5          |

Distal part of left radius about 52 mm long as preserved and 30.0×30.9 mm in diameter of distal end; styloid process eminent. Distal part of right clavicle about 71 mm long as preserved.

Pisces

Order Percida

Family Scombridae

*Thunnus orientalis* (TEM. & SCHL), 1842

(Pl. XV, Figs. 13 a, b)

- 1842 *Thynnus orientalis* TEM. & SCHL. In SIEBOLD'S Faun. Jap., Pisces, pp. 94, 95.  
 1923 *Thunnus orientalis* (SCHL.), KISHINOUE. Jour. Coll. Ag. Imp. Univ. Tokyo, vol. 8, no. 3, pp. 437-441.  
 1938 *Thunnus orientalis* (TEM. & SCHL.), OKADA. Cat. Vert. Jap., p. 169.  
 1955 *Thunnus thynnus* (L.), MATSUBARA. Fish Morph. Hier., pt. 1, p. 515.

**Specimens:** Anterior precaudal vertebra from Ube-Kôsan's quarry.

**Description:** Vertebra probably of eighth to twenty-fourth precaudal, tolerably large and broken in neural arch; centrum amphicoelous and marginal periphery of anterior- and posterior ends partially broken; both discs nearly circular and notochord lies a little higher than centre of discs; ventral surface of centrum smooth, nearly flat and with very obsolete haemal canal; lateral surface of centrum conspicuously concave and with many minute grooves and striae, which form porous walls at base of neural arch and haemal spines; inferior foramen lying below neural arch small sized and oval in outline; median longitudinal dorsal canal distinct. Dimensions follow.

|                                                               |             |
|---------------------------------------------------------------|-------------|
| Longitudinal dorsal length .....                              | 71.0 mm     |
| Median longitudinal length of ventral surface as preserved .. | 64.2        |
| Diameters of anterior disc.....                               | 73.4 × 72.0 |
| Transverse width of centrum at notochord .....                | 22.8        |

**Remarks:** In size, this specimen may belong to this species which is very common in the near sea of Japan and larger than *alalunga* BONNATERRE (= *germon* LACÉP.), and it may be great interest to know by what kind of animal this was carried into the fissure.

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### Explanation of Plate IV

*Sus leucomystax* TEM. .... P. 73

- Fig. 1. Cranium from Husen-ana. Upper side.  $\times 0.7$ .
- Figs. 2 a, b. Lower symphysis with right  $I_1$ , left  $I_1$ ,  $I_2$  from ditto. a, upper side; b, lower side.  $\times 0.5$ .
- Figs. 3 a, b. Lower right C from ditto. a, buccal side; b, lingual side.  $\times 0.6$ .
- Figs. 4 a, b. Fragment of upper right jaw with  $P^4$ ,  $M^1$ ,  $M^2$  from ditto. a, buccal side; b, palatal side.  $\times 0.7$ .
- Figs. 5 a, b. Fragment of upper left jaw with  $P^4$ ,  $M^1$ ,  $M^2$  from Koziki-ana. a, buccal side; b, palatal side.  $\times 0.7$ .
- Figs. 6 a, b. Fragment of upper right jaw with  $P^3$ - $M^2$  from ditto. a, buccal side; b, palatal side.  $\times 0.7$ .
- Figs. 7 a, b. Fragment of upper left jaw with  $M^1$ ,  $M^2$  from Husen-ana. a, buccal side; b, palatal side.  $\times 0.7$ .
- Figs. 8 a, b. Upper right  $M^3$  from Koziki-ana. a, palatal side; b, inner side.  $\times 0.75$ .
- Figs. 9 a, b. Lower right  $DM^3$  from Koziki-ana. a, upper side; b, buccal side.  $\times 0.65$ .
- Figs. 10 a, b. Left calcaneum from Husen-ana. a, inner side; b, anterior side.  $\times 0.7$ .
- Figs. 11 a, b. Right calcaneum from ditto. a, inner side; b, anterior side.  $\times 0.7$ .
- Figs. 12 a, b. Right third metatarsus from ditto. a, anterior side; b, inner side.  $\times 0.7$ .
- Figs. 13 a, b. Right fourth metatarsus from ditto. a, anterior side; b, outer side.  $\times 0.7$ .



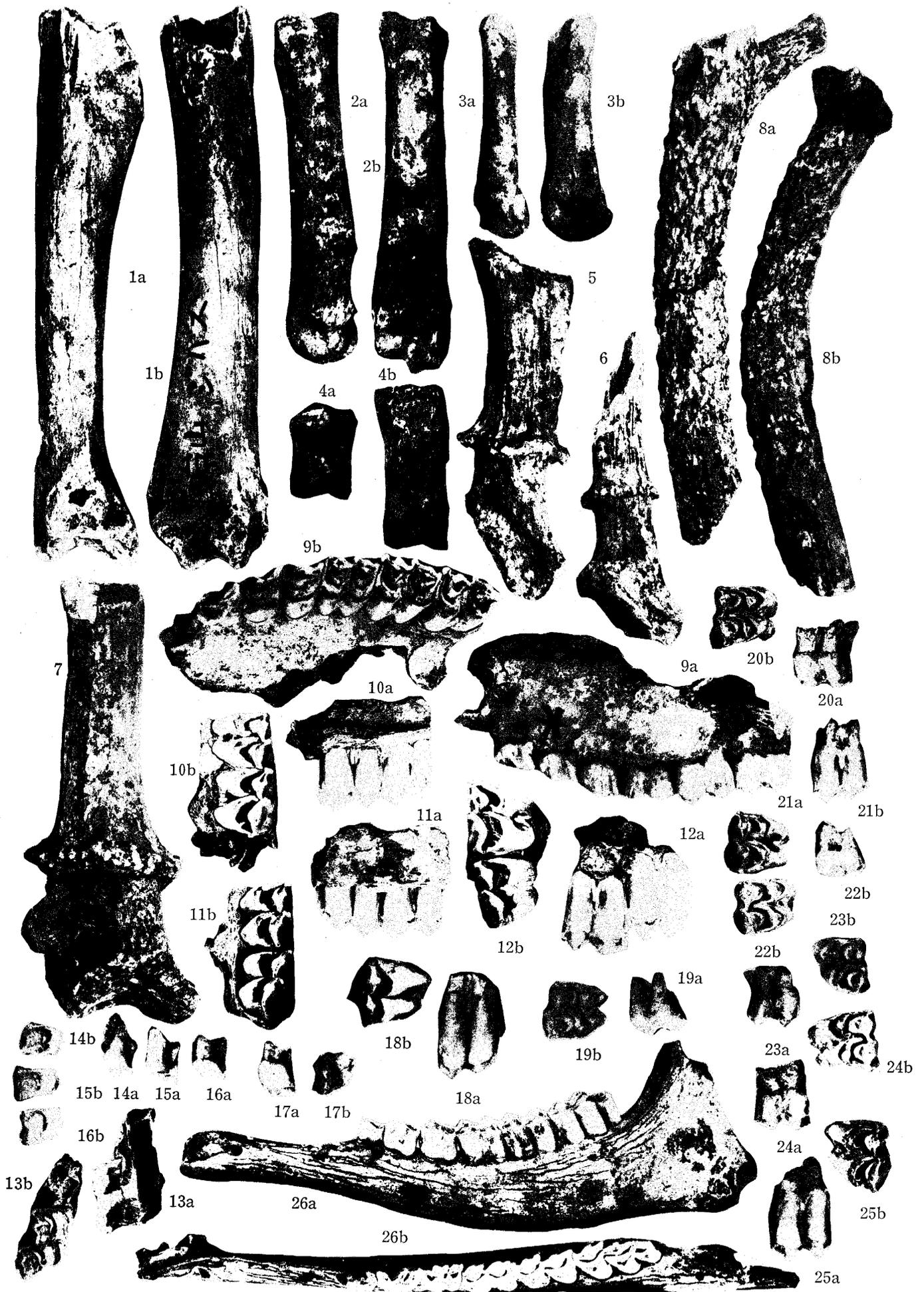
## Explanation of Plate V

*Sus leucomystax* TEM. .... P. 73

- Figs. 1 a, b. Distal part of right tibia from Husen-ana. a, anterior side; b, outer side.  $\times 0.7$ .  
Figs. 2 a, b. Right third metacarpus from ditto. a, outer side; b, anterior side.  $\times 0.7$ .  
Figs. 3 a, b. Right second metatarsus from ditto. a, anterior side; b, inner side.  $\times 0.7$ .  
Fig. 4 a. Right third proximal phalange from ditto. Anterior side.  $\times 0.7$ .  
Fig. 4 b. Right third middle phalange from ditto. Anterior side.  $\times 0.7$ .

*Cervus (Depéretia) praenipponicus* SHIKAMA ..... P. 75

- Figs. 5, 6, 7. Basal part of right antlers from third quarry of Nippon-Sekkai. 5, outer side; 6, 7, postero-outer side.  $\times 0.5$ .  
Figs. 8 a, b. Main beams of right antler from ditto. a, anterior side; b, outer side.  $\times 0.5$ .  
Figs. 9 a, b. Upper left jaw from Mizusimano-ana. a, buccal side; b, outer side.  $\times 0.5$ .  
Figs. 10 a, b. Fragment of upper left jaw with M<sup>1</sup> and M<sup>2</sup> from third quarry of Nippon-Sekkai (No. 17). a, inner side; b, palatal side.  $\times 0.6$ .  
Figs. 11 a, b. Fragment of upper left jaw with M<sup>2</sup> and M<sup>3</sup> from ditto (No. 16). a, inner side; b, palatal side.  $\times 0.6$ .  
Figs. 12 a, b. Fragment of upper right jaw with M<sup>2</sup> and M<sup>3</sup> from ditto (No. 5). a, inner side; b, palatal side.  $\times 0.6$ .  
Figs. 13 a, b. Fragment of upper right jaw with P<sup>3</sup> and P<sup>4</sup> from ditto (No. 11). a, inner side; b, palatal side.  $\times 0.6$ .  
Figs. 14 a, b. Upper right P<sup>4</sup> from ditto (No. 13). a, inner side; b, palatal side.  $\times 0.6$ .  
Figs. 15 a, b. Ditto (No. 12).  $\times 0.6$ .  
Figs. 16 a, b. Upper right P<sup>3</sup> from ditto (No. 14). a, inner side; b, palatal side.  $\times 0.6$ .  
Figs. 17 a, b. Upper right P<sup>2</sup> from ditto (No. 15). a, inner side; b, palatal side.  $\times 0.5$ .  
Figs. 18 a, b. Upper right M<sup>3</sup> from ditto (No. 6). a, inner side; b, palatal side.  $\times 0.5$ .  
Figs. 19 a, b. Upper right M<sup>1</sup> from ditto (No. 8). a, inner side; b, palatal side.  $\times 0.5$ .  
Figs. 20 a, b. Ditto (No. 9).  $\times 0.5$ .  
Figs. 21 a, b. Upper right M<sup>2</sup> from ditto (No. 7). a, inner side; b, palatal side.  $\times 0.6$ .  
Figs. 22 a, b. Upper right M<sup>1</sup> from ditto (No. 10). a, inner side; b, palatal side.  $\times 0.5$ .  
Figs. 23 a, b. Upper left M<sup>1</sup> from ditto (No. 20). a, inner side; b, palatal side.  $\times 0.6$ .  
Figs. 24 a, b. Ditto (No. 19).  $\times 0.6$ .  
Figs. 25 a, b. Upper left M<sup>2</sup> from ditto (No. 18). a, inner side; b, palatal side.  $\times 0.6$ .  
Figs. 26 a, b. Left ramus from Mizusimano-ana (No. 32). a, buccal side; b, upper side.  $\times 0.6$ .

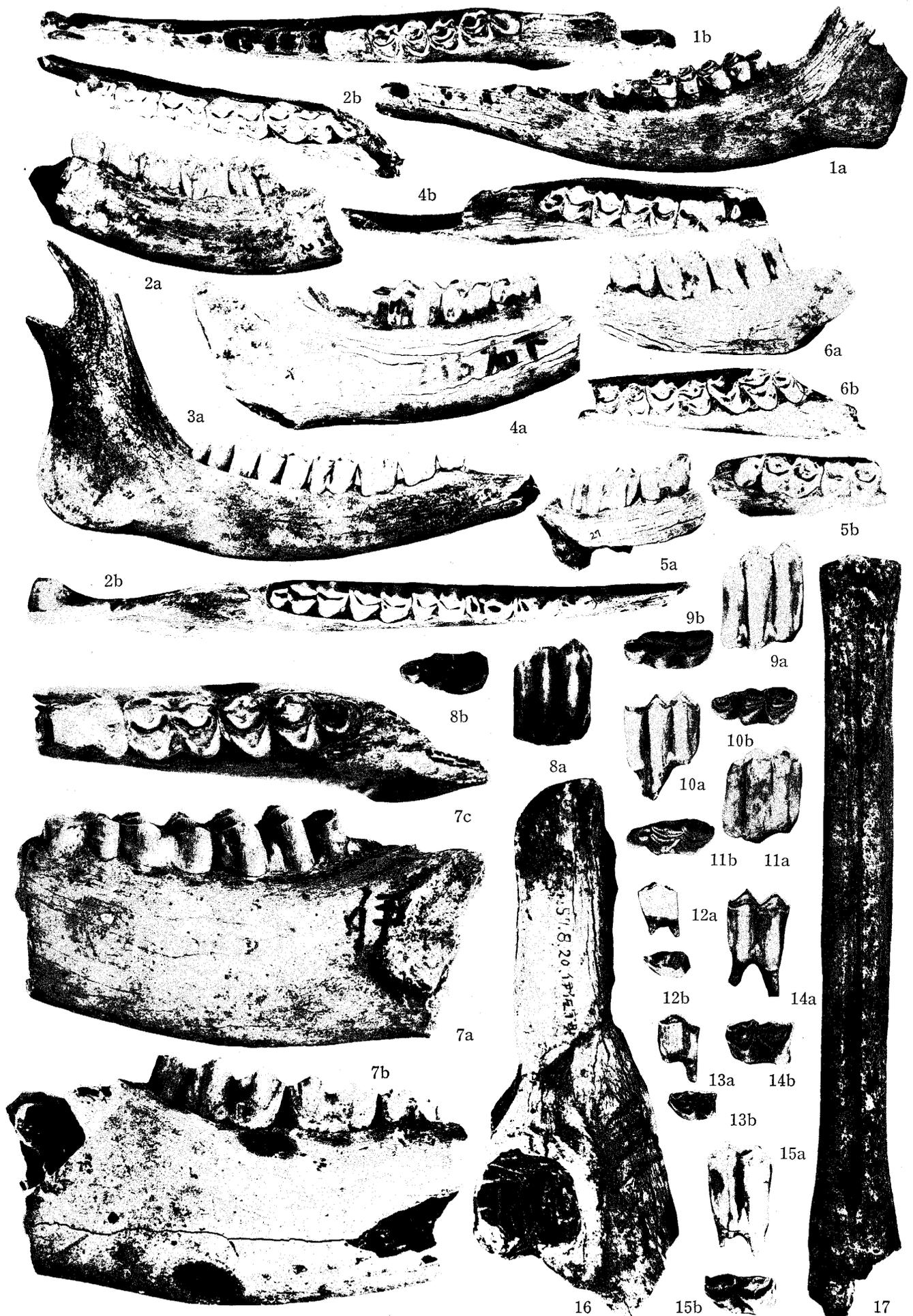


Hasegawa photo.

## Explanation of Plate VI

*Cervus (Depéretia) praenipponicus* SHIKAMA ..... P. 75

- Figs. 1 a, b. Left ramus from Husen-ana (No. 1). a, buccal side; b, upper side.  $\times 0.55$ .
- Figs. 2 a, b. Left ramus from third quarry of Nippon-Sekkai (No. 2). a, buccal side; b, upper side.  $\times 0.5$ .
- Figs. 3 a, b. Right ramus from Mizusimano-ana (No. 33). a, buccal side; b, upper side.  $\times 0.55$ .
- Figs. 4 a, b. Right ramus from third quarry of Nippon-Sekkai (No. 4). a, buccal side; b, upper side.  $\times 0.55$ .
- Figs. 5 a, b. Fragment of right ramus with  $M_2$  and  $M_3$  from ditto (No. 27). a, buccal side; b, upper side.  $\times 0.5$ .
- Figs. 6 a, b. Fragment of left ramus with  $M_1$ - $M_3$  from ditto (No. 21). a, buccal side; b, upper side.  $\times 0.6$ .
- Figs. 7 a, b. Left ramus from Ube-Kôsan's quarry. a, buccal side; b, lingual side.  $\times 1$ .
- Figs. 8 a, b, 9 a, b, 10 a, b, 11 a, b. Lower right  $M_3$  from third quarry of Nippon-Sekkai. 8, No. 31; 9, No. 30; 10, No. 28; 11, No. 29. a, buccal side; b, upper side.  $\times 0.55$ .
- Figs. 12 a, b. Lower left  $P_3$  from ditto (No. 25). a, buccal side; b, upper side.  $\times 0.6$ .
- Figs. 13 a, b. Lower left  $P_4$  from ditto (No. 24). a, buccal side; b, upper side.  $\times 0.5$ .
- Figs. 14 a, b, 15 a, b. Lower left  $M_2$  from ditto. 14, No. 23; 15, No. 22. a, buccal side; b, upper side.  $\times 0.55$ .
- Fig. 16. Left innominate bone from Ube-Kôsan's quarry. Outer side.  $\times 0.6$ .
- Fig. 17. Left metatarsus from Tanuki-ana. Anterior side.  $\times 0.5$ .



Hasegawa photo.

## Explanation of Plate VII

*Sinomegaceros (Sinomegacerooides) yabei* (SHIKAMA) ..... P. 78

- Figs. 1 a, b. Upper left P<sup>3</sup> from Husen-ana. a, inner side; b, palatal side. ×0.5.  
Figs. 2 a, b, c, d. Upper right M<sup>3</sup> from ditto. a, postero-inner side; b, posterior side; c, d, palatal side. a, c, ×0.6; b, d, ×0.7.  
Figs. 3 a, b. Lower left M<sub>2</sub> from ditto. a, buccal side; b, upper side. ×0.7.  
Figs. 4 a, b. Lower left M<sub>3</sub> from ditto. a, buccal side; b, upper side. ×0.7.  
Figs. 5 a, b. Piece of antler crown from ditto. a, lateral side; b, lower side. ×0.4.  
Fig. 6. Lumbar vertebra from ditto. Lateral side. ×0.4.  
Figs. 7 a, b. Anterior thoracic vertebra from ditto. a, lateral side; b, anterior side. ×0.4.  
Figs. 8 a, b. Proximal part of left scapula from ditto. a, outer side; b, inner side. ×0.5.  
Figs. 9 a, b. Proximal part of right scapula from ditto. a, outer side; b, inner side. ×0.5.  
Figs. 10 a, b. Right humerus from ditto. a, anterior side; b, posterior side. ×0.4.  
Figs. 11 a, b. Head of right humerus from ditto. a, outer side; b, proximal side. a, ×0.4; b, ×0.5.  
Figs. 12 a, b. Trochlear part of right humerus from ditto. a, anterior side; b, posterior side. ×0.45.



Hasegawa photo.

### Explanation of Plate VIII

*Sinomegaceros (Sinomegacerooides) yabei* (SHIKAMA) ..... P. 78

- Figs. 1 a, b. Left radius from Husen-ana. a, anterior side; b, posterior side.  $\times 0.35$ .  
Figs. 2 a, b. Proximal part of right femur from ditto. a, anterior side; b, posterior side.  $\times 0.4$ .  
Figs. 3 a, b. Entocondyle of left femur from ditto. a, inner side; b, posterior side.  $\times 0.4$ .  
Figs. 4 a, b. Right tibia from ditto. a, anterior side; b, inner side.  $\times 0.5$ .  
Figs. 5 a, b. Right calcaneum from ditto. a, inner side; b, anterior side.  $\times 0.4$ .  
Figs. 6 a, b. Distal end of right (?) metatarsus from ditto. a, anterior side; b, posterior side.  $\times 0.5$ .  
Figs. 7 a, b. Right (?) third proximal phalange from ditto. a, anterior side; b, posterior side.  $\times 0.4$ .  
Figs. 8 a, b. Right (?) fourth proximal phalange from ditto. a, anterior side; b, posterior side.  $\times 0.5$ .  
Figs. 9 a, b. Right (?) third middle phalange from ditto. a, anterior side; b, posterior side.  $\times 0.4$ .



Hasegawa photo.

### Explanation of Plate IX

*Lepus brachyurus* TEM. .... P. 97

- Fig. 1. Right humerus from Mizusimano-ana. Posterior side.  $\times 0.7$ .
- Fig. 2. Right ulna and radius from ditto. Inner side.  $\times 0.7$ .
- Fig. 3. Left femur from ditto. Posterior side.  $\times 0.7$ .
- Fig. 4. Left tibia from ditto. Anterior side.  $\times 0.7$ .

*Canis lupus* L. .... P. 85

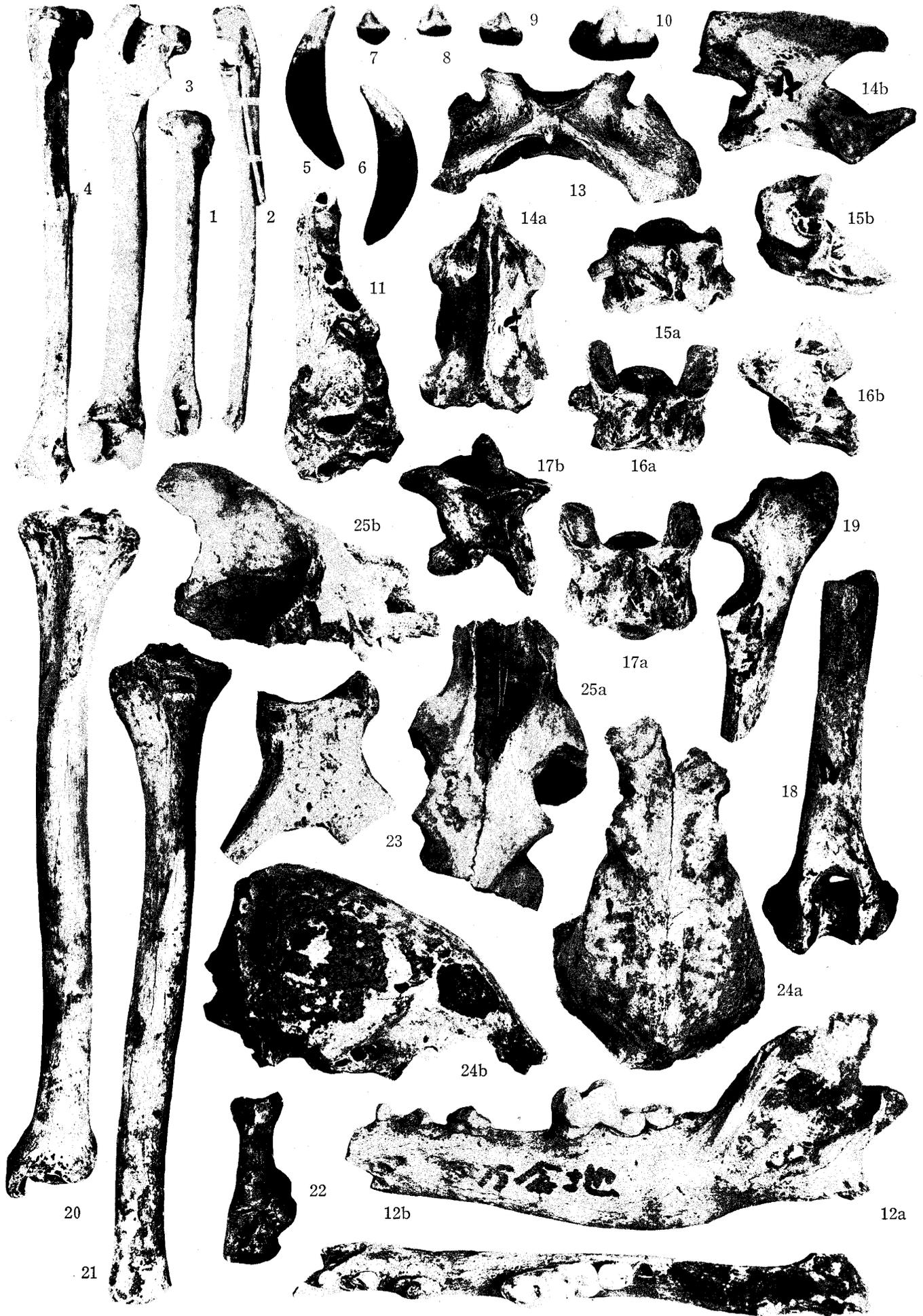
- Fig. 5. Lower left C from Husen-ana. Buccal side.  $\times 0.5$ .
- Fig. 6. Lower right C from ditto. Buccal side.  $\times 0.5$ .
- Fig. 7. Lower right P<sub>2</sub> from ditto. Lingual side.  $\times 0.5$ .
- Fig. 8. Lower left P<sub>2</sub> from ditto. Buccal side.  $\times 0.5$ .
- Fig. 9. Lower left P<sub>4</sub> from ditto. Lingual side.  $\times 0.5$ .
- Fig. 10. Lower right M<sub>1</sub> from ditto. Buccal side.  $\times 0.5$ .

*Canis lupus hodopylax* TEM. .... P. 86

- Fig. 11. Upper left jaw from Makurazino-ana. Palatal side.  $\times 0.7$ .
- Figs. 12 a, b. Left ramus from ditto. a, buccal side; b, upper side.  $\times 0.7$ .
- Fig. 13. Atlas from ditto. Ventral side.  $\times 0.6$ .
- Figs. 14 a, b. Axis from ditto. a, dorsal side; b, right lateral side.  $\times 0.7$ .
- Figs. 15 a, b. Cervic vertebra from ditto. a, dorsal side; b, left lateral side.  $\times 0.6$ .
- Figs. 16 a, b. Cervic vertebra from ditto. a, dorsal side; b, left lateral side.  $\times 0.6$ .
- Fig. 18. Distal part of right humerus from ditto. Anterior side.  $\times 0.6$ .
- Fig. 19. Proximal part of right ulna from ditto. Inner side.  $\times 0.56$ .
- Fig. 20. Left tibia from ditto. Anterior side.  $\times 0.6$ .
- Fig. 21. Right tibia from ditto. Anterior side.  $\times 0.6$ .
- Fig. 22. Right calcaneum from ditto. Anterior side.  $\times 0.6$ .
- Fig. 23. Proximal part of right scapula from ditto. Inner side.  $\times 0.5$ .

*Canis* sp. aff. *familiaris* L. .... P. 88

- Figs. 24 a, b. Cranium from Maruyamano-ana. a, upper side; b, right lateral side.  $\times 0.5$ .
- Figs. 25 a, b. Rostrum from Makurazino-ana. a, upper side; b, right lateral side.  $\times 0.5$ .



Hasegawa photo.

### Explanation of Plate X

*Canis* sp. aff. *familiaris* L. .... P. 88

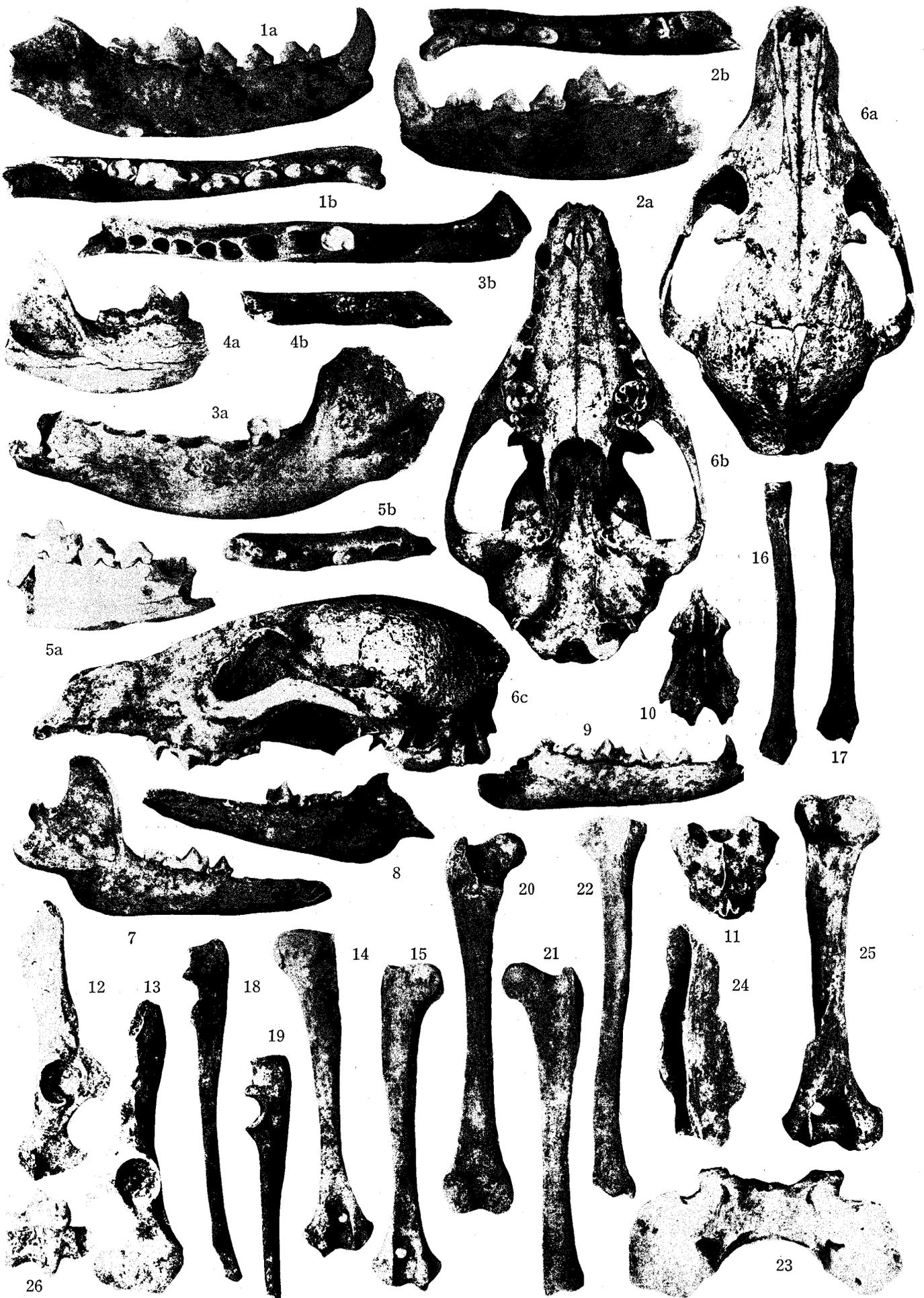
- Figs. 1 a, b. Right ramus from Nakao-dô. a, buccal side; b, upper side.  $\times 0.6$ .  
Figs. 2 a, b. Left ramus from ditto. a, buccal side; b, upper side.  $\times 0.6$ .  
Figs. 3 a, b. Left ramus from Makurazino-ana. a, buccal side; b, upper side.  $\times 0.6$ .  
Figs. 4 a, b, Figs. 5 a, b. Right rami from ditto. a, buccal side; b, upper side.  $\times 0.6$ .

*Nyctereutes viverrinus* TEM. .... P. 89

- Figs. 6 a, b, c. Cranium from Obaga-ana. a, upper side; b, palatal side; c, left lateral side.  $\times 0.7$ .  
Fig. 7. Right ramus from ditto. Buccal side.  $\times 0.7$ .  
Fig. 8. Left ramus from ditto. Buccal side.  $\times 0.7$ .  
Fig. 9. Right ramus from Makurazino-ana. Buccal side.  $\times 0.65$ .  
Fig. 10. Axis from Obaga-ana. Dorsal side.  $\times 0.65$ .  
Fig. 11. Sacrum from ditto. Dorsal side.  $\times 0.7$ .  
Fig. 12. Right innominate bone from ditto. Ventral side.  $\times 0.7$ .  
Fig. 13. Left innominate bone from ditto. Ventral side.  $\times 0.7$ .  
Fig. 14. Right humerus from ditto. Posterior side.  $\times 0.7$ .  
Fig. 15. Left humerus from ditto. Posterior side.  $\times 0.7$ .  
Fig. 16. Left radius from ditto. Posterior side.  $\times 0.7$ .  
Fig. 17. Right radius from ditto. Anterior side.  $\times 0.7$ .  
Fig. 18. Left ulna from ditto. Outer side.  $\times 0.7$ .  
Fig. 19. Right ulna from ditto. Inner side.  $\times 0.7$ .  
Fig. 20. Left femur from ditto. Posterior side.  $\times 0.7$ .  
Fig. 21. Right femur from ditto. Posterior side.  $\times 0.7$ .  
Fig. 22. Right tibia from ditto. Anterior side.  $\times 0.7$ .

*Meles anakuma* TEM. .... P. 94

- Fig. 23. Atlas from Makurazino-ana. Dorsal side.  $\times 0.8$ .  
Fig. 24. Proximal part of right scapula from ditto. Outer side.  $\times 0.7$ .  
Fig. 25. Left humerus from COIFFAIT's cave. Posterior side.  $\times 0.7$ .



Hasegawa photo.

## Explanation of Plate XI

*Nyctereutes viverrinus* TEM. .... P. 89

Fig. 1. Same of Pl. X, Fig. 7.

Fig. 2. Ditto of Pl. X, Fig. 8.

Fig. 3. Ditto of Pl. X, Fig. 9.

*Ursus arctos* L. .... P. 90

Figs. 4 a, b. Anterior part of right ramus from fifth quarry of Nippon-Sekkai. a, lingual side; b, buccal side.  $\times 0.8$ .

Figs. 5 a, b, c. Right humerus from Ube-Kōsan's quarry. a, postero-inner side; b, outer side; c, anterior side.  $\times 0.38$ .

Figs. 6 a, b. Right ulna from ditto. a, outer side; b, inner side.  $\times 0.4$ .

*Meles anakuma* TEM. .... P. 94

Figs. 7 a, b, c. Rostrum from COIFFAIT's cave. a, upper side; b, palatal side; c, left lateral side.  $\times 0.8$ .

Figs. 8 a, b. Right ramus from Tanuki-ana. a, buccal side; b, upper side.  $\times 0.6$ .

Figs. 9 a, b. Right ramus from Makurazino-ana. a, buccal side; b, upper side.  $\times 0.7$ .

*Mustela itatsi* TEM. .... P. 93

Figs. 10 a, b. Left ramus from Makurazino-ana. a, buccal side; b, upper side.  $\times 0.7$ .

Figs. 11 a, b. Right ramus from COIFFAIT's cave. a, buccal side; b, upper side.  $\times 0.7$ .

Figs. 12 a, b. Rostrum from COIFFAIT's cave. a, upper side; b, palatal side.  $\times 0.8$ .

*Mustela erminea* L. .... P. 92

Figs. 13 a, b. Right ramus from Tokuyama-Soda's quarry. a, buccal side; b, upper side.  $\times 1$ .



Hasegawa photo.

### Explanation of Plate XII

*Felis tigris* L. .... P. 95

Figs. 1 a, b. Upper right C from Ube-Kôsan's quarry. a, inner side; b, posterior side.  $\times 0.7$ .

Figs. 2 a, b, c. Left humerus from ditto. a, anterior side; b, posterior side; c, inner side.  $\times 0.4$ .

Figs. 3 a, b. Proximal end of right ulna. a, outer side; b, inner side.  $\times 0.4$ .

*Palaeoloxodon amoriensis* TOKUNAGA & TAKAI ..... P. 83

Figs. 4 a, b. Lower right  $M_2$ ? from Husen-ana. a, buccal side; b, upper side. a  $\times 0.8$ , b  $\times 0.7$ .



Hasegawa photo.

### Explanation of Plate XIII

*Homo sapiens* L. .... P. 99

- Figs. 1 a, b, c. Right half of cranium from Ube-Kōsan Company's quarry. a, lateral side; b, upper side; c, inner side.  $\times 0.55-0.6$ .  
Figs. 2 a, b. Lower P from Koziki-ana. a, lateral side; b, upper side.  $\times 0.82$ .  
Figs. 3 a, b. Upper right  $M^1$  from Koziki-ana. a, buccal side; b, palatal side.  $\times 0.8$ .  
Figs. 4 a, b. Sixth (?) thoracic vertebra from Ube-Kōsan's quarry. a, posterior side; b, right lateral side.  $\times 0.7$ .  
Figs. 5 a, b. Fourth (?) cervic vertebra from ditto. a, posterior side; b, right lateral side.  $\times 0.75$ .  
Figs. 6 a, b. Distal part of left radius from ditto. a, anterior side; b, posterior side.  $\times 0.57$ .  
Figs. 7 a, b. Distal part of right clavicle from ditto. a, anterior side; b, posterior side.  $\times 0.7$ .

*Macaca fuscata* (BLYTH) .... P. 98

- Figs. 8 a, b. Upper left jaw from Mizusimano-ana. a, inner side; b, palatal side.  $\times 0.8$ .  
Figs. 9 a, b. Upper left jaw with C from Nippon-Sekkai's quarry. a, inner side; b, palatal side.  $\times 1$ .  
Figs. 10 a, b, 11 a, b, 12 a, b. Lower right  $M_2$  from ditto. a, buccal side; b, upper side.  $\times 1$ .  
Figs. 13 a, b. Lower right  $M_3$  from ditto. a, lingual side; b, upper side.  $\times 1$ .

Artificially cut bones from Koziki-ana .... P. 56

- Fig. 14. Limb bone of boar cut into a ring like piece.  $\times 0.77$ .  
Fig. 15. Needle.  $\times 0.8$ .  
Fig. 16. Needle.  $\times 0.74$ .  
Fig. 17. Costa of boar, an end of which is cut.  $\times 0.78$ .  
Fig. 18. Ditto, surface of which carries many striations cut by knife.  $\times 0.8$ .

*Lepus brachyurus* TEM. .... P. 97

- Fig. 19. Cranium from Mizusimano-ana. Upper side.  $\times 0.75$ .  
Fig. 20. Upper jaw from ditto. Palatal side.  $\times 0.6$ .  
Fig. 21. Ditto.  $\times 0.83$ .  
Figs. 22 a, b. Lower right jaw from ditto. a, buccal side; b, upper side.  $\times 0.6$ .



## Explanation of Plate XIV

### *Nyctereutes vivvaurinus* TEM.

Figs. 1 a, b. Lower left  $M_2$  from Makurazino-ana. a, buccal side; b, upper side.  $\times 2.7$ .

### *Petaurista leucogenys* TEM.

Figs. 2 a, b. Right ramus from Makurazino-ana. a, buccal side; b, upper side.  $\times 3.5$ .

### *Rattus* sp.

Figs. 3 a, b, c. Right ramus from Koziki-ana. a, buccal side; b, lingual side; c, upper side.  $\times 2.8$ .

Figs. 4 a, b, c. Fragment of left ramus from ditto. a, lingual side; b, buccal side; c, upper side.  $\times 3$ .

### *Apodemus speciosus* (TEM.)

Figs. 5 a, b, c. Left ramus from Makurazino-ana. a, buccal side; b, lingual side; c, upper side.  $\times 2.4$ .

Figs. 6 a, b, c. Right ramus from ditto. a, buccal side; b, lingual side; c, upper side.  $\times 2.5$ .

### *Apodemus geisha* (THOMAS)

Figs. 7 a, b, c, 8 a, b. Left ramus from Makurazino-ana. a, lingual side; b, buccal side; c, upper side.  $\times 3$ .

### *Microtus montebelli* (MILNE-EDWARDS)

Figs. 9 a, b, c. Right ramus from Makurazino-ana. a, lingual side; b, buccal side; c, upper side.  $\times 2.5$ .

### *Rhinolophus* sp.

Figs. 10 a, b. Rostrum from Makurazino-ana. a, upper side; b, palatal side.  $\times 4$ .

### *Rhinolophus ferrum-equinum nippon* TEM.

Figs. 11 a, b. Upper left jaw from Makurazino-ana. a, buccal side; b, palatal side.  $\times 2.5$ .

Figs. 12 a, b, c. Right ramus from ditto. a, buccal side; b, lingual side; c, upper side.  $\times 2.5$ .

Figs. 13 a, b. Right scapula from Husen-ana. a, inner side; b, outer side.  $\times 2.7$ .

### *Pipistrellus* (?) sp.

Figs. 14 a, b. Right ramus from Makurazino-ana. a, buccal side; b, lingual side.  $\times 3$ .

### *Mogera wogura* (TEM.)

Figs. 15 a, b, c. Right ramus from quarry of Tokuyama-Soda. a, lingual side; b, buccal side; c, upper side.  $\times 2.3$ .

Figs. 20 a, b. Right humerus from ditto. a, anterior side; b, posterior side.  $\times 2.5$ .

### *Urotrichus talpoides* TEM.

Figs. 16 a, b. Fragment of right ramus from quarry of Tokuyama-Soda. a, buccal side; b, lingual side.  $\times 2.3$ .

Figs. 17 a, b. Fragment of left ramus from ditto. a, buccal side; b, lingual side.  $\times 2.2$ .

### *Anourosorex japonicus* SHIKAMA & HASEGAWA

Figs. 18 a, b. Fragment of left ramus from quarry of Tokuyama Soda Company. a, lingual side; b, upper side.  $\times 2.2$ .

### *Sorex shinto* THOMAS

Fig. 19. Right ramus from quarry of Tokuyama Soda. Buccal side.  $\times 2.3$ .

### Aves, gen. & sp. indet.

Fig. 28. Dentary from Koziki-ana. Upper side.  $\times 0.7$ .

### *Natrix tigrina* (BOIE)

Figs. 21 a, b, 22 a, b. Left rami (dentary) from Makurazino-ana. a, buccal side; b, lingual side.  $\times 2.5$ .

Fig. 25. Posterior vertebrae from Koziki-ana. Dorsal side.  $\times 2.4$ .

### *Elaphe* sp.

Figs. 26 a, b, 27 a, b. Vertebrae from Koziki-ana. a, dorsal side; b, ventral side.  $\times 2.5$ .

### Ophidia, gen & sp. indet.

Figs. 23 a, b, 24 a, b. Right upper jaw (maxilla) from Makurazino-ana. a, upper side; b, inner side.  $\times 2.5$ .



Hasegawa photo.

## Explanation of Plate XV

### *Bufo vulgaris formosus* BOULENGER?

- Fig. 1. Right lower jaw from Koziki-ana. Ventral side.  $\times 2.4$ .  
Figs. 2 a, b, 3 a. Vertebrae from ditto. 2 a, ventral side; 2 b, 3, dorsal side.  $\times 2.5$ .  
Fig. 4. Left scapula from ditto. Inner side.  $\times 2.8$ .  
Fig. 5. Left ilium from ditto. Outer side.  $\times 2.3$ .  
Fig. 6. Right humerus from ditto. Anterior side.  $\times 2.2$ .  
Fig. 7. Right humerus from Husen-ana. Anterior side.  $\times 2.2$ .  
Figs. 8, 9. Right tibio-fibulae from Koziki-ana. Inner side.  $\times 2.2$ .  
Fig. 10. Right tibio-fibula from Husen-ana. Inner side.  $\times 2.5$ .  
Fig. 11. Distal part of right femur from Koziki-ana. Postero-outer side.  $\times 2.4$ .  
Fig. 12. Tibiale from ditto.  $\times 2.5$ .

### *Thunnus orientalis* (TEM. & SCHL.)

- Figs. 13 a, b. Anterior pre-caudal vertebra from quarry of Ube-Kôsan. a, lingual side; b, buccal side.  $\times 0.8$ .

### Pisces, gen. & sp. indet.

- Figs. 14 a, b. Lower left jaw (dentary) from the fossil man pit of Ube-Kôsan's quarry. a, lingual side; b, buccal side.  $\times 0.8$ .  
Fig. 15. Fin spine from Koziki-ana.  $\times 0.7$ .

### Decapoda, gen. & sp. indet.

- Fig. 16. Fragment of chela from Koziki-ana.  $\times 0.7$ .

### *Haliotis* sp. aff. *discus* REEVE

- Fig. 17. Inner side of fragment from Koziki-ana.  $\times 0.8$ .

### *Tegula (Chlorostoma) argyrostoma tubinata* (A. ADAMS)

- Figs. 18 a, b. From Koziki-ana. a, basal side; b, apical side.  $\times 0.8$ .

### *Semisulcospira libertina nassaeformis* KURODA & KANAMARU

- Figs. 19, 20, 21. From Koziki-ana.  $\times 0.8$ .  
Fig. 22. Recent specimen from brook beside Syuho-dô.

### *Corbicula japonica* PRIME

- Figs. 23 a, b. Right valve from Makurazino-ana. a, inner side; b, outer side.  $\times 0.7$ .

### *Maetra veneriformis* REEVE

- Figs. 24 a, b. Fragment of left valve from Koziki-ana. a, outer side; b, inner side.  $\times 0.7$ .

### *Meretrix lusoria* (RÖDING)

- Fig. 25. Left valve from Koziki-ana. Inner side.  $\times 0.8$ .

### *Cyclina sinensis* (GMELIN)

- Figs. 26 a, b. Fragment of right valve from Koziki-ana. a, outer side; b, inner side.  $\times 0.7$ .

### *Prunus* sp. cf. *mume* SIEB. & ZUCC.

- Figs. 27 a, b. Seed from Makurazino-ana. b, indicating a mark gnawed by *Petaurista*.  $\times 0.8$ .



Hasegawa photo.