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AN OCCURRENCE OF A FOSSIL SEA LION IN THE MIOCENE DEPOSITS OF SINANO, JAPAN

By

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With 2 Plates

(Contribution from the Department of Geology and Mineralogy,
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A fragment of a skull of a large sea lion was recently submitted to the writer for examination by Mr. H. YOKOUTI, a teacher of Gozyô Primary School in the Province of Sinano, to whom the writer wishes to express his hearty thanks. No remains of fossil pinnipeds have hitherto been reported from Japan, except *Eumetopias watasei* MATSUMOTO from the Upper Pliocene Sanuki bed of the Province of Kazusa¹⁾. Hence the new occurrence of this fossil in the much older rock is important from both the geological and palaeontological stand points.

It is reported that the fossil was collected by a country woman some twenty years ago on a valley bottom in Gozyô-mura, Province of Sinano. The material is the anterior portion of the skull with the teeth in situ, but it has suffered much deformation after burial in sediments. The broken surface which is not weathered, shows that there were preserved also some other portions, possibly the entire skull including the complete lower jaw, but the posterior portion behind the first molar was lost before or after it was obtained. Examination shows that the present material bears a close relationship with *Eumetopias jubata* (SCHREBER) (= *E. stelleri* LESSON), the northern sea lion, living in our northern seas, but it is characterized by some more primitive features, evidently shown in the teeth.

(1) H. MATSUMOTO: On Two Species of Fossil Pinnipedia from Kazusa and Saghalin. Sci. Rep. Tohoku Imp. Univ., Ser. II, Vol. X, 1926, p. 13, pl. VI, figs. 1, 2.

Journ. Fac. Sci., Hokkaido Imp. Univ., Ser. IV, Vol. VI, No. 2, 1941.

According to Prof. H. HOMMA,⁽¹⁾ the Bessyo bed from which the present fossil has been derived, is covered with a slight unconformity by the Aoki bed and passes gradually into the underlying Utimura bed. The Utimura bed consists of conglomerate, green tuff and sandstone in its lower part, and of sandy shale, sandstone and shale in its upper. In the shale intercalated in the uppermost part there are contained *Thyasira bisecta* CONRAD, and other molluscs. The Bessyo bed is a series composed in the main of shale and contains remains of fish, cetacean and mollusc, besides rich plant fossils.⁽²⁾ The following molluscs collected at two places near the locality of the present pinniped were identified by Mr. T. KURODA⁽³⁾:

Anadara amicula (YOKOYAMA)
A. cf. setoensis YOKOYAMA
Macrocallista pacifica (DILLWYN)
Buccinum sp. (*sinnanoensis* MAKIYAMA ?)

Mr. YOKOUTI also collected a number of molluscs from a fossiliferous layers exposed at a point very near the valley bottom where the fragment of the skull was obtained. Among these molluscs which have been sent to the writer with the sea lion skull, six species are distinguished; they are

Glycimeris yamasakii (YOKOYAMA)
Anadara amicula (YOKOYAMA)
Dosinia cf. angulosa (Phil.)
Lucina acutilineata CONRAD
Chrysodomus modestus Kuroda
Nassarius nakamurai Kuroda

The Bessyo bed is considered by Prof. MAKIYAMA⁽⁴⁾ to be Upper Langian or the lower part of Middle Miocene in age, since the underlying Utimura bed is most probably Upper Langian. It is also, not improbably, of the middle part of Middle Miocene.

(1) H. HOMMA: Geology of Central Sinano, 1932, p. 114.

(2) An important fossil dolphin, *Sinanodelphis izumidaensis* MAKIYAMA, has been derived from this complex exposed in the vicinity of Ueda, some thirty kilometers east of the locality of the present pinniped. J. MAKIYAMA: *Sinanodelphis izumidaensis*, a New Miocene Dolphin of Japan. Mem. Coll. Sci., Kyoto Imp. Univ., Ser. B, vol. IX, 1936, p. 115.

(3) T. KURODA in HOMMA: Op. cit., pt. 4, p. 23.

(4) J. MAKIYAMA: Op. cit., p. 118.

From a detailed study of the flora contained in the Bessyo bed, Mr. E. KONNO⁽¹⁾ is of the opinion that this complex most probably enjoyed a climate warmer than what now prevails in this region, since he finds in this flora numerous species which flourished in a warm temperate zone. The presence of the northern sea lion under consideration in this formation is remarkable in that it may indicate a far southern extension of a cooler current in this district at about the middle part of the Miocene time; the molluscan fossils seemingly point in this direction in the general assemblage.

DESCRIPTION OF THE MATERIAL

Eumetopias, GILL.

Eumetopias sinanoensis sp. nov.

Pls. XXIV (I), XXV (II).

Locality. Asô, Sittakô, Gozyô-mura, Higasi-Tikuma-gun, province of Sinano.⁽²⁾

Horizon. Bessyo bed. Middle Miocene(?)

The material is represented by the anterior portion of the skull the part posterior to the plane of the first lower molar being missing. The maxillae and mandibles together with the premaxillae are much deformed so that reconstruction is almost impossible and nothing can be said about their original contour. The right side of the snout is displaced upward in relation to the opposite side, and consequently the upper portion of the right maxilla is turned to the other side, becoming invisible in right side view. The lower margin of the horizontal ramus of the left mandible is very incomplete. The right horizontal ramus and left maxilla are secondarily flattened so as to become deeper than they originally were. The maxillo-premaxilla sutures are not easily identified but apparently these two bones are fused to each other.

The depth of the horizontal ramus behind the canine, as shown in the right side, although much deformed, is apparently very great, greater than *Eumetopias jubata* and probably also than *Allodesmus*

(1) E. KONNO in HOMMA: Op. cit., pt. 4, p. 125.

(2) 信濃國東筑摩郡五常村執田光麻生 (同地望月主殿氏所藏)

of North America. The chin is most probably rounded abruptly as suggested by the anterior margin of the symphyseal surface, inclining downward and backward rather steeply. The symphysis is only partly visible, but seems to be stout, much elongated and not ankylosed. The surface is corrugated and probably bounded by a ligament. No well developed protuberance is observable on the lower border of the ramus for the attachment of the digastric muscle.

TEETH

The upper jaw has three incisors (I^1 , I^2 , I^3 ,) and as in *Allodesmus*, *Alachtherium* and *Prorosmarus* the lower one has two (I_2 , I_3). Of the molariform series, nine left and seven right teeth are found in the specimen. All the teeth including the canines are rather well preserved, though most of the canines and incisors are more or less broken at the tips. The crowns are black in colour and the roots white. The dental formula is determined as follows from the preserved teeth:

$$I \frac{3}{2}, \quad C \frac{1}{1}, \quad Pm \frac{4}{4}, \quad M \frac{?}{1+?}$$

Incisors

The lower jaw. The outer incisor (I_3) is large, caniniform, and nearly circular in cross-section. The inner one (I_2) is much reduced in size but still functional, about equal to one-half the size of the outer incisor, and situated a little posterior to the latter. The left inner incisor is nearly circular in cross-section while the right one is the larger and slightly elongated anteroposteriorly. Both inner incisors seem to be almost parallel with the outer ones, and as far as can be judged, more vertical than in *Eumetopias jubata* and *Allodesmus*. It may be pointed out, moreover, that in *Eumetopias jubata* the outer incisor tends to fall off or disappear, while the inner one persists.

The upper jaw. The outer incisor (I^3) is long, also caniniform, quite large, being the largest of all incisors, and only a little smaller than the lower outer one. The middle one (I^2) is rather small, smaller than one half the size of the outer; the inner incisor (I^1) is very small and slightly smaller than even the upper inner incisor.

The outer one is slightly and the others moderately elongated antero-posteriorly.

Canines

All the canines are large and conical, the upper ones being larger. They are directed a little forward and outward, faintly curving backward at the apex, subelliptical in cross-section at the base of the crown, with the longest diameter antero-posterior, but without distinct edge on any side. The roots are long, that of the upper canine reaching beyond the plane of the upper third molariform tooth, without grooves externally or internally. The basal portion of the crown is in all canines decorated with numerous, crowded, fine circular wrinkles which extend in the right upper canine for some distance into the root. The roots are provided with numerous, crowded longitudinal ribs. The apex is broken in all canines except the left upper one in which it is only slightly abraded.

Molariform series

This series is situated very close to the external surface of the ramus and maxilla, haplodont and, as far as can be observed, have no trace of an anterior or posterior accessory cusp, and with a very poorly defined cingulum. The crown is low-conical, bluntly pointed and slightly curved backward at tip, subcircular in cross-section, without any developed cutting edge, and usually slightly elongated antero-posteriorly. They are all relatively large; there is scarcely a progressive increase in size from the anterior teeth to the posterior, the first premolar being only slightly smaller than the fourth. The last tooth preserved in the left side of the lower jaw, the first true molar, is probably similar in size and form to the next anterior premolar, though the former is very incomplete. The roots of the teeth are circular in cross-section and usually not grooved externally, except in the first and second in both jaws, which are very faintly grooved. The inner side of the third premolars of both jaws has been observed to be not grooved. In all features the molariform series are very closely similar to some teeth of *Allodesmus kernensis* KELLOGG figured by KELLOGG (figs. 6, 7) except in that they have a slightly higher crown.

Abrasion

All the teeth may be said to have suffered practically no marked wearing. The antero-internal surface of the upper canine and the postero-external one of the lower canine are only slightly abraded. The incisors are also very little worn; the second incisors of both lower jaws are moderately worn at tip, but the third, incomplete in this point, apparently not much worn as suggested by the casts pressed on the matrix. The molariform teeth are also weak in abrasion; both anterior and posterior surfaces are only a little worn. This slightness of wear might be attributed to the immaturity of the specimen, but its large size, matching nearly with that of an adult *Eumetopias* and *Allodesmus*, probably precludes this supposition.

Measurements

Upper jaw

I ₁ , length	6 mm	P ₁ , length	14 mm
width	4	width	12
I ₂ , length	9	P ₂ , length	15
width	7.5	width	14
I ₃ , length	17	P ₃ , length	18(?)
width	15	width	15
C, length	28.5	P ₄ , length	15(?)
width	20 (estimated)	width	14
Extreme length as preserved 140 mm			
Distance of the anterior margin of the canine from the posterior margin of P ₃ 82 mm			
Distance of the anterior margin of P ₁ from the posterior margin of P ₃ 60 mm			

REMARKS

It is evident that the species under consideration belongs to Otariidae and especially is closely related to Recent *Eumetopias jubata* (SCHREBER), being similar in general outline of the mandible ramus, the abrupt rounding of the chin, the form of the symphysial surface which is not ankylosed, the number and position of the mental foramina, the dentition, the large canines and in other less important features. Some of these points easily separate this species from *Alacatherium cretsii* DU BUS⁽¹⁾ from the Middle Pliocene of

(1) P. J. VAN BENEDEN: Description des ossements fossiles des Environs d'Anvers. Ann. Mus. Roy Hist. Nat. de Belgique, vol. II, pt. I, 1877, pls. I-V; VI, figs. 1-4.

Belgium and *Prorosmarus alleni* BERRY and GREGORY⁽¹⁾ reported from the Upper Miocene Yorktown formation of Virginia, North America. These two foreign species were described to have closer relationships with walrus in various points than with *Eumetopias*.

Aside from *Eumetopias jubata*, *Allodesmus kernensis* KELLOGG⁽²⁾ from the Lower Miocene Temblor formation of California seems, among the Recent and fossil otarids, to be most closely related to the present fossil sea lion. This American species, founded on an incomplete mandibular ramus which lacks the posterior portion, has, as described by KELLOGG, a close relationship with *Eumetopias* in almost all features cited above in the comparison of the latter with the fossil from Sinano.

Allodesmus seems to differ from *Eumetopias* in that it bears a more robust and deeper mandibular ramus with less abraded teeth; in these points the Japanese fossil seems to be more closely similar to *Allodesmus* than to *Eumetopias*. *Allodesmus* is distinct, moreover, from the Recent species in having two lower molars of which M_1 is much elongated and two-rooted and M_2 much smaller, the alveolus of the latter being about one half of that of M_1 . It may be remarkable that *Allodesmus* of North America on the one side, and the present form from Japan on the other, have close relationships with the Recent pinniped in various features of the teeth.

The new species has a mandibular ramus as deep as that of the American form, the mental foramina as numerous and similarly set, and the dentition almost identical. In the former, four upper and five lower molariform teeth are preserved. Since the posterior portion of the ramus is missing, the presence or absence of the second lower molar and its character are uncertain. However, as far as the material is examined, it seems to be distinguishable from that American Miocene otarid in having apparently a slightly deeper horizontal ramus, almost unworn teeth, a rather smaller canine, and a larger lower outer incisor, than in *Allodesmus*. All the premolar are also relatively larger in the Japanese form than in

(1) E. W. BERRY and W. K. GREGORY: *Prorosmarus alleni*, a new genus and species of Walrus from the Upper Miocene of Yorktown, Virginia. Amer. Jour. Sci., Ser. 4, vol. XXI, 1906, p. 444, text-figs. 1, 4a.

(2) R. KELLOGG: Pinnipeds from Miocene and Pleistocene Deposits of California. Univ. Calif. Publ. Bull. Dept. Geol. Sci., vol. XIII, 1922, p. 26, text-figs. 1-17.

Allodesmus, with the roots more regularly circular in cross-section. The first lower molar is injured in the present skull. From the above statements, it will be seen that the Japanese otarid is somewhat more similar to *Allodesmus* than it is to *Eumetopias jubata* in some points.

Another species which deserves comparison is *Desmatophoca oregonensis* CONDON¹⁾ from the Upper Miocene of Oregon. This form seems to be similar in many features to *Eumetopias*. Attention has been drawn by WORTMAN, however, to its peculiar implantation of the molariform teeth; it possesses P^2 and P^3 two rooted, and P^4 three rooted. Moreover, P^4 bears three "distinct" cusps. There is a record of another large fossil otarid from the Miocene of the West Coast of North America. This is *Pontolis magnus* TRUE²⁾ from the Empire formation of Oregon which can not be compared with the present one, being represented only by the posterior portion of the skull, but is stated to resemble Recent *Eumetopias jubata*.

Owing to the deformation to which it has been subjected and the absence of the cranium, the Japanese species can not be precisely compared with *Eumetopias jubata*, but similarity and dissimilarity are shown to some extent. Two old skulls of that living species, one doubtless male and the other probably female, have been lent by the Museum of the Hokkaidô Imperial University for comparison. Also three skulls of *Zalophus* have been lent from the same museum and compared.

As cited before, the present pinniped from Sinano is closely similar to *Eumetopias*. The dentition is quite identical. In the fossil species three upper and two lower incisors are retained, I^1 being much reduced in size but still functional. In *Eumetopias* the incisors tend to be reduced in number, the lower outer incisor having a tendency to fall off or to disappear, while the inner one persists. This tendency is well shown in the two skulls at hand. As to the molariform teeth, four upper and five lower teeth are preserved in

(1) T. CONDON: A new fossil pinniped (*Desmatophoca oregonensis*) from the Miocene of the Oregon coast. Univ. Oregon Bull., vol. III, suppl. no. 3, 1906, p. 6, pl. II. (This paper is not accessible to the writer.) See also J. L. WORTMAN: A new fossil seal from the marine Miocene of the Oregon coast region. Science, n. s., vol. XXIV, 1906, p. 89.

(2) F. W. TRUE: A further account of the fossil sea lion *Pontolis magnus*, from the Miocene of Oregon. U. S. Geol. Surv., Prof. Pap., 59, 1909, p. 143, pls. XXI-XXIII.

the fossil form, the last lower one being the first molar. The presence of the upper molar is unfortunately uncertain in the material, but most probably one molar is present as in *Desmatophoca* and in many specimens of *Eumetopias*. The presence of the second lower molar as in *Allodesmus*, or its absence as in *Eumetopias*, is also undeterminable in the fossil under consideration.

Although the skull is much deformed and, moreover, insufficient for measurements, it appears probable that the horizontal ramus of the present species is deeper with a longer symphysial surface than in the living otarid. The upper outer incisor is relatively larger, the canine rather smaller and regularly elliptical in cross-section and all molariform teeth also larger, with the roots circular in cross-section. The crown of the premolars is nearly circular in cross-section, conical, blunt-topped and large, while in the two skulls of *Eumetopias* at hand they are provided with more or less longitudinally elongated root and crown except probably for P_1 . Moreover, the lower molar of the Miocene form is, though incomplete, as wide as the fourth premolar, also conical without any elongation or cutting edges. In Recent *Eumetopias* the crown of the same tooth is narrower than P_4 , moderately elongated and provided with anterior and posterior edges. Most significant is the fact that all teeth are almost unworn in the new species. All the above statements seem to indicate a much greater primitiveness of the fossil at hand in comparison with the Recent otarid.

The specimen of *Eumetopias watasei* MATSUMOTO⁽¹⁾ from the Upper Pliocene, is represented only by the right side of the upper snout anterior to the fourth premolar. It is considered by Dr. MATSUMOTO as belonging to an adult male individual. In this species the roots of the premolars are slightly larger and more regularly circular in cross-section than in *E. jubata* and it stands nearer to the form under consideration in these points. However, the upper canine and the distance between it and the outer incisor are larger, and the outer incisor itself seems also to exceed in size, as suggested by its alveolus, that of the latter species. The inner incisor is smaller. As stated by MATSUMOTO, one of the most pronounced differences observable between his species and *jubata*

(1) H. MATSUMOTO: On Two Species of Fossil Pinnipeds from Kazusa and Saghalin. Op. cit., p. 13, pl. vi, figs. 1, 2.

is the far greater length of the snout anterior to the canine, a fact not determined in the present species due to deformation, but the relative smallness of the canine, incisors and the distance between the outer incisor and the canine seem to indicate a shorter anterior snout in the latter. Since no premolar in MATSUMOTO's specimen has retained the crown, a more precise comparison is impossible.

The differences cited before, together with the much older geologic age, seem to be sufficient for separating the present form generically from *Eumetopias jubata*. However, without more materials, the writer would not feel justified in establishing a new genus or subgenus to receive the present fossil.

In concluding, the writer wishes to express his hearty thanks to Prof. H. YABE of the Institute of Geology and Palaeontology in Sendai for his generosity in giving permission for the free use of his private library. Indebtedness is also acknowledged to the authorities, especially to Prof. T. INUKAI, of the Museum of the Hokkaido Imperial University for the loan of skulls of *Eumetopias jubata* and other pinnipeds for comparison.

Postscript

After the completion of the present paper, Dr. MATSUMOTO (Zoological Magazine, Vol. II, no. 5, 1939, p. 257) reported an occurrence of a new sea lion, *Zalophus kimitsensis* MATSUMOTO, in the Upper Pliocene of Kazusa.

EXPLANATION OF THE PLATES

(All figures are of natural size.)

Plate XXIV (I)

- Fig. 1. Left side view.
Fig. 2. Anterior view.

Plate XXV (II)

- Fig. 1. Right side view.
Figs. 2a-2d. Left p³; a, ventral, b, posterior, c, outer, and d, inner view.
Fig. 3. Left p⁴; anterior view.
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Fig. 1

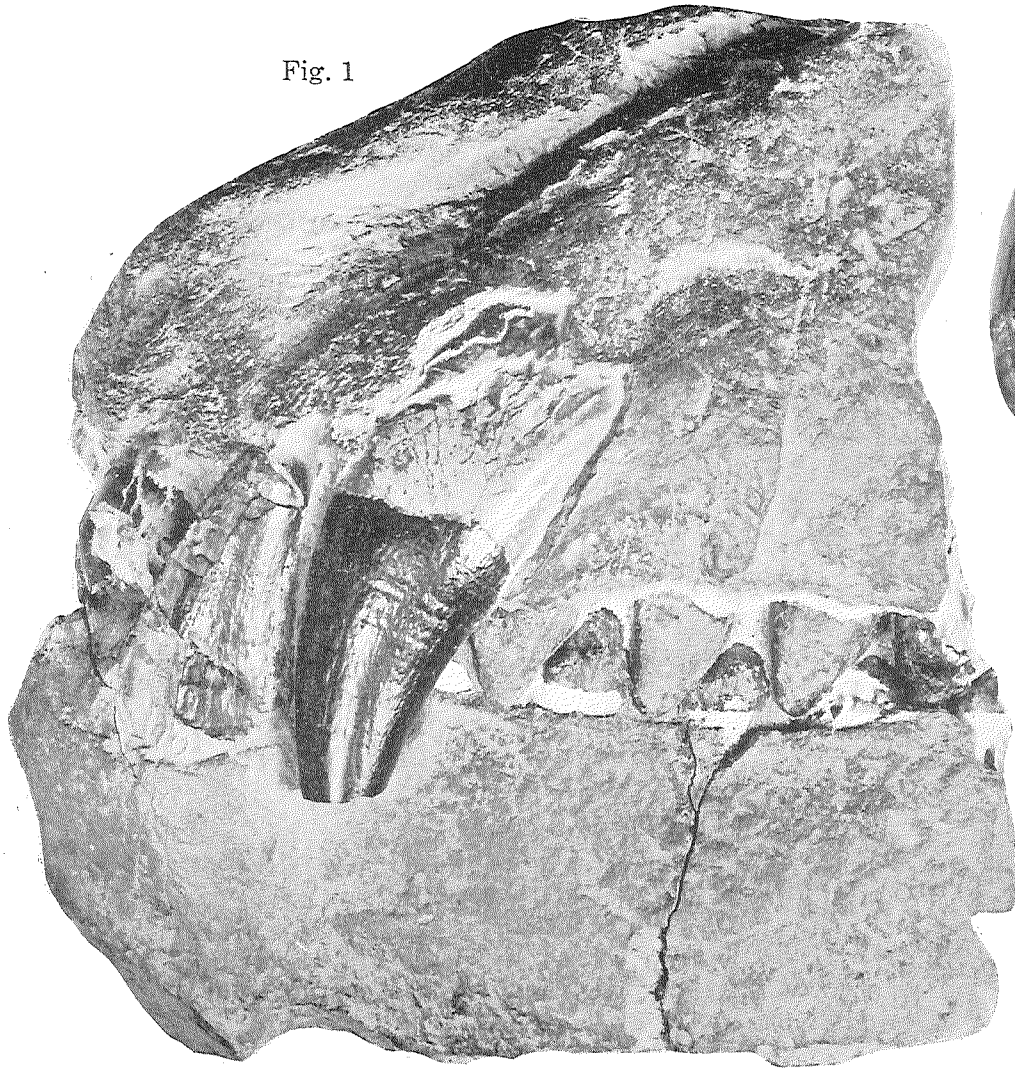
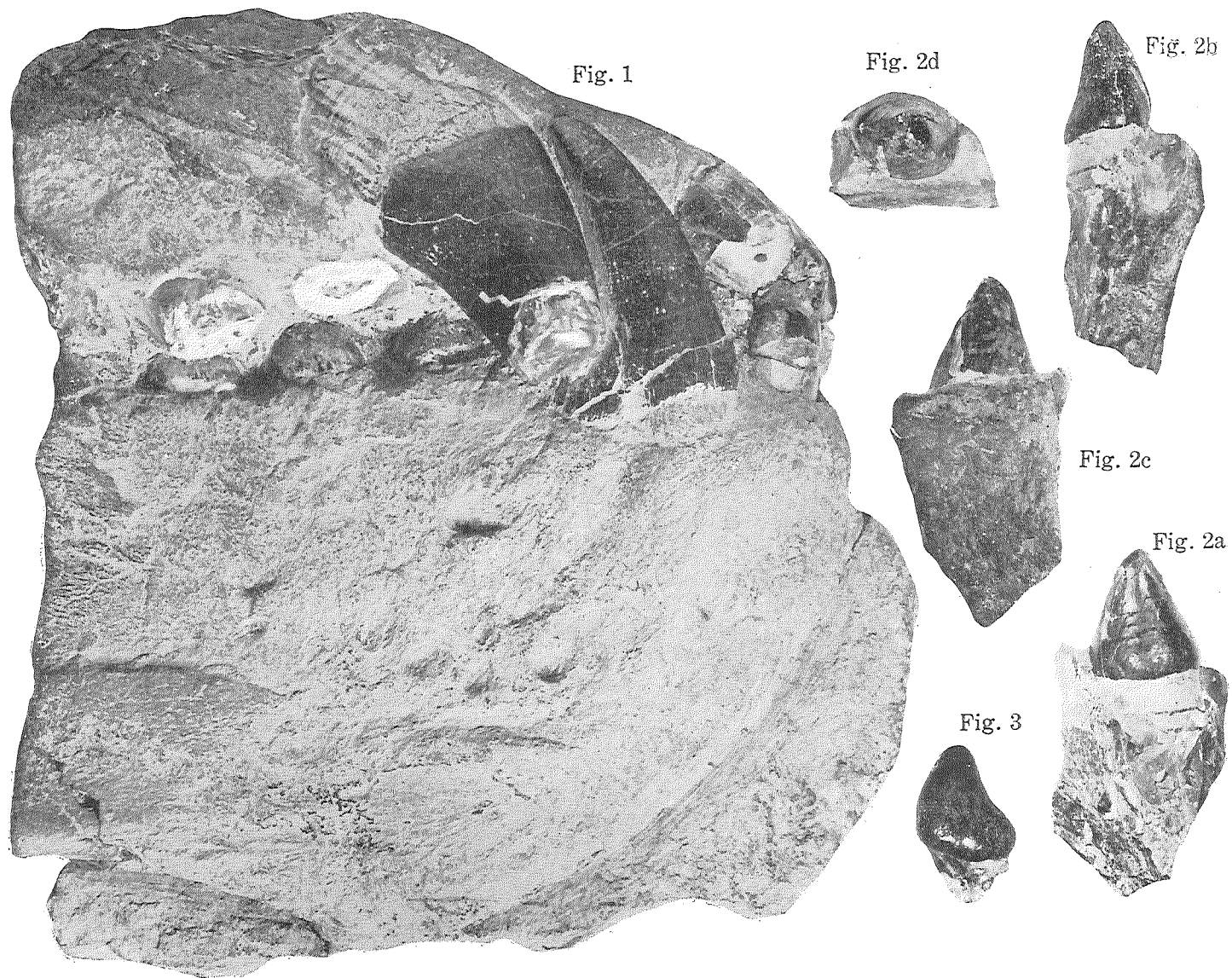


Fig. 2



Kumano photo.

T. Nagao : A Fossil Sea Lion.



Kumano photo.

T. Nagao: A Fossil Sea Lion.