

ON NEW MATERIAL OF SOME MACHAIRODONTS OF PONTIAN AGE FROM SHANSI

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The specimens described in the present paper was collected from the Pliocene of Pao-Teh and Yü-Shêh districts, Shansi Province. The material consists of two skulls and one lower jaw. The preservation of one skull is quite perfect and only a little damaged. Another skull and lower jaw of the same individual are much damaged and heavily compressed. The specific characters, however, are still well recognizable.

Family Felidae Gray
Sub-family Machairodontinae
Genus *Machairodus* Kaup
***Machairodus palanderi* Zdansky**

(Pl. I, Figs. 1—5)

1924. *Machairodus palanderi* Zdansky. Jungtertiäre Carnivoren Chinas. Palaeontologia Sinica, Ser. C., Vol. II. Fasc. I. pp. 108-116,
Taf. XXIV, Figs. 4—9; Taf. XXV, Figs. 1 and 2;
Taf. XXVI, Figs. 1—4; Taf. XXVII, Figs. 1 and 2.

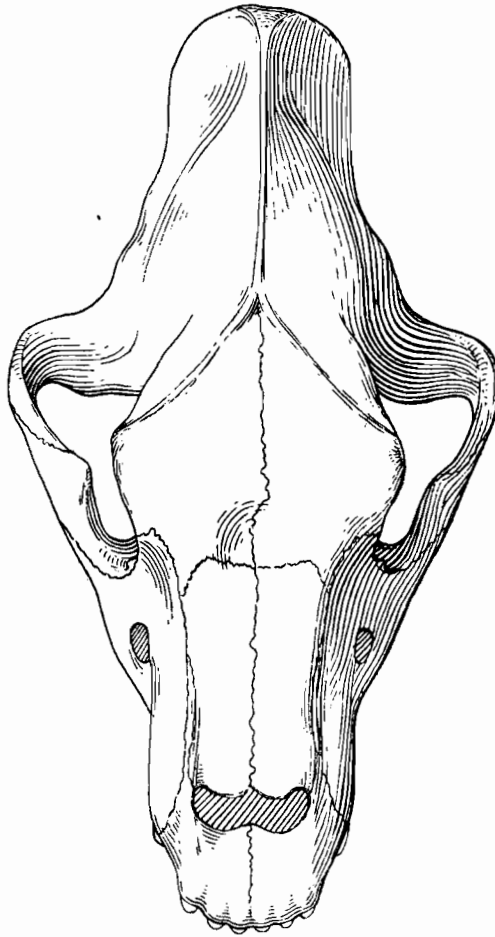
DESCRIPTION

Skull: The skull is rather long and narrow. Premaxilla not in contact with frontal. Nasalia obtangular in shape and of equal width at both anterior and posterior ends. Sagittal crest prominent and with sharp edge. Braincase rather low, but broad. Occiput low and broad. Anterior frontal foramen large. Bulla tympanica oval and swollen.

No comparison can be made with EX. 2 (Taf. XXV, Figs. 1 and 2) and EX.3 (Taf. XXVI, Figs. 3 and 4) of Zdansky, because those skulls belong to young individuals and of much smaller size.

The general shape of the skull of machairodonts is very similar to that of living species *Felis leo*. Only the following differences can be noticed: The skull of *Machairodus palanderi*

is comparatively narrower than that of *Felis leo*; the zygomatic arch of the latter is much thicker and stronger; Nasalia of *Felis leo* is much broader at the anterior and narrower at the posterior end, while that of *Machairodus palanderi* is obtangular in shape i.e. equal in width at both anterior and posterior ends. Of course, the character of the dentition is quite different between them (see Textfig. 1).



Textfigure 1. Top view of the Skull of *Machairodus palanderi* Zdansky

Upper dentition: I^3 , The third upper incisor being conical in shape. The crown finely serrated along the upper part of the external edge. An accessory cusp exists at the base along the posterior edge.

I² and I¹: The second upper incisor being also conical but much smaller than I³. Along the inner side at the base of the crown exist two accessory cusps and cingulum. I¹ quite similar as I² but a little smaller.

Upper canine: Between I³ and the upper canine there exist a short diastema (13 mm). The upper canine is flat with sharp edges and curved. A very promising character of the crown is the presence of fine serration on both anterior and posterior edges. The posterior edge is sharp and serrated throughout its whole length and the greater part of the anterior edge; while the anterior edge of basal part (24 mm from the alveola) becoming broad and not serrated.

Comparing the present described upper canines with that of Zdansky's (1924, Taf. XXIV, Fig. 4) all characters are similar except that the dimensions of our specimens being a little smaller. This is only individual difference.

Premolars and Molars: Behind the upper canine there follows a diastema of 11 mm in length and then exists P². P² rudimentary, exceedingly small and with a single cone. Behind P² there follows again a short diastema in front of P³. The third premolar P³ is long and slender with a prominent main cusp, one anterior and two posterior accessory cusps. P⁴ also rather long, slender and usually with 4 external cusps; the main cusp prominently developed and the two anterior cusps decreasing gradually in size. Behind the main cusp there builds actually a long sharp blade. The inner cusp or the protocone being always absent and this is the distinguishing character of the *Machairodonts* from other *Felids*. M¹ rudimentary and lying obliqually beside the carnassial in a right angle.

Dimensions of the dentition (in mm)

H. of I ¹	15.00	Diastema P ² —P ³	4.00
L. of I ¹	8.00	L. of P ³	22.00
H. of I ²	17.00	W.	12.00
L. of I ²	9.60	L. of P ⁴	42.00
H. of I ³	24.00	W.	17.00
L. of I ³	14.00	L. of M ¹	12.00
H. of upper canine	105.00	W.	7.00
L.	36.00	Length from P ² —P ⁴	62.00
W. (thickness)	13.00	Length from C—P ⁴	123.00
L. of P ²	7.00	Length of Palatine	158.00
W.	5.00	W. from P ² —P ² ...	70.00
	 P ⁴ —P ⁴ ...	113.00

The described skull of *Machairodus palanderi* Zdansky is the best known specimens so far obtained from China. It was collected from Pao-Teh district, Shansi Province, the famous Pontian Hippasion beds in China. Regist. No. V. 905.

Machairodus tingii Zdansky

(Pl. III, Figs. 1—4; Pl. IV, Figs. 1—3.)

1924. *Machairodus tingii* Zdansky. Jungtärtären carnivoren Chinas. Palaeontologia Sinica, Ser. C, II, Fasc. I, pp. 116 — 120, Taf. XXVII, Figs. 3 and 4; Taf. XXVIII, Figs. 1 and 2.

One skull and one lower jaw belong to this species. The skull is strongly damaged and much deformed especially on its back part. The nasal and the frontal portions of the skull being also heavily compressed.

All six incisors, the right canine, the right P⁴, the left P³, P⁴ and M¹ being *in situ*. All of them, however, being so much worn down that a better description can not be made. The specific determination is mainly based upon the character of the upper right canine.

The upper canine being flat and curved. The crown is only serrated at the greater part of the posterior edge, while the basal portion of it not serrated. That the anterior edge of the crown which is broad and not serrated can be well recognised. This is the distinguishing character of *Machairodus tingii* Zdansky from *Machairodus palanderi* Zdansky. Approximate height of the right upper canine measured 94 mm.

Dimensions of the dentition (in mm)

L. of P ³	23.00	W. of P ⁴	18.00
W. of P ³	10.00	L. of M ¹	10.00
L. of P ⁴	42.00	Diastema I ³ —C	16.00

The lower jaw is badly preserved and broken at the posterior; the coronoid process and the condyle of the left half of the lower jaw are still preserved but strongly damaged, while the posterior portion of the right half being broken. The lower symphyseal border with rectangular flange, which is a characteristic feature of the machairodonts. All incisors, canines, P₃, P₄ and M₁ of both sides being *in situ*. But the right M₁ being strongly damaged. All teeth being so much worn down that the characters cannot be well recognized. Lower canine stout, worn down. P₃ and P₄ with three cusps, the protoconid, the paraconid and the metaconid. M₁ trenchant with sharp edges.

Dimensions of the dentition (in mm)

L. of P ₃	21.00	L. of M ₁	33.00
W. of P ₃	10.00	W. of M ₁	14.00
L. of P ₄	29.00	Diastema C—P ₃	51.00
W. of P ₄	12.00	Diastema P ₃ —P ₄	55.00

These specimens were collected from Yü-sheh district, Shansi Province, and belong also to Pontian age, the lower Pliocene. Regist. No. V. 906.

Function of the dentition of the machairodonts with special regard to the sabre-tooth canine.

As always in palaeontology, when we study the function of a certain organ of an extinct animal, first of all we must closely examine the structure or morphology of that organ and then its function. Every organ of an animal is specially adapted for a certain kind of living. In this sense, an organ, therefore, has a special form and a definite function. If we know the form of an organ, then we can think about its function. Reversely if we know the function, then we can suppose its form. This work is a detailed study of form and function. Based on the form of an organ, we can bring out the mechanical principle of the function and the adaptation with natural conditions or environment. From this standpoint of view let us have a closer examination and study on the function of the dentition of the machairodonts.

The size of the lower canine of the machairodonts is only a little larger in dimension than its neighbouring incisor I_3 and from which the remaining I_2 and I_1 quite gradually decrease in size. They are all conical and curved a little backward. In this sense the lower canines are more or less incisor-formed and becoming functionally as a part of the incisor series. The size, form and structure of the upper incisors are quite similar with those of the lower incisors. They are used evidently in cooperation with the upper incisors for holding and tearing the prey.

The upper canines of the machairodonts are becoming quite enlarged into long, curved and flattened tusks, from which the designation sabre-tooth being derived. As already described in the preceding paragraph the flattened canines being furnished with sharp edges at both anterior and posterior borders; by some species such as *Machairodus palanderi* Zdansky the sharp edge of the crown is fine serrated at both anterior and posterior borders, while by some other species such as *Machairodus tingii* Zdansky only the posterior border being serrated.

Regarding the function of the sabre-tooth of the machairodonts there are quite different opinions among different authors. Some authors such as Hereuf Winge, Max Weber, O. Abel and B. Bohlin maintain that the sabre-tooth canines are used for slicing the prey (the slicing theory); while other authors such as W. D. Matthew, R. S. Lull, S. Schaub, W. B. Scott, G. L. Jepson and G. G. Simpson, etc., maintain that for stabbing the prey (the stabbing theory). In the first case the action was performed with the mouth closed; while in the second case the action was performed with the mouth wide open which was assisted with the strong development of the jaw muscles. The function of the elongated sabre-tooth was regarded by W. D. Matthew and other authors as adapted to pierce the thick-skinned, slow-moving pachyderms such as rhinoceroses, proboscideans etc.

Judging from the principle of form and function and according to my own observation I would be inclined to the stabbing theory. Because slicing must be preceded by stabbing and without stabbing how could slicing be performed? As we know that the canine being furnished with sharp edges at both anterior and posterior borders, could the machairodont used its sabre-tooth both backward and forward slicing? What will be the use of the serrated border for slicing? Judging from the mechanical principle I do not see any advantage for slicing with a serrated knife-blade.

The carnassial P^4 and M_1 are both furnished with well developed knife-blade and operated obviously for cutting the prey.

Judging from the form and structure of the dentition of the machairodont, especially from the enormously enlarged, flattened and sharp-edged upper tusks the machairodont adapted obviously to prey upon the thick-skinned and slow moving animals such as rhinoceros and proboscideans etc. rather than carrions.

ACKNOWLEDGEMENTS

My warmest thanks are due to the following; to Dr. C. C. Young, Director of the Institute of Vertebrate Palaeontology, Academia Sinica, for the opportunity to work on this material; to Dr. W. C. Pei and Dr. M. C. Chow for delivering valuable discussions during the vacation for preparing this work and for reading the manuscript; to Mr. C. F. Wang for taking the photographs used in the plates; to my colleagues C. K. Hu, H. H. Hsü and Y. H. Hsü for various helpness during the session in the preparation of this work.

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山西上新統蓬蒂层劍齿虎之研究

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中文摘要

这篇短文研究的材料是从山西保德、榆社上新統蓬蒂层所采得。計有两个头骨和一个下顎骨，其中一个头骨保存完美仅微有损坏；另一头骨与下顎属于一个个体，损伤較甚并受挤压，但种屬性質尚可辨識。

经过研究鑑定的結果，这些材料是属于两种不同的劍齿虎；一名巴氏劍齿虎 *Machairodus Palanderi* Zdansky；一名丁氏劍齿虎 *Machairodus Tingii* Zdansky。

劍齿虎屬貓科劍齿虎亞科，它的特征是：上顎具左右門齿各三个，犬齿一个，前臼齿两个与臼齿一个；下顎齿的数目与上顎者相同。劍齿虎与貓亞科不同之点是：上顎犬齿一对特別发育，扁而長；前后兩面均具有銳利的鋒刃与貓亞科犬齿成圓錐形者不同。劍齿虎下顎一对犬齿成圓錐形与貓亞科者相似，但形体很小，不似貓亞科下犬齿之特別发育，劍齿虎上顎第三前臼齿(P³)主尖凸聳，前面具一副尖而后面具兩副尖。第四前臼齿長而狹，外方具四尖，內尖缺失，这是与貓亞科区别之点。下顎之前臼齿与臼齿的構造与貓亞科相似，但窄而長。

巴氏劍齿虎与丁氏劍齿虎之区别是：前者的上犬齿前后兩面均具有銳利鋒刃，刃上并具有小鉅齿；而丁氏劍齿虎則仅在犬齿之后面具有銳利之鋒刃和小鉅齿，齿之前面变圓而鈍，沒有小鉅齿。这两种劍齿虎均发现于山西上新統之蓬蒂层里；巴氏劍齿虎采自山西保德，而丁氏劍齿虎則采自山西榆社；二者均产于三趾馬紅土层中。

劍齿虎的劍齿(上犬齿)与其他牙齿的功用。

一般古生物学研究上，当研究某种动物的某一器官功用的时候，首先应当研究該器官的形态，然后再研究它的功用。动物的器官具有一定形态，适应于一定的生活环境，因此就具有一定的功用。假使我們已經知道某一器官的形态，就可以想象它的功用；反之，如果我們

知道某一器官的功用，我們就可以想象該器官的形态。这就是形态和功用統一的研究。根据这种观点与方法，讓我們把劍齿虎牙齿的功用来作一番研究。

劍齿虎下顎的犬齿比相鄰的第三門齿稍微大一些，門齿与犬齿均为圓錐形并稍微向后弯曲，从構造形态上来看，犬齿近似門齿化了，并且与門齿具有同一功用；它們显然与上顎門齿一同被用来作为捉拿食物之用。

上犬齿变成很長的、扁平并向后弯曲的大牙，这就是“劍齿”之名的由来。劍齿的前后兩边均具有銳利的鋒刃和小鉅齿（丁氏劍齿虎仅后面具有小鉅齿）。

关于劍齿的功用，古生物学者持有不同的意見；有些学者認為劍齿是为切割敌人之用；更有些学者認為是为了刺杀敌人之用。根据形态和功用的原理，作者認為后者较为合理。很显然，劍齿虎是以行动迟緩身軀被有厚皮的动物（如犀牛和象）为食品，而不是如其他学者所想像的以动物的尸体为食物的。

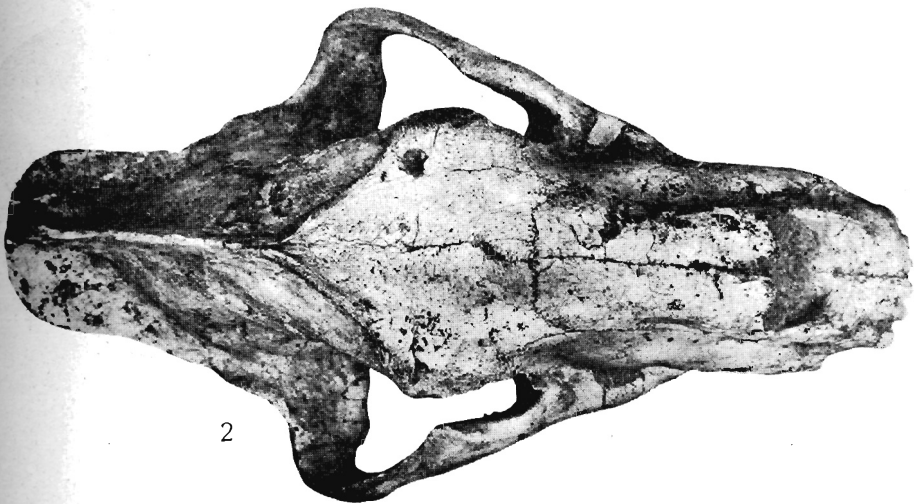
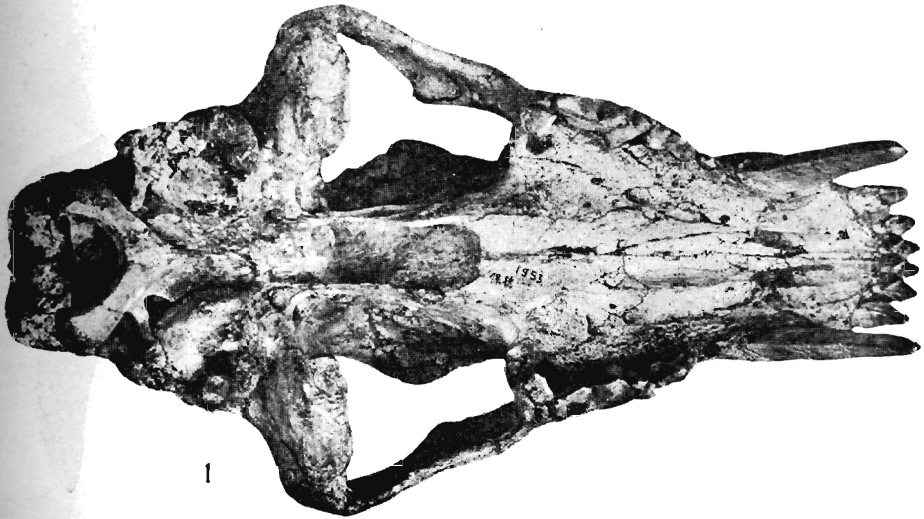


Fig. 1. *Machairodus palanderi* Zdansky. Skull palatal view. 1/3.

Fig. 2. *Machairodus palanderi* Zdansky. Skull top view. 1/3.

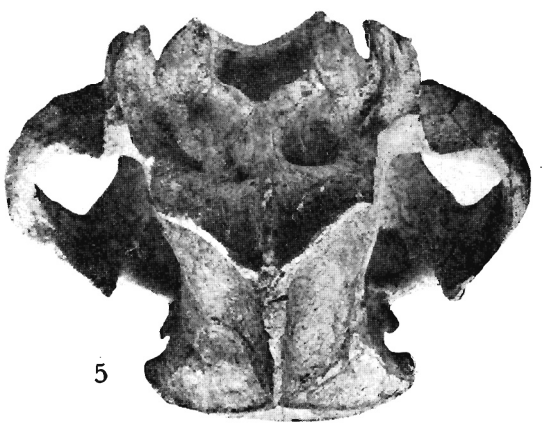
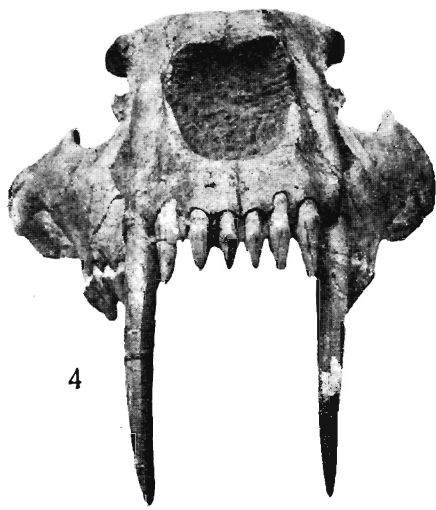


Fig. 1. *Machairodus palanderi* Zdansky. Skull right side view. 1/3.
Fig. 2. *Machairodus palanderi* Zdansky. Skull front view. 1/3.
Fig. 3. *Machairodus palanderi* Zdansky. Skull back view. 1/3.



Fig. 1. *Machairodus tingii* Zdansky. Skull top view, 1/3.
Fig. 2. *Machairodus tingii* Zdansky. Skull palatal view, 1/3.
Fig. 3. *Machairodus tingii* Zdansky. Skull right side view, 1/3.
Fig. 4. *Machairodus tingii* Zdansky. Skull front view, 1/3.



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Fig. 1. *Machairodus tingii* Zdansky. Lower jaws, right side view. $\frac{1}{2}$.
Fig. 2. *Machairodus tingii* Zdansky. Lower jaws, left side view. $\frac{1}{2}$.
Fig. 3. *Machairodus tingii* Zdansky. Lower jaws, top side view. $\frac{1}{2}$.