POLSKA AKADEMIA NAUK
ZAKŁAD ZOOLOGII SYSTEMATYCZNEJ I DOŚWIADCZALNEJ

ACTA ZOOLOGICA CRACOVIENSIA

Tom XXIII Kraków, 31. XII. 1978 Nr 7

TERESA CZYŻEWSKA

A Natural Cast of the Endocranium of *Arctomeles pliocaenicus* STACH from Węże near Działoszyn (Poland)

[Pp. 93-100, pl. XXI—XXII]

Naturalny odlew endocranium *Arctomeles pliocaenicus* STACH z Węży I koło Działoszyna (Polska)

Abstract. This paper comprises a description of a natural cast of the endocranium of *Arctomeles pliocaenicus* STACH from the locality Węże I near Działoszyn and characteristics of the brain of this species. The brains of *Arctomeles*, *Meles meles* L. and *Arctonyx collaris* Cuv. have been compared and conclusions have been made on the basis of the external structure of the brain and dentition as to the genetic relationships and behaviour of these three species.

INTRODUCTION

Numerous remains of large and small mammals and other terrestrial vertebrates have been found in the bone breccia that filled a vertical funnel-shaped part of an old cave at the locality Węże I in the Zelce Reserve near Działoszyn, Sieradz Province (Poland). In addition to the skeletal fragments, natural casts of the endocranium have also been preserved in the deposits. So far, only a cast of the endocranium of *Desmana kormosi* SCHREUDER has been described from Węże I (SYCH and RZEBIK-KOWALSKA, 1972).

The purpose of this work is to describe a big fragment of an endocranial cast and to characterize the external structure of the brain of *Arctomeles pliocaenicus* STACH, the beaver occurring at Węże I and closely related to *Meles meles* L. and *Arctonyx collaris* Cuv. (STACH, 1951). This cast has been got out of a breccia block, which, in addition to other bones, contained a skull of *Procapreolus wenzensis* (CZYŻ.) (CZYŻEWSKA, 1968). The deposits of the Węże I cave were not accumulated all the same time, but in separate sedimentary cycles (GŁAZEK et al., 1973; SAMSONOWICZ, 1934). The fragment of breccia with the endocranial cast of *Arctomeles* would belong to the third sedimentary cycle (3·3—

4·0 million years), which occurred in the cool period at the beginning of the Villafranchian.

The terminology adopted for the brain and cerebral arteries in this paper is that used by BRAUER and SCHOBER (1970), STELMASIAK (1958) and JANSEN and BRODAL (1954). The comparative material consisted of 11 skulls of male and female *Meles meles* L. in the possession of the Museum of Natural History, Wrocław University (MPUW). Latex casts of the endocranium of *Meles meles* L. were also made. The specimen of the endocranial cast under study belongs to the Museum of Earth, Polish Academy of Sciences, in Warsaw (MZVIII—Vn 355/4).

This investigation has been carried out under the scheme of Project MR 113.

I wish to express my thanks to Prof. K. KOWALSKI, Head of the Institute of Systematic and Experimental Zoology, Polish Academy of Sciences, for placing the holotype of *Arctomeles pliocaenicus* STACH at my command and to Prof. W. RYDZEWSKI, Director of the Museum of Natural History, Wrocław University, for lending me the beaver skulls and permitting me to perform latex casts. I am also indebted to Miss B. DROŻDŻ for taking photographs.

DESCRIPTION

(Pls. XXI and XXII)

The natural endocranial cast of *Arctomeles* under description was found broken along the median line in such a way that its left part and, posteriorly as well as on the ventral side, a fragment of the right part of the cast are preserved. The following structural details of the brain can be seen on the cast and are particularly distinct on its upper surface. The hemispheres of the brain were covered frontally by the frontal sinuses and nasal conchae reaching backwards as far as the precruciate and rostral composite gyri (Pl. XXI, 1 and 1a). The outline of the cast of the olfactory bulb and the anterior part of the frontal lobe is visible on the broken internal surface of the cast. The brain must have been slightly narrowed towards the front, its greatest width occurred on the lower surface of the caudal ectosylvian gyrus. In the lateral view the brain must have been only somewhat convex with a shallow depression of the outline at the level of the cruciate sulcus (Pl. XXI, 1 and 1a; Pl. XXII, 1 and 1a).

The measurements and indices of the endocranial cast of *Arctomeles* show a great width of the cerebral hemispheres of this beaver, its brain being also relatively high. The parts of the hemispheres lying posteriorly to the cruciate sulcus were long compared with the anterior parts.

The following sulci were visible on the cerebral hemispheres of *Arctomeles*: The lateral sulcus ran nearly parallel to the longitudinal fissure of cerebrum and at the back joined the postlateral sulcus, which was bent downwards. Anteriorly, the fairly long ansate sulcus branched off from the lateral sulcus

toward the median line and the relatively straight coronal sulcus downwards and obliquely to the front; the end of this last sulcus was covered by the nasal conchae. The cruciate sulcus extended across the hemisphere and the short and branching postcruciate sulcus ran in the bottom of a marked depression in the

Measurements and indices of endocranial cast of *Arctomeles pliocaenicus* STACH and endocranial casts of *Meles meles* L.

Ser. no.	Measurements and indices	*Arctomeles pliocaenicus* STACH	*Meles meles* L.		
			brain BRAUNER & SCHOBER 1970	endocranial cast MPUW	
1.	Greatest worm of cerebellum-olfactory bulb distance	75	79	77	75
2.	Length of hemisphere without olfactory bulb	56	61	53	55
3.	Distance between posterior margin of hemispheres and cruciate sulcus	43	—	34	33
4.	Distance between cruciate sulcus and anterior margin of hemispheres	13	—	22	33
5.	Greatest width of hemispheres	60	53	60	54
6.	Greatest height of brain	39	34	32	32
7.	Greatest height of hemispheres	30	—	27	29
8.	Width of cerebellum (with parafloccullus)	40	43.7	—	—
	1 : 2	74.7	78.2	68.8	74.3
	2 : 3	76.8	—	64.2	60.0
	1 : 5	80.0	68.0	77.9	73.0
	1 : 6	52.0	43.6	41.6	43.2
	1 : 8	53.3	56.0	—	—

postcruciate gyrus. The visible segment of the presylvian sulcus surrounded the rostral composite gyrus. The rostral and caudal rhinal sulci were situated relatively low. The sylvian fissure was deep and surrounded by the arch of the suprasylvian sulcus, strongly inclined to the rear, but nowhere did they come into touch (Pls. XXI 1, 1a and XXII 1, 1a).

The coronal gyrus was wide, with a characteristic short sulcus in the middle. The ectosylvian gyrus was very narrow rostrally, its width being 3 mm, whereas its caudal part was markedly broader, reaching about 10 mm. This difference in width between the anterior and posterior parts of the ectosylvian gyrus resulted from the operculization of the region of the sylvian fissure (Pl. XXI 1, 1a).

There are distinct traces of two narrow, convex and ramifying blood-vessels. The anterior cast of the vessels begins in front of the pyriform lobe; higher, in the lower part of the ectosylvian gyrus it splits into a branch directed forward on to the rostral composite gyrus and a posterior one, extending along the ectosylvian gyrus. The posterior cast of the vessels is visible on the caudal ectosylvian gyrus, where it divides to form an anterior branch, running upwards, and a posterior one, which tends obliquely on to the adjacent suprasylvian gyrus. They were cortical branches of the median cerebral artery, running to the temporal, parietal and frontal regions (Pl. XXI, 1 and 1a).

The cerebellum of *Arctomeles* was relatively short and its part protruding beyond the posterior edges of the hemispheres was small. The length index of hemisphere to cerebellum was 34·3 and that of hemisphere to the part of cerebellum protruding beyond the hemispheres, 7·6. The situation of the vermis and, at the side, that of the simplex lobule, both parts of the ansiform lobule, paramedial lobule and paraflocculus can be distinguished in the cerebellar region in the endocranial cast of *Arctomeles*. Fissure VI is present on the vermis and fissure VII below; between them there are more delicate groves which separate five laminae. Fissure V (fissura prima) is not visible from the outside, as it was covered by the hemispheres (Pl. XXI, 2 and 2a).

Posteriorly, on the ventral side of the cast there is an impress of the skull-base, with its characteristic shape, narrowing to the front. The single condylar canal is preserved in the form of a cast, about 10 mm long. The foramen for nerve XII was posterior to the greatest widening of the internal surface of the skull-base, and the posterior lacerate foramen (n. IX, X and XI), further, the internal acoustic pore and the opening of the carotid canal were located on the line of this widening. These last opening must have been large. The casts of the canals leading to the orbital fissure and the rotund foramen (n. III, IV, VI and 2 V) have great diameters. The hypophyseal fossa must have been capacious in relation to the presumable measurements of the skull, its outline was oval, the greatest depth was in the front, and the diameters of its cast are 7·5 and 4·5 mm (Pl. XXII, 2).

COMPARISON

The endocranial cast under description belonged unquestionably to the species *Arctomeles pliocaenicus* STACH. Its skull was about 127 mm long, in which it did not differ from *Meles meles* L., whose skull length ranges from 100 to 144 mm (GEPTNER et al., 1967; KOWALSKI, 1964; MILLER, 1912; 10 skulls of *Meles meles* L. from MPUW). In length the endocranial cast of *Arctomeles* corresponds to the skull of a medium-sized badger. The fragments of bones preserved on the cast but damaged heavily made it possible to reconstruct the general shape of the occiput, similar to that in *Arctomeles*. In the middle and at the side of the occipital bones there were protuberances, and they are usually missing in *Meles*.

The sagittal crest was not preserved. The angle between the frontal crests was about 60° as in *Arctomeles*, whereas in *Meles* this angle is much more obtuse. The distance between the junction of the frontal crests into the sagittal crest and the line connecting the postorbital processes was about 32 mm, thus approaching that in *Arctomeles* but being nearly twice as long as that on the skull of *Meles*.

The great occipital foramen of *Meles meles* L. and the corresponding region on the cast have an elliptic outline, whereas in the skull of *Arctomeles* described by STACH (1951) it is round (Pl. XXI, 2).

The brains of *Arctomeles* and *Meles meles* L. are similar in shape. The brain of these badgers narrows gradually toward the front. The brain of *Arctonyx collaris* CUV. is more spherical and so there is no narrowing of the anterior parts of the hemispheres. The frontal lobe of cerebral hemispheres in *Meles* and *Arctonyx* is distinctly larger than that in *Arctomeles*. In *Arctonyx* this lobe is, in addition, high and the anterior slope of the hemispheres is very steep. The outline of the frontal lobe in *Arctomeles* was similar. The olfactory bulbs of *Arctonyx* and *Arctomeles*, seen from the side, resemble each other in shape and size.

RADINSKY (1973) strongly emphasizes the fact of occurrence of the large orbital gyrus in *Meles* and *Arctonyx*. The estimation of the size of this region in the endocranial cast of *Arctomeles* is difficult, because it is only partly seen. Nevertheless, in view of the shorter anterior part of the hemispheres in *Arctomeles*, the orbital gyrus was probably smaller.

The brain of big badgers like *Taxidea*, *Meles* and *Arctonyx* has the postlateral sulcus (RADINSKY, 1973), which is also present in *Arctomeles*. The sylvian fissure of the brain in badgers under comparison is long, but in *Arctomeles* and *Meles* it does not reach the suprasylvian sulcus, which it joins in *Arctonyx*. The coronal sulcus in *Arctomeles* was rather straightened out and in *Meles* and *Arctonyx* it is bent. The degree of operculization of the region of the sylvian fissure is similar in the cerebral hemispheres of *Arctomeles* and *Meles*, whereas in *Arctonyx* it is much higher owing to the lapping of the coronal gyrus over the upper section of the sylvian fissure. The coronal gyrus of *Arctonyx* and *Arctomeles* is particularly extensive, there being pits on this gyrus in *Arctonyx* and a distinct longitudinal furrow in *Arctomeles*.

The shape of the internal surface of the skull base, the distribution of the foramina for cranial nerves and blood-vessels, and the situation of the hypophyseal fossa are similar in *Arctomeles* and *Meles*, but the canal of the orbital fissure, the rotund foramen and the hypophyseal fossa of *Arctomeles* were distinctly larger against the subequal skull lengths.

REMARKS

Meles, *Arctonyx* and *Arctomeles* are closely related genera. The subfamily *Melinae*, to which they belong, is not a genetically homogeneous group, and parallel strains that have been evolving since the Miocene can be observed in it

(THENIUS, 1969). The evolutionary line of *Meles* goes back through the genera *Melodon* and *Promeles* to the Upper Miocene. *Arctonyx* is the terminal link of a strain that branched off from this line in the Upper Pliocene (Petter, 1971). According to THENIUS (1969), *Arctomeles* belongs to the group *Arctonyx*. The structure of the endocranial cast and dentition (STACH, 1951; PETTER, 1971) makes it possible to present the relationships between the above-mentioned genera in more detail.

The brain of *Arctomeles*, *Taxidea* *, *Meles* and *Arctonyx* is characterized by the presence of the postlateral sulcus and the operculization of the ectosylvian gyrus. These characters of badgers are connected with the size of body and brain (RADINSKY, 1973).

In its shape of the brain and degree of operculization of the ectosylvian gyrus *Arctomeles* more resembles *Meles* and differs distinctly from *Arctonyx*, in which the operculization of the ectosylvian gyrus is much more advanced.

The great size of the coronal gyrus in *Arctomeles* and *Arctonyx* and the depressions in it indicate a different specialization of this region of the cerebral hemispheres as compared with *Meles*. RADINSKY (1973) explains the growth of the coronal gyrus and the differentiation of its surface in *Arctonyx* by an increase in the significance of the sense of touch in the nasal region. *Arctonyx* burrows in earth with its elongate snout (WALKER, 1964). In *Arctomeles* from the Lower Villafranchian the sense of touch and the behaviour connected with it, i. e. burrowing earth with the snout in search of food might have developed to at least the same degree as in *Arctonyx*, which would be pointed to by the similarity of the shapes of their coronal gyri.

The structure of the brain of *Arctomeles* indicates a very close relationship of this genus to the tribe *Meles* (shape of brain, degree of operculization) and at the same time it shows some primitiveness in comparison with *Meles* and *Arctonyx* (small frontal area) accompanied by the specialization of the coronal gyrus region, similar to that in *Arctonyx*. The relationships existing between the genera *Arctomeles*, *Meles* and *Arctonyx* are manifested better by the structure of their dentition. The regression of P^4 and the simultaneous development of M_1 and M^1 are observed in the history of the tribe *Meles* (PETTERS, 1971). The regression of P^4 occurred also in the *Arctomeles-Arctonyx* line and P^4 of *Arctomeles* is distinctly longer and relatively narrower than that of *Meles*, and for this reason it may be supposed that the separation of the tribes *Meles* and *Arctomeles-Arctonyx* took place on the Pliocene, earlier than PETTER (1971) suggests, i. e. at the time when P^4 in both these tribes showed a similar degree of regression. In the tribe *Arctomeles-Arctonyx* the evolution of M^1 was expressed, above all, by the lengthening of the labial part of crown and its simultaneous narrowing. This very specific

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* THENIUS (1969) and PETTER (1971) think that *Taxidea*, the American badger, is not fairly closely genetically related to *Meles* and *Arctonyx*.

type of structure of M^1, typical of the *Arctomeles-Arctonyx* line, must have arisen in a relatively short period, from the separation of this tribe to the time of occurrence of *Arctomeles pliocaenicus* STACH in the Villafranchian.

University of Wrocław
Zoological Institute
Dept. of Palaeontology
Wrocław, Sienkiewicza 21

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STRESZCZENIE

Odlew endocranium *Arctomeles pliocaenicus* STACH został znaleziony w Wężach I koło Działoszyna, województwo sieradzkie. Sądząc z odlewu mózg *Arctomeles* musiał być zwężony ku przodowi, jego profil był nieznacznie uwypuklony. Półkule były szerokie i stosunkowo wysokie, miały krótką część leżącą z przodu przed sulcus cruciatus. W układzie bruzd powierzchni półkul charakterystyczna była obecność sulcus postlateralis, sulcus coronalis był prawie prosty, postcruciatus krótki i rozgałęziony. Sulcus rhinalis rostralis i caudalis znajdowały się stosunkowo nisko. Szeroki gyrus coronalis miał pośrodku krótką bruzdę. Operkulizacja okolicy fissura sylvia wyrażała się znacznym zwężeniem części rostralnej gyrus ectosylvius. Odgałęzienia arteria cerebri media przebiegały na powierzchni gyrus compositus rostralis, gyrus ectosylvius i gyrus suprasylvius. Cerebellum było w dużej części przysłonięte przez półkule mózgu tak, że fissura V (fissura prima) nie była widoczna od zewnątrz.

Mózg *Arctomeles* przypominał mózg dzisiaj żyjącego *Meles meles* L. zwężeniem półkul z przodu, stopniem operkulizacji rejonu fissura sylvia oraz formą wewnętrznej powierzchni podstawy czaszki, rozmieszczeniem otworów nerwów czaszowych i fossa hypophyseos. Mózg *Arctomeles* zbliżony był do mózgu *Arctonyx collaris* CUV. profilem płatu czołowego, wielkością i kształtem opuszek węchowych, rozległością gyrus coronalis i uformowaniem powierzchni tego zakrętu.

Cechami swoistymi mózgu *Arctomeles* były małe rozmiary płatu czołowego, przypuszczalnie mniejszy gyrus orbitalis i prosty przebieg sulcus coronalis.

Rozrost gyrus coronalis i zróżnicowanie jego powierzchni RADINSKY (1973) łączy ze wzrostem znaczenia zmysłu dotyku (czuciem) w okolicy nosowej, towarzyszącym ryciu ziemi wydłużonym pyskiem.

Budowa mózgu *Arctomeles* świadczy o bliskim związku tego rodzaju ze szczepem *Meles* (forma mózgu, mniej zaawansowany stopień operkulizacji), wykazuje ona również pewną pierwotność w odniesieniu do *Meles* i *Arctonyx* (mały obszar czołowy) przy równoczesnej specjalizacji okolicy gyrus coronalis, podobnej do tej u *Arctonyx*.

Plate XXI

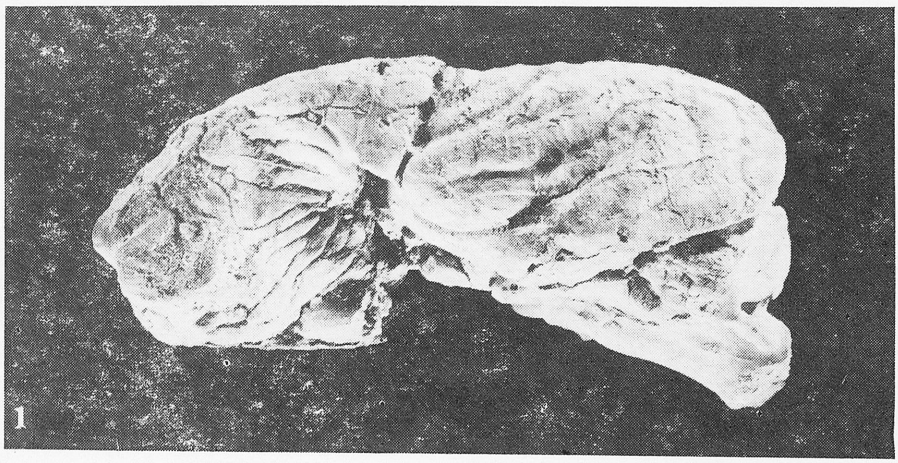
Cast of endocranium of *Arctomeles pliocaenicus* STACH (MZVIII-Vn 355/4) × 1

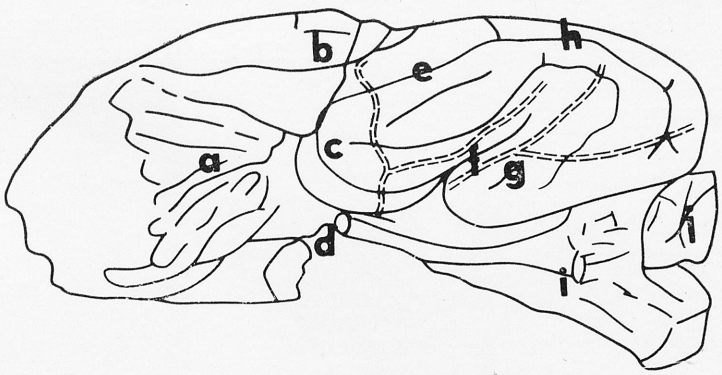
1. Lateral view

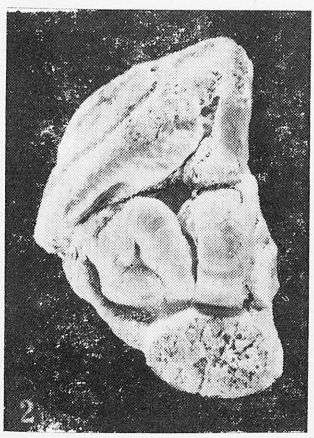
1a. Schematic drawing of the same; a. nasal conchae, b. frontal sinus, c. rostral composite gyrus, d. orbital fissure, e. coronal sulcus, f. Sylvian fissure, g. caudal ectosylvian gyrus, h. lateral sulcus, i. carotic foramen, j. cerebellum

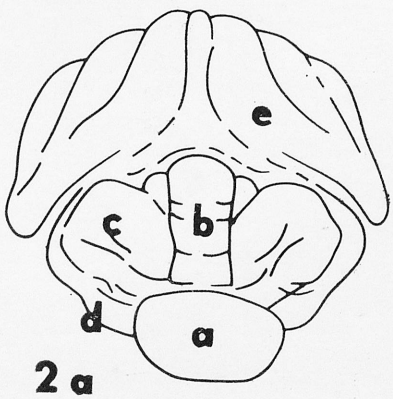
2. Occipital view

2a. Schematic drawing of the same; a. foramen magnum, b. vermis, c. cerebellar hemisphere, d. condylar canal, e. cerebral hemisphere









T. Czyżewska

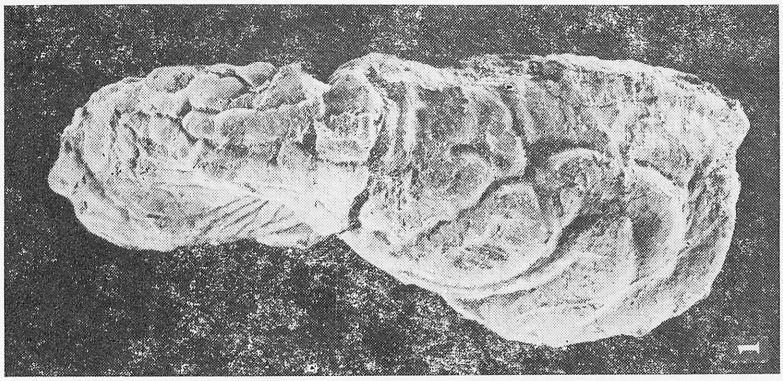
Plate XXII

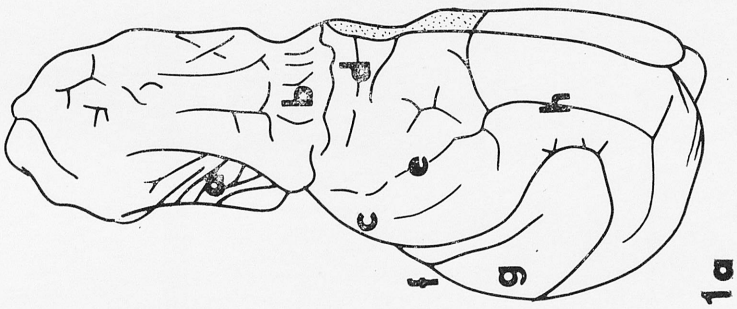
Cast of endocranium of *Arctomeles pliocaenicus* STACH (MZVIII-Vn 355/4) × 1

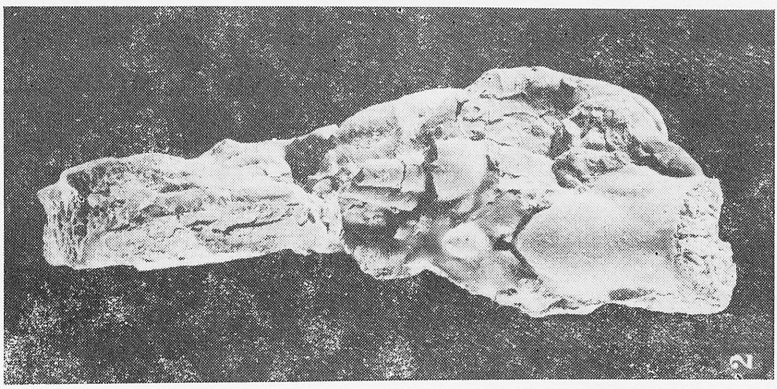
1. Dorsal view

1a. Schematic drawing of the same; a. nasal conchae, b. frontal sinus, c. rostral composite gyrus, d. cruciate sulcus, e. coronal sulcus, f. Sylvian fissure, g. caudal ectosylvian gyrus, h. lateral sulcus

2. Ventral view







T. Czyżewska

ISBN 83—01—00431—2
ISSN 0065—1710

Redaktor zeszytu: dr B. Sych

PAŃSTWOWE WYDAWNICTWO NAUKOWE — ODDZIAŁ W KRAKOWIE — 1978

Nakład 800+80 Ark. wyd. 0,75. Ark. druk. $^{8}/_{16}$+2 wkładki. Papier ilustr. kl. V 70×100 71 g.
Zam. 346/78 Cena zł 10.—

DRUKARNIA UNIWERSYTETU JAGIELLOŃSKIEGO W KRAKOWIE