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Natural Endocranial Casts of the *Canidae* from Weże I near Działoszyn (Poland)*

[PL. X]

Naturalne odlewy endocranium *Canidae* z Weżów I koło Działoszyna (Polska)

Abstract. The external structure of the brains of *Nyctereutes megamastoides* (POMEL), known from the locality Weże I, and *Canis* sp., a member of the *Canidae* new to Weże I, are characterized and described on the basis of their natural endocranial casts.

INTRODUCTION

Two natural casts of the endocranium of the *Canidae* discussed in this paper come from the locality Weże I, situated in the area of the Zelce Reserve near Działoszyn, Sieradz Province (Poland). This locality was a part of a larger cave, a vertical shaft connected with a horizontal passage at the bottom, filled with deposit which contained remains of vertebrates, mainly large and small mammals (SAMSONOWICZ, 1934; SULIMSKI, 1959; GŁAZEK et al., 1976). The natural endocranial casts of *Desmana kormosi* SCHREUDER (SYCH and RZEBIK-KOWALSKA, 1972), *Arctomeles pliocaenicus* STACH (CZYŻEWSKA, 1978) and three species of the *Mustelinae* (CZYŻEWSKA, 1981) described earlier were also derived from Weże I.

The objective of this work is a description and characterization of the external structure of the brains of *Nyctereutes* and *Canis* sp. from Weże I. The occurrence of *Nyctereutes* sp. at Weże I was stated by STACH (1954); later, the skull and mandibular fragment found at this locality were referred to *Nyctereutes sinensis* (SCHLOSSER) (CZYŻEWSKA, 1969). SORIA and AGUIRRE (1976) express their convincing opinion that the *Nyctereutes* population inhabiting Eurasia in the Villafranchian consisted of one species, *Nyctereutes megamastoides* (POMEL 1843), and that *Nyctereutes sinensis* (SCHLOSSER) is only an East-Asiatic subspecies of *Nyctereutes megamastoides*. Thus, the raccoon-dog from Weże I should be included in the species *Nyctereutes megamastoides* (POMEL).

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The deposit of Weże I was accumulated in several sedimentation cycles. The endocranial casts of *Nyctereutes megamastoides* (POMEL) and *Canis* sp. were obtained from grey bony breccia of the third sedimentation cycle, the age of this sediment being estimated at 3.3—4 million years, the end of the Pliocene to the Lower Villafranchian (GŁAZEK et al., 1976).

The commonly used terminology of BRAUER and SCHÖBER (1970) and KLATT (1954) is adopted in this study and that of HERRE and STEPHAN (1955) to distinguish the cerebral lobes of the *Canidae*. Latex casts of the endocranium of *Canis lupus* L., *Vulpes vulpes* L. and *Canis familiaris* L. and 11 skulls of adult *Nyctereutes procyonoides* (GRAY) were used as comparative material. The endocranial casts of *Nyctereutes megamastoides* (POMEL), MZ VIII—V-355/2, and *Canis* sp., MZ VIII-V-360/1, are in the possession of the Museum of Earth, Polish Academy of Sciences, in Warsaw.

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NYCTEREUTES MEGAMASTOIDES (POMEL 1843)

Description (Pl. X, 4—5)

Material: Fragmentary endocranial cast without frontal and ventral regions, MZ VIII-V-355/2; skull, VIII-V-355/1 (CZYŻEWSKA, 1969, Pl. XXV—XXVII).

Some details of the brain structure are preserved on the fragmentary endocranial cast MZ VIII-V-355/2. The endolateral sulcus of the brain of *Nyctereutes megamastoides* (POMEL) from Weże I runs parallel to the longitudinal cerebral fissure, the short lateral sulcus joins the coronal and ansate sulci rostrally and is connected with the ectolateral sulcus by means of an additional furrow caudally. The suprasylvian sulcus, preserved only in the posterior and middle sections, has a small deep furrow directed obliquely anteromedially. The sylvian fissure is short and the mark of the ectosylvian sulcus is preserved only as a small rostral fragment.

The lateral and suprasylvian gyri are narrow, the temporal lobe is poorly developed, especially in the anterior part, and so is the parietal lobe, and consequently the hemispheres are flattened in this region; the occipital lobe is short and not wide-spread. The posterior edge of the hemispheres, seen from above, is almost straight.

The cerebellum has a low position in relation to the cerebral hemispheres and protrudes markedly beyond them. The anterior lobe is only partly cov-

ered, large lobule V (? VI) being visible on it. As in the dog and wolf, there was probably no distinct boundary between the vermis and the cerebellar hemispheres on the anterior lobule (WILL, 1973). Deep fissure V (fissura prima) has the same position as in dogs. This fissure was directed vertically downwards. The position of the paramedian lobule, crus I and crus II can be distinguished on the cast of the cerebellum. The vermis is twisted forward and has no lateral bend, which occurs so often in the *Canidae*.

A large venous sinus (sinus sagittalis) and the branching medial cerebral artery occur on the surface of the cerebral hemispheres. The anterior width of the cerebral hemispheres, measured behind the cruciate sulcus of our specimen, is about 36 mm and the greatest posterior width about 47 mm.

Remarks

The fragmentary cast of the endocranium MZ VIII-V-355/2 corresponds to the skull of *Nyctereutes megamastoides* (POMEL 1843), MZ VIII-V-355/1, in size and shape. In relation to the basal length the endocranium of this skull is long and it is fairly broad at the narrowing behind the postorbital process. The length of the endocranium of cast MZ VIII-V-355/2 is not known, the widths approximating those in *Nyctereutes megamastoides* (POMEL). The distribution of the marks of grooves and gyri on the cast does not differ from that in the *Canidae* (KLATT, 1954). The distribution of grooves and gyri analogous to that in the *Canidae* may also occur in *Nyctereutes*. However, in view of the damaged surface and fragmentary state of the specimen MZ VIII-V-355/2, notably lack of the anterior region (prorean and orbital gyri), the affiliation of this cast to *Nyctereutes* is not quite certain although very probable. *Nyctereutes* resembles the dog in the relative length of the prorean gyrus but differs from it in the lack of a marked two-sided narrowing of this region (RADINSKY, 1973).

The ansate sulcus, present in *Nyctereutes megamastoides* (POMEL) and missing in modern *Nyctereutes procyonoides* (GRAY), occurs in the raccoon-dog from Weze I. RADINSKY (1973) thinks that the presence of this sulcus indicates a greater development of the cortex of the hemispheres in *Nyctereutes megamastoides* (POMEL) than in *Nyctereutes procyonoides* (GRAY). The form from Weze I is somewhat larger than the latter but differs distinctly in size from the largest specimens of *Nyctereutes megamastoides* (POMEL). Since despite its small size it has the ansate sulcus, it seems that not only the large size of cerebral hemispheres is decisive of the presence of this sulcus.

The prorean sulcus of the rostral region of the brain in *Nyctereutes* is relatively long (as in *Canis*) and slightly narrowed laterally (as in *Vulpes*) (RADINSKY, 1973). Although this characteristic is not visible on the cast MZ VIII-V-355/2, the skull MZ VIII-V-355/1 is characterized by its comparatively great postorbital width, which suggests also a great anterior width of the interior of the cerebral cranium. The prefrontal cortex of this region is respon-

sible for the function of inhibition (RADINSKY, 1969; SZWEJKOWSKA et al., 1965).

The cortex of the pre- and postruciate gyri of *Nyctereutes megamastoides* (POMEL) is poorly developed. Such a development, if present, manifests itself in a marked bend of the coronal sulcus (RADINSKY, 1973), whereas in *Nyctereutes megamastoides* (POMEL) this sulcus is not bent, and nor is it in *Nyctereutes procyonoides* (GRAY). The postruciate gyrus is visible on our cast. RADINSKY (1971, 1973) is of the opinion that the expansion of the pre- and postruciate gyri in the *Canidae* indicates the primary improvement of the locomotor control of muscles and sensibility. Judging from the small size and shape of the posteruciate in *Nyctereutes megamastoides* (POMEL) from Weże I, the cortical control of the activity of muscles and sensibility was probably not very efficient. The somatosensory region between the coronal sulcus and the ansate sulcus of *Nyctereutes megamastoides* (POMEL) is small (KRUSKA, 1975).

The temporal and parietal lobes of the slightly laterally flattened cerebral hemispheres of *Nyctereutes megamastoides* (POMEL) are poorly developed and hardly bulging. In the *Canidae* the auditory cortex occupies the middle part of the ectosylvian gyrus (RADINSKY, 1969, 1973), in *Nyctereutes megamastoides* (POMEL) this cortex is small in area.

In the caudal region of the hemispheres the lateral sulcus marks the position and extension of the subordinated centre of optic projection and the ectolateral sulcus forms the rostral boundary of the zone of optic association in dogs (KRUSKA, 1975; RADINSKY, 1969). The occipital lobe of the cerebral hemispheres in *Nyctereutes megamastoides* (POMEL) is short and not extensive.

Judging from the size and development of the cerebellum surface, the motor mechanism of *Nyctereutes megamastoides* (POMEL) and then the coordination of movements, the control of posture and the regulation of the tension of skeletal muscles must have acted fairly competently.

In *Nyctereutes megamastoides* (POMEL) and other species of *Nyctereutes* the motor efficiency of the trunk and extremities is lower than that in dogs and the movement of the jaws show a specific specialization. The high and robust mandible of *Nyctereutes*, characterized by its subangular lobe, teeth with relatively large and broad crown and the condyle of mandible raised high above the level of the teeth, is adapted to movements connected with the wide opening of the short and narrow snout and grinding of harder vegetable food (MARTIN, 1971; CZYŻEWSKA, 1969, 1973). Out of the *Canidae*, *Otocyon* from Africa and *Dusicyon* from South America have their mandible and teeth built similarly, but this resemblance is not the exponent of the close relationship of these genera, it rather results from the change of their food habit, i. e. the adaptation to omnivorousness and vegetable food. THENIUS (1970) writes that the similar structural transformation of the skull, mandible, and dentition, defined as airohynchia (mammalian skull with its maxilla lifted upwards) may even cause changes in the endocranium.

CANIS SP.

Description (Pl. X, 1—3)

Material. Fragmentary endocranial cast without olfactory lobes, MZ VIII-V-360/1.

The endocranial cast MZ VIII-V-360/1 was exposed from under the very badly destroyed bones of the brain-pan, where the bone is very thick in relation to the skull size and with characteristic reticular sculpture on the surface. It is a small fragment of the very massive sagittal crest. The skull must have been compressed laterally before its interior was filled and, as a result, the endocranial cast is accordingly deformed. Its ventral surface is heavily damaged.

Some structural characters of the brain surface of *Canis sp.* have been preserved on the cast. The cerebral hemispheres of *Canis sp.* narrow towards the front and are rather low. The sulci run straight, without additional bends. The lateral sulcus is parallel to the longitudinal cerebral fissure, it bends inferolaterally in its caudal part and rostrally joins the coronal sulcus, which is also bent inferolaterally and reaches the anterior surface of the hemisphere. The coronal sulcus gives off a short branch towards the postruciate gyrus. The ansate sulcus is short, deep and deflected anteromedially. The cruciate sulcus is also short and bent rostrally, and behind it extends the very short postruciate sulcus, parallel to the coronal sulcus. The part of the hemisphere lying in front of the cruciate sulcus is short. The presylvian sulcus tends almost vertically upwards and bends slightly to the rear. The endolateral sulcus is short and presumably shallow. The long ectolateral sulcus reaches the posterior edge of the hemisphere and perhaps passes on to its inner surface, while anteriorly it curves to become parallel to the lateral sulcus. The suprasylvian sulcus forms a backward-inclining arch, its rostral part parallel to the coronal sulcus and the caudal reaching the edge of the posterior temporal lobe. The suprasylvian sulcus has a short lateral furrow near the ansate sulcus, the ectosylvian sulcus has also two lateral furrows and the sylvian fissure is relatively short.

The rostral ectosylvian gyrus is distinctly narrower than the caudal ectosylvian gyrus and it lacks a secondary sulcus which frequently occurs in the *Canidae*. The rather short prorean gyrus is narrow and so is the sylvian gyrus. The posterior temporal lobe and the central lobe occupy a relatively large area of the hemisphere surface, while the anterior temporal, occipital and parietal lobes are not extensive. The posterior edge of the cerebral hemispheres is mildly bent.

The piriform lobe, short and regularly bulging on the sides, is covered from above by the gyri of the posterior temporal lobe.

The cerebral hemispheres rather poorly cover the cerebellum, whose upper surface is raised fairly high. The vermis, bulging very much and lacking a lateral twist, has fissure VII cut-in deep and no traces of other fissures. The

position of the paramedian lobule and crus II can be distinguished in the casts of the cerebellar hemispheres.

A branch of the medial cerebral artery runs along the caudal suprasylvian sulcus to split several times to the back. The measurements of the endocranial cast MZ VIII-V-360/1 of *Canis* sp. are as follows: the anterior width of the cerebral hemispheres behind the cruciate sulcus is about 40 mm, the greatest posterior width of the cerebral hemispheres about 53 mm, the greatest height from the piriform lobe to the top of the hemisphere about 44.5 mm and the anterior height from the olfactory tract to the surface of the cerebral hemisphere in front of the cruciate sulcus about 25 mm. The greatest length from the posterior edge of the hemisphere to the frontal most edge of the frontal lobe is above 60 mm and the length of the brain-pan approximates 80 mm. The height at the hip calculated for the specimen of *Canis* sp. from those values would be about 50 cm (WYROST and KUCHARCZYK, 1967; LÜPS, 1974).

Remarks

The only member of the *Canidae* described from Weże I is *Nyctereutes megamastoides* (STACH, 1954; CZYŻEWSKA, 1969), no other members being hitherto known from this locality.

The endocranial cast MZ VIII-V-360/1 corresponds in size to the skull about 17 cm or a little more in length. The condylo-basal length of the skull of the contemporary population of *Canis lupus* L. living in the central and southern wooded regions of the USSR is 235.25—244.95 cm for males and 229.49—238.26 mm for females. The wolves of the population of the region situated farther to the north are much larger and those from the arid areas of Kazakhstan, Turkmenia or Mongolia are smaller (ROSSOLINO and DOLGOV, 1965). The condylo-basal length of the wolf from the Białowieża Forest is 218—253 mm (averaging 237 mm) for males and 207—242 mm (averaging 227 mm) for females (GEPTNER et al., 1967). In the case of the wolf from Poland this length is 220—262 (KOWALSKI, 1964). This is a forest wolf living in lowlands and a more temperate climate. Thus the contemporary wolf is larger than *Canis* sp. from Weże I. The condylobasal length of the skull of the contemporary *Vulpes vulpes* L. ranges from 115 to 160 mm (GEPTNER et al., 1967; KOWALSKI, 1964; MILLER, 1912) and then it is smaller than that of *Canis* sp. The condylo-basal length of the skull of modern *Cuon alpinus* PALLAS, ranging between 174 and 188 mm (GEPTNER et al., 1967); approximates that of *Canis* sp. KLATT (1954) thinks that it is hard to distinguish the wolf, *Cuon*, and *Lycaon* from each other by the arrangement of cerebral sulci. The specimen MZ VIII-V-360/1 has a large sagittal crest, in which it differs from *Cuon*, whose crest is small.

The shape of the cast of *Canis* sp. indicates a comparatively regularly, both frontally and caudally, elongated endocranium (LÜPS, 1974). The endocranium of long- and narrow-headed wolves from the southern Ukraine and

Moldavia is relatively long (LÜPS, 1974; GURSKIY, 1973) and that of *Cuon* is broad and high.

As for the relatively large size of the brain of *Canis* sp., the arrangement of the sulci of cerebral hemispheres is simple and regular.

The long ectolateral sulcus, the presence of the endolateral sulcus, the appearance of the cruciate sulcus region, similar to that on the cerebral hemispheres of medium-size dogs, the presence of a short sulcus running from the coronal sulcus on to the posteruciate gyrus would suggest that our cast represents a member of the genus *Canis*. The degree in which the cerebellum is covered by the cerebral hemispheres resembles that in the *Canidae*. The ectolateral and caudal suprasylvian sulci of the brain of *Canis lupus* L. pass posteriorly beyond the margin of the hemisphere, which happens rarely in the fox and brings the cast close to the brain of the wolf. *Canis lupus mosbachensis* SOERGEL, known from many localities of Central Europe (e. g. STEHLIK, 1936; THENIUS, 1965; MUSIL, 1969; RABEDER, 1976), is a relatively common small wolf of the Early Pleistocene. However, it is hard to determine which species of *Canis* lived at Weže I as long as we do not know any bony remains, and for this reason the name is limited to *Canis* sp.

In dogs the presylvian sulcus is very deep (DZIURDZIK, 1965); it is difficult to estimate the depth of this sulcus in *Canis* sp. but the expansion of the rostral composite gyrus is distinct in this region.

The prorean gyrus of the *Canis* sp. brain is short and markedly narrowed. RADINSKY (1973) emphasizes that we lack data concerning the dorsal expansion of the prorean gyrus in the *Canidae* living from the Middle Pliocene to the Late Pleistocene. There are *Canidae* known from the Late Pleistocene with such proportions of the prorean gyrus as those in the contemporary members of this family. *Canis* sp. from Weže I fills the gap in our knowledge to a certain degree, its prorean gyrus is narrowed as in the wolf and dog but it is still relatively short.

The expansion of the pre- and posteruciate gyri in the *Canidae*, indicating the increasing cortical control of the action of muscles and sensibility (RADINSKY, 1971), is advanced, though not very much, in *Canis* sp., which is expressed by an only small bend of the coronal sulcus and the presence of the short posteruciate sulcus. In *Canis lupus* L. the development of the pre- and posteruciate gyri is more marked, the coronal sulcus of the wolf is strongly bent, the posteruciate sulcus larger and more differentiated in shape. Along with the relatively small surface area of the prorean gyrus such a structure of the anterior region of the cerebral hemispheres might suggest a weaker development of more agile and sophisticated patterns of behaviour in *Canis* sp. (RADINSKY, 1973).

The regions of the auditory corex, medial ectosylvian gyrus and optic cortex, which is bounded by the ectolateral sulcus, were not well developed in *Canis* sp. The size and structure of its cerebellum suggest motional efficiency.

The details of the structure of the brain visible on the cast MZ VIII-V-360/1

do not provide fairly exact data about the individual age of the specimen of *Canis* sp. The sulci of the cerebral hemispheres of the *Canidae* are formed gradually during their individual development by the accretion of numerous, separately appearing, small grooves, which process may still linger in adult specimens (KLATT, 1954). The short and shallow endolateral sulcus of *Canis* sp. would be such a groove and does not prove young age. In the course of ontogeny the brain of dogs becomes slimmer, the overall length of the hemispheres grows most, the elongation of the hemispheres taking place above all in the anterior region (HERRE and STEPHAN, 1955). The slimness of the brain of *Canis* sp. may be an evidence of its adult age. In adult sheep-dogs the lateral gyrus and the area of the hemisphere bordering upon it widen and shift further to the back, compared with the brain of a puppy of this race (HERRE and STEPHAN, 1955). The elongation of the ectolateral sulcus up to the margin of the cerebral hemispheres in the specimen MZ VIII-V-360/1 may indicate its adult age. In wolves the occipital part of the sagittal suture of the skull begins to grow over at the age of 9—11 months and it is completely grown over in specimens about one year old. Moreover, between the 2nd and 4th year of life the formation of the sagittal crest comes to an end and at the age of 1—2 years the parietal bones become rougher and the characteristic reticular ornamentation appears (GURSKIY, 1973). The preserved fragments of bones of the specimen MZ VIII-V-360/1, with ornamentation and the caudal portion of the large sagittal crest present and devoid of any marks of the sagittal suture, indicate that it was an adult individual, at least 2—4 years old or probably still older.

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STRESZCZENIE

Wśród pochodzących z Węzów I koło Działoszyna (Polska) naturalnych odlewów endocranium jest odlew endocranium *Nyctereutes sinensis* (SCHLOSSER) i innego przedstawiciela *Canidae*, którego szczątki szkieletu nie są znane, odlew ten należy do rodzaju *Canis*.

Nyctereutes sinensis (SCHLOSSER), sądząc z budowy zewnętrznej mózgu, odznaczał się niezbyt sprawną kontrolą aktywności mięśniowej i wrażliwości czuciowej, znaczenie słuchu i wzroku u tego gatunku było przeciętne. Podobnie jak *Nyctereutes megamastoides* (POMEL) mózg jego miał sulcus ansatus, którego brak u współczesnego jenota.

Canis sp. był mniejszy od współczesnych wilków, gyrus proreus mózgu u *Canis* sp. był zwężony, ale stosunkowo krótki. Ekspansja kory zawojów płatu centralnego była zaawansowana w mniejszym stopniu niż u współczesnego wilka. Kora półkul mózgu *Canis* sp. była słabiej rozwinięta niż u wilków czy psów.

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Plate X

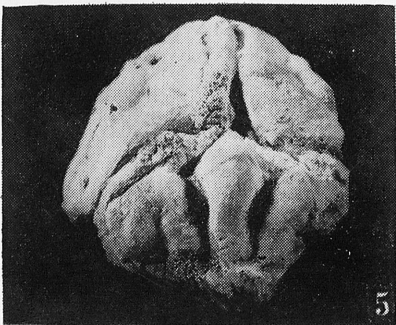
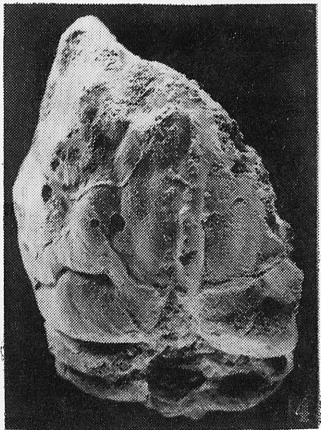
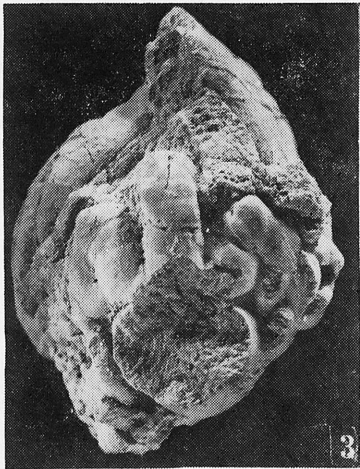
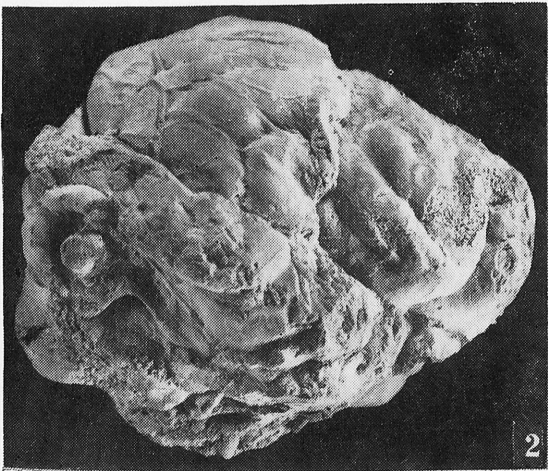
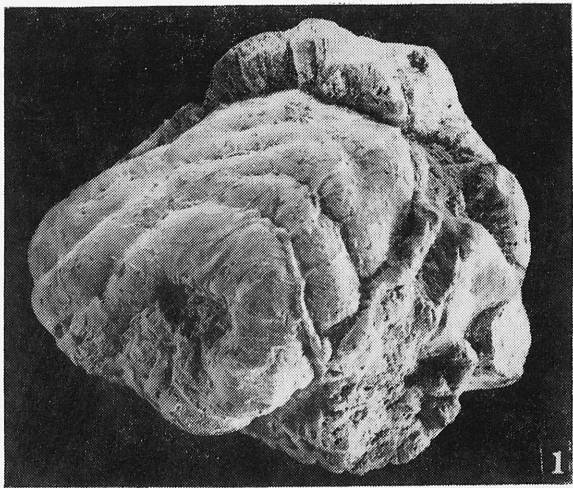
Endocranial cast of *Canis* sp., MZ VIII—V—360/1

1. Seen from the left side, × ca 1.
2. Seen from the right side, × ca 1.
3. Seen from the caudal side, × ca 1.

Endocranial cast of *Nyctereutes megamastoides* (POMEL 1843)

4. Seen from above, × ca 1.
5. Seen from the caudal side, × ca 1.

Phot. B. DROŹDŹ



T. Czyżewska, Natural...