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THE SECOND WOOLLY RHINOCEROS (COELODONTA ANTIQUITATIS BLUM.) FROM STARUNIA, POLAND

(GEOLOGY, MINERALOGY, FLORA AND FAUNA)

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Drugi Nosorożec z warstw dyluwialnych Staruni oraz charakter jego otoczenia. — The second woolly Rhinoceros (Coelodonta antiquitatis Blum.) from Starunia, Poland. (Geology, Mineralogy, Flora and Fauna)

Notes préliminaires

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présentées dans la séance du 10 Février 1930 par MM. J. Nowak m. c., Wł. Szafer m. t., J. Stach m. c.

(Planches 1—10).

I. The Geological Conditions of the Starunia Excavations

by

J. NOWAK and *E. PANOW*

1. General situation

The Map in Fig. 1 introduces us to the general situation of the Starunia discovery. According to it, Starunia lies in the area of the Eastern Carpathians and its distance from the nearest border of the greatest Polish glaciation is about 120 km to the East of Przemyśl: the distance from the local Carpathian glaciers of the diluvial epoch, situated in the South (Gorgany, Swidowiec, Czarnohora) is 40—60 km. The fact of such a great distance from glaciers is very remarkable because the area under discussion is situated beyond the influence of the glaciers. On the other hand the fact the discovery is situated in the area of the Flysch Carpathians seems also to be of great importance. These Carpathians composed of conglomerates, sandstones, marl and argillaceous shales of the Flysch facies and upper cretaceous, upper and lower tertiary periods, arose at the end of the Miocene from the sea and became shaped in a series of complicated folds and thrust

folds spreading to the NE. Already in the time of the Sarmat and Pliocene the towering mountains were subjected to erosion, so

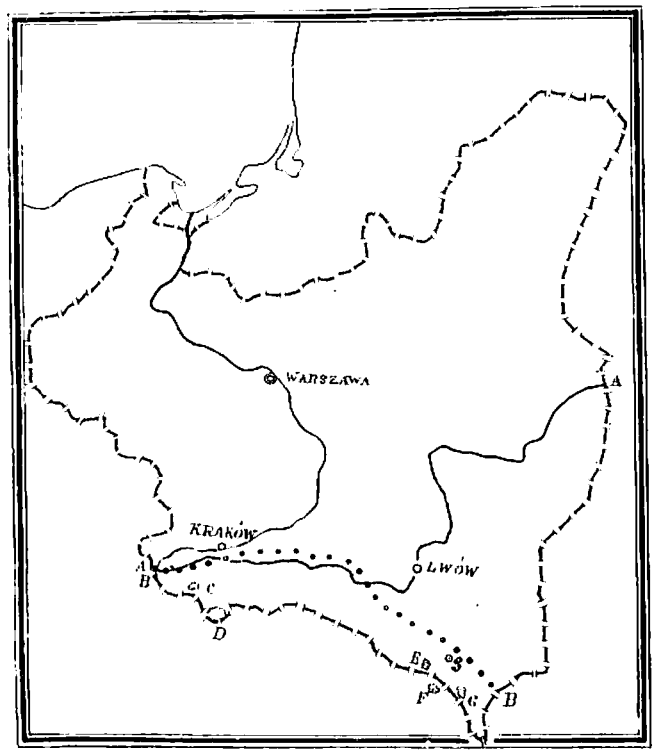


Fig. 1. — Line A—A: The area of the greatest North European glaciation, Line B—B: the Northern boundary of the Carpathian glaciers, C: Babia góra, D: Tatras, E: Western Gorganes, F: Swidowiec, G: Czarnohora, S: the discovery in Starunia.

that the glaciation that came from the north found a landscape not much different from the contemporary one. The diluvium of

the glacial epoch left here at the bottom of river-valleys a stratum about 4 m. thick and later sedimentation gave a stratum about 4—6 m. thick.

The locality where the rhinoceros was now found lies in the voivodship (county) of Stanisławów, in SE Poland. It is situated in the Southern part of the commune Starunia, and the surrounding country is called Ropiszcze from the word »ropa« which is the name for crude oil and ozocerite drilled here from immemorial times by means of wells. Between the towns Solotwina and Nadwórna lies a great syncline 2—4 km wide, filled with Miocene silts partly saliferous which cover the anticline of the Eastern hills and sinks under the projecting anticline of the hills situated to the West. The river Lukawiec Wielki flows along the bottom of this syncline and falls into the river Bystrzyca Solotwińska, a right-side tributary of the Dniestr. Ropiszcze is situated near the Western bank of the Lukawiec at a height of 417 m above sea-level.

2. Excavations of 1907

In 1907 a shaft was dug out in Ropiszcze for the purpose of reaching the saliferous Miocene in which ozocerite veins are found. The purpose was the exploitation of ozocerite. At a depth of 12.5 m, the remains of *Elephas Primigenius* Blum were found, and at a depth of 17.6 m the front part of *Rhinoceros antiquitatis* Blum, preserved with the skin and flesh. In so far as these remains in themselves did not raise any doubts as to their diluvial age — the great number of fauna and flora, which was found together with those vertebrae and many of which still live at the present time raised a picture difficult to understand. The research undertaken in July 1929 had for its chief aim not only the discovery of the remains of the rhinoceros which presumably had been left over in the shaft in 1907, but also the elucidation of the very queer mixture of old and new forms, and an eventual discovery of other traces of life in that period. All these aims were fully realised.

3. Results of tasks undertaken in 1929

According to the plan proposed by the Starunia Committee of the Polish Academy of Sciences it was decided to excavate a new

shaft at a distance of 15 m to the N of the 1907 shaft and to connect the two by a gallery at a depth of 18 m, at which depth the rhinoceros had been found in 1907. The works which were started in the middle of July 1929 were directed by E. Panow, who in addition to collecting the specimens also took notes on the geological observations made during the work.

The new shaft pierced four meters of old dead rock, then struck clays and alluvial gravels and at a depth of 10.5 m there were already found dark grey, compressed salt silts of the Miocene period which continued up to the 18 m level. On this level, in the NW corner of the shaft appeared different silts, very soft, full of excellently preserved insects (water and land) *Carabidae*, *Cerambycidae*, *Curculionidae*, *Buprestidae*, *Dytyscidae*, *Hemiptera* and others; and leaves and branches of trees and shrubs (*Tilia*, *Quercus*, *Acer*, *Corylus* and others). Both the fauna and the flora correspond to that found in 1907.

At this level a gallery was dug out leading towards the shaft of 1907, which explained the genesis of the above mentioned formations. They are composed of an unstratified heap of silts and clays showing traces of air disintegration. In these silts there are very carelessly strewn fragments of branches and logs mostly in a vertical or slanting position, leaves crumpled in every way, and besides, burned logs, branches cut by sharp tools and also there was found a basket made of tree bark such as the peasants use for gathering strawberries, and a small wooden spade undoubtedly made with a steel chisel. M. Lomnicki records conscientiously a similar fact from 1907 [1].

The matter can be explained by the fact that the old shaft of comparatively recent date has been filled with dead rock originating from the surface, wherein, remains of to-day's flora and fauna had become intermixed, especially if the filling of the shaft was a slow and protracted process. Most probably the remains of the mammoth and the rhinoceros which had been dug out in the process of former excavations were also thrown back in the pit that was being filled — as proof of this theory we may regard the fact that the horn of the rhinoceros in 1907 was found at a different depth from the rhinoceros itself.

[1] Kosmos, Lwów 1908.

Since during the former work pieces of bones and animal tissue were dug out, two short galleries were conducted now in the horizontal direction, however except for a few fragments of bones and a bit of skin (the edge of the rhinoceros' ear) nothing of any interest was found. It was the gallery on the 12.5 m level, leading to the South of the 1907 shaft which after piercing the old works at a distance of 3.3 m from the shaft entered into the grey diluvial silts in which lay the rhinoceros preserved with the skin and flesh. Its head was turned SE, and its left side was leaning on the steep edge made of Miocene silts. The silt material in which the rhinoceros was found is, in places, saturated with plant detritus with numerous diluvial land and water insects. To the E the silt becomes much more sandy and contains pebbles of the Carpathian rocks. Above the rhinoceros were visible the ribs and pieces of the spinal column of another rhinoceros devoid of soft parts.

Since in 1907 the extraction of the rhinoceros was impossible owing to the narrowness of the shaft, another shaft 4×4 m wide was built at a distance of 8 m from the other which completed the profile of the first shaft. Here the old dead rock reached to a depth of 5.5 m, while to a depth of 8 m there were clays and to a depth of 9.5 m alluvial gravel followed to the bottom of the shaft by Miocene silts. The diluvial silts fill therefore the valley which was eroded in the Miocene silts by the current waters of Łukawiec Wielki or its tributaries.

In the top of the diluvial silts strata (as seen on the enclosed profiles on Fig 2.) there is a stratum of Carpathian river grave lying intermixed on the Miocene and diluvial silts. Consequently at the time between the sedimentation settling of diluvial silts and the inflow of gravel there exists a sedimentation interval. A similar interval can be proved in the first shaft of the Academy where in an analogical rubble there is an intercalation of sands with fragments of branches belonging to trees larger than the diluvial ones, which proves a change in flora as related to the diluvium. The interval was also confirmed by the surface works near Łukawiec in the village of Starunia and near Łukawiec Mały in the village of Hwozd (SE of Starunia), where on the gravels with lenses of silts with *Betula nana* lie intermixedly gravels, sands and silts containing leaves of deciduous tress.

On the other hand between the gravels and the clays lying

on them there is no interruption, because in the first shaft of the

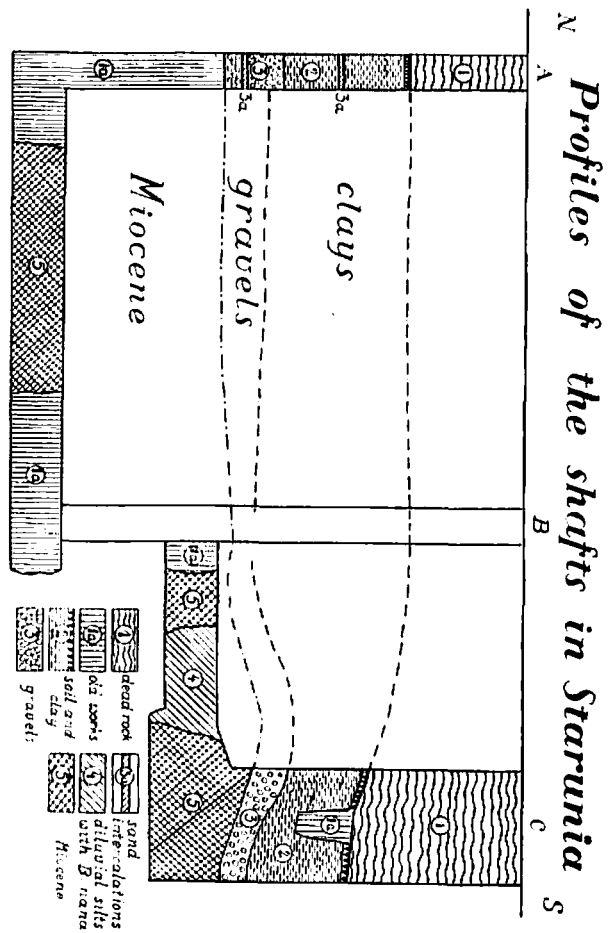


Fig. 2. — 1, Dead rock, 1a old works, 2 alluvial soil and clay, 3 alluvial gravels, 3a sand interstratifications, 4 diluvial silts with *B. nana* and the rhinoceros, 5 Miocene saliferous silt. A shaft of the Polish Academy of Sciences, B the old shaft (1907), C the shaft from which the rhinoceros was excavated.

Academy the number of pebbles diminishes slowly as we move

from the gravel to the clays and the number of silt admixtures increases, so that finally the stratum becomes pure clay. The second figure illustrates these conditions.

4. Conclusions

From the fact that the left side of the rhinoceros has damaged skin and the fact that its interior is partly filled with silts we can draw the conclusion that as a dead carcass it was dragged for some distance by current waters; however the fact that several bodies of large vertebrae were found on the same spot would suggest their sudden joint death, most probably caused by some elemental catastrophe, e. g. flooding of the river.

From the Miocene silts in many places there flows salt water; they are also saturated with crude oil, which has permeated even the younger formations. The skin of the animal showed in many dry spots efflorescences of salt and it is also saturated with crude oil. These were probably the most important factors preserving the soft parts of the rhinoceros. However, special research alone shall perhaps elucidate the chemistry of the conservation, and the rôle played in this connection by one factor or another.

The discovery of the remains of another rhinoceros higher up, and without the soft part suggests that it lay already beyond the sphere of the conserving factors — provided it had not been beforehand bereft of skin and flesh. The fact that here we have represented only one epiglacial sediment would lead most probably to the conclusion that the time of that sediment corresponds to the time of the greatest Polish glaciation. This conclusion we are proposing as nearest to the truth; however, we want to state conscientiously that we are not able to furnish an immediate scientific proof of its correctness in our present state of knowledge.

The fact that the diluvial silts are situated on the level of the present-day Lukawiec in connection with the fact that in Niezwiska near the Dniestr were found bones of large diluvial mammals in clay under loess lying at the height of the inundation terrace of the present day Dniestr proves that the profile of erosion balance on the area of Lukawiec—Bystrzyca—Dniestr in Niezwiska has not been stirred by any tectonical event since the time of the Starunia diluvium.

II. The Analysis of Diluvial Silt from the Immediate Environment of the Rhinoceros Found in Starunia

by

J. TOKARSKI

Among the petrographical problems connected with the geological structure of the Starunia substratum in which the remains of the rhinoceros were discovered, the problem of the chemical characteristics of the environment which succeeded in preserving these remains to the present day seems to be the most actual. The body of the animal was found in diluvial silt which lay under a stratum of gravel below the tenth meter of the profile of the shaft through which it was later brought to the surface, in a side gallery dug out in the northern wall of the shaft. This silt was the material which directly influenced the conservation of the rhinoceros. Consequently there must have been in its chemical and mineral structure some components which prevented decaying processes, such as would undoubtedly have caused a complete destruction of the organic substances of this beautiful relict of the diluvial fauna of Starunia.

The answer to the question as to what were these components in the silt is found in the results obtained in an accurate chemical and microscopical analysis. These results are as follows:

For study a specimen of silt was taken from the immediate environment of the rhinoceros, from a depth of 11—12·5 m (No. 4 of Prof. Nowak's profile).

This specimen presented a mass of soil of greyish-brown colour, pelitic structure, veined with darker material which contained larger accumulations of organic substances. A characteristic smell proved the presence in it of bituminous material.

A suitable quantity of this specimen was prepared for analysis, by means of sifting it through a set of sieves, after it had been washed. In this way the silt was freed of larger fragments (few) of hard sandstone gravels and fibrous organic admixtures, the latter consisting for the most part of the hairs of the rhinoceros.

Microscopic study of this silt proved the presence of a large quantity of a small-grained, silto-pelitic substance which could not be determined accurately. This substance reacted obviously to polarised light and when strongly magnified showed a structure mainly fibrous, resembling e. g. the laminae of small-grained sericite. Numerous, very small-grained fragments of quartz whose diameter averaged below 0·01 mm, were mixed with the above-mentioned silt substance. In addition to such fragments of this mineral there are also present larger grains of it, though not in a great quantity. The main component of the Starunia silt are crystalline carbonates among which our attention is drawn by large crystals of rhomboidal shape. Rare minerals are very scarce here. Several fragments of green hornblende, alkaline feldspar as well as zirkon and glauconite grains — are all that has been found in a specimen weighing several grammes. All components mentioned are covered with a dirty bituminous substance. The chemical analysis proved the presence in this silt of a relatively large percentage of sodium chloride, however it could not be perceived under the microscope, probably owing to the too small grains and the fact, that the groundmass of the specimens was coloured by bituminous matter.

The chemical analysis was conducted temporarily in three directions[1]): the water extract of the primary substance (A): the chloroform extract (B.); as well as the parts indissoluble in these reagents (C). The results obtained in these analyses were computed in the usual manner into mineral results, in order to illustrate approximately the petrographical composition of the silt.

The results obtained were:

		weight %	mol. relations × 10000
A. The part soluble in H_2O:	Ca	0·15	38
	Mg	0·01	3
	Na	0·91	395
	K	0·01	2
	Cl	1·58	445
	SO_4	trace	—
		Sa = 2·66	
B. The part soluble in $CHCl_3$	Bitumen 8·00		
		Sa = 8·00	

[1]) This analysis was performed with the assistance of Wł. Wawryk and St. Biskupski.

		weight %	mol. relations ×10000
C. The parts insoluble in H_2O and $CHCl_3$:	SiO_2	48.20	8033
	Al_2O_3	13·57	1330
	Fe_2O_3	0·91	57
	FeO	4·65	646
	MnO	*trace*	—
	CaO	3·67	655
	MgO	3·67	917
	K_2O	3·54	377
	Na_2O	0·36	58
	P_2O_5	0·16	11
	S	0·66	206
	SO_4	0·10	10
	CO_2	6·76	1536
	$+H_2O$	0·89	494
	$-H_2O$	2·43	
		Sa = 89·57	
	Sa = 100·23		

The water extract reacted alkalically and reduced visibly the solution $KMnO_4$. The results of its analysis computed into the sum of weight percentages yielded the following numbers: Ca 5·74, Mg 0·27, Na 34·17, K 0·31, Cl 54·47, SO_4 trace. If we compare these numbers with the analyses of 77 various specimens of sea water (C. Dittmar Challenger Report, Phys. and Chem. Vol. I, 1884) it will be seen that although the quantity of salt contained in the studied silt nears the average content of oceans, the relation of the components is different here. The solution A contained a considerable percentage of Ca and a small content of Mg and K: therefore differed from the results shown by sea-water analyses. The relations among the soluble components in the Starunia silt which undoubtedly is of tertiary origin were subjected later to considerable changes in the course of diagenesis.

The chloroform extract B was subjected to a special analysis in the laboratory of Oil Technology in the Lwów Polytechnic under the direction of prof. Pilat. Thanks to the kindness of my Colleague I am able to present this analysis, which was performed by Eng. Sereda.

The results are:

Content of bitumen extract — 8%: chloroform extract 8·5%: ether extract 7·5%.

The dissolvent was distilled in a glycerine bath at a temperature of about 160° C., then it was rectified and as a result several drops of a yellowish, oil-smelling liquid were obtained. No components boiling at low temperatures were discovered. The characteristics of the extract:

1. Specific weight (determined with piknometer) $d_{15°} = 0·8995—0·9088$.
2. Solidification point (in test tube of 25 mm diameter) — 0·5° C.
3. Index of refraction $n_D^{20} = 1·5033 — 1·5083$.
4. Acidity: = 2·2 (*with alkaline blue 6B*), consequently the bitumen is composed mainly of neutral components.
5. Content of sulphur: (in bomb B-M) = 0·98%.
6. Reaction of Wohl for S positive (sulphur is present in unoxygenised form).
7. Reaction of Lassaigne for N negative (after S'' had been precipitated as CdS).
8. Reaction of Chariczkow for naphthein acids negative.
9. Reaction of Morawski for resinous acids negative.
10. Reaction of Graefe for phenols positive but weak.

The extract of the Starunia silt contained consequently 8% of liquid hydrocarbons with an admixture of solid ones (solidification point — 0·5° C.) It contains important quantities of sulphur compounds, bound in the organic group.

On the basis of the numbers presented above, illustrating the molecular relations among fractions A and C, a probable mineral composition of the silt was reconstructed in molecular percentages (naturally only approximately).

It is the following:

Fraction A: NaCl 3·13, KCl 0·02, $CaCl_2$ 0·24, $MgCl_2$ 0·04, $CaCO_3$ 0·13, $CaSO_4$ trace.

Fraction C: $CaCO_3$ 4·85, $MgCO_3$ 7·27, $CaSO_4$ 0·08, $Ca_3(PO_4)_2$ 0·17, FeS_2 1·22, quartz and silt substance 82·85.

In the item »quartz and silt substance« a complete quantity of SiO_2 and Al_2O_3 was placed, next to the rest of the molecules of iron, potash and magnesium, after these atoms had compounded with the anions Cl, SO_4 as well as CO_3, S_2.

We reach the following conclusion based on the above mentioned results of all parts of the analyses:

1. The main component of the Starunia rock which preserved the remains of the rhinoceros is the delicate quartz-silt-polite, next to which there appears 8% of bituminous matter and 3% of common salt.

2. Components of the rock appearing in important quantities are also calcium and magnesium carbonates: sulphates appear in minimal quantities.

3. A characteristic component is the sulphid of iron appearing in over 1% mol.

4. The »silt substance« creates a component which differs both in microscopic appearance and chemical composition from the kaolinic products of alteration and nearing rather the derivative chlorite resp. sericite groups. This substance contains absorbed bivalent iron compounds, potash and magnesium compounds (this last in small quantity).

5. The water extract contains, to an overwhelming quantity of common salt, calcium chloride, as a characteristic factor.

6. A characteristic feature of the silt is the small quantity of water obtainable in a temperature above 100° C.

7. Probably the whole group of all the components, salt as well s oil with traces of phenol and the silt contained in a considerable quantity in the rock acted as a preserving anti-decaying factor.

III. The Diluvial Flora in Starunia

by

WŁ. SZAFER

1. Introduction

In the work entitled »The excavations in Starunia« published in 1914 by the Muzeum Im. Dzieduszyckich (Lwów), the flora of the mammoth shaft was described in chapter III: the leaves and fruits were determined by Marjan Raciborski and the specimens of wood (about 86 of them) were determined anatomically by the author of the present paper.

As a result of these botanical researches a conclusion was reached, which stood in blatant discord with the prevailing opinions that the mammoth *(Elephas primigenius)* and the rhinoceros *(Rhinoceros antiquitatis* Blum *s. tichorchinus* Fisch.) were accompanied in Starunia by the flora of a warm mixed forest, composed of *Quercus pedunculata, Prunus avium, Carpinus Betulus, Ulmus montana, Ulmus campestris, Fraxinus exelsior, Acer platanoides, Populus tremula* and *Betula verrucosa*, with an abundant undergrowth of shrubs, such as *Corylus avellana, Rhamnus cathartica, Cornus sanguinea, Prunus spinosa* and others. Two pieces of coniferous wood, one of the genus *Picea*, the other of the genus *Juniperus* showed clear traces of transport by water from farther environs.

Presenting the general character of the flora of the mammoth shaft in 1914, Marjan Raciborski stated distinctly (loc. cit. p. 28) that: »the fossil flora in Starunia does not differ from the present-day flora of the warm slopes of the Carpathian hills« and that »it does not contain any plants which would testify to a colder, damper or more mountainous climate than that of present-day Starunia». In the last sentence (loc. cit. p. 29) he drew from the character of the fossil flora then found (1907) together with the rhinoceros and the mammoth, the conclusion that »the Starunia flora proves that it is younger than the interglacial and glacial period« and that it is post-diluvial, although »it is impossible to define the time of its existence in the post-glacial period«.

To-day, when — as shown in greater detail in the geological part of this bulletin — it has been proved that the remains of the mammoth and the rhinoceros were lying there on a secondary bed among mixed material that had been thrown into an old oil pit by man, we must remember and stress the statements Raciborski quoted above. He alone had the courage to pronounce the very bold and almost paradoxical, as it seemed at the time, statement that the flora accompanying the remains of diluvial animals in Starunia is post-diluvial.

To that apt characterization of this flora we can only add now that, in its fossil stage, it has been lying in Starunia for about 70 years and that it does not differ in anything from the present-day flora of the nearest environs of the shaft.

Therefore we do not wonder any more at facts described by

Raciborski[1] at the time when, even prior to the examination of the whole of the Starunia flora, he became interested in the microchemistry of some leaves and fruits furnished by Marjan Łomnicki.

While to-day we definitely exclude the flora described in 1914 from the series of diluvial florae, we have the good fortune of being able to present the picture of the diluvial flora of this sub-Carpathian place, found on an undoubtedly primary bed together with diluvial fauna also situated »in situ« and among which the most important is the magnificent specimen of the woolly rhinoceros. Since the diluvial flora accompanying the rhinoceros has been excellently preserved and is of an unsurpassed abundance we shall be able to reconstruct a living and encompassing picture of the diluvial sub-Carpathian tundra. On account of technical difficulties in separating and preparing plant remains and also on account of their abundance and variety the work will take a longer time and will occupy several specialists. At the present moment the plant material is in the stage of preparation, the process taking place in the Physiographic Museum of the Polish Academy of Sciences, in Kraków, under the direction of the botanical curator J. Lilpop and in the Botanical Institute of the Jagellonian University. The present paper will be chiefly concerned with those relatively few plant-remains which were first found and determined from among the leaves on Angiosperms, because the main quantity of seeds and fruits and the whole flora of the *same age found in the neighbourhood of Starunia (by the river* Lukawiec) which is especially rich in mosses *(Musci)* has not been studied as yet.

I want to acknowledge the assistance of my Colleague J. Lilpop in the speedy preparation of this paper and that of my wife in photographing some of the plant-remains reproduced in the enclosed table.

2. The position of fossil flora in the Starunia sections

Turning to the geological sections performed in the shafts or appearing in natural surface works by the river Lukawiec Mały

[1] M. Raciborski. Reakcje szczątków roślinnych ze Starunii (Paläochemie der Pflanzenreste aus Mammoththonen in Starunia). Kosmos, Lwów 1910.

in Hwozd, an accurate description of which is to be found in the geological part of this bulletin, we state that the fossil flora appears on three different levels.

The first, lying immediately on the tertiary salt-silts and composed of sandy, grey silts with an admixture of gravel is the one in which the rhinoceros was found »in situ« together with the accompanying flora and fauna. In the top of this level lies a stratum of diluvial gravel, which in natural surface works in Hwozd by Lukawiec Mały contains intercalations of sandy, greyish silts with the flora of tundra, with which we shall not concern ourselves at all in this present paper.

On the complex of the strata of the first level there lie gravels, sands and clays in which, both in the valley of Lukawiec Wielki and in the valley of Lukawiec Mały, appear distinctly two further levels with fossil flora: the lower one with a preponderance of coniferous trees and the upper one with a preponderance of deciduous tress. Both present rich forest florae very well preserved, which will be the subject of accurate research, not begun as yet. We must note that this fossil flora was, as early as 1910, studied by W. Rogala and that this author considered it to be diluvial, though he did not propose any close approximation of its age. Since the diluvial age of the clays, which partly separate and partly cover this forest flora, has not been determined as yet — and the character of the flora in itself — as far as we know it — does not point to its geological age[2]), the problem of the age of *the two levels of forest flora* under discussion is still an open one.

I wish to add that the horizontal area of both these forest florae is comparatively a wide one and that — it would seem — they appear in the whole valley of Starunia, irrigated to-day by Lukawiec Wielki and Lukawiec Mały and their tributaries. The thickness of the strata containing forest florae is not the same, owing to the activities of current waters and other local conditions: they appear rather in the shape of wide lenses, which at some places disappear completely or are substituted by the appearance

[2]) *In as far as it can be judged now*, it could be just as well forest flora of the interglacial period as forest flora of the post-glacial period from the epoch of other climates than the present one.

of bits of wood or sticks and in other places develop magnificently. The more resistant part of forest flora, i. e. bits of wood and spruce-cones underwent certainly a secondary water transportation, and might have reached here and there some of the deep cavities and pits which abound in that territory. According to the testimony of older geologists St. Olszewski and R. Zuber (1885, 1888) there were found logs of wood and cones at a depth of thirty to forty meters during boring shafts on Ropiszcze, which — if it were confirmed — would point distinctly to the transportation by water of the younger forest flora and a secondary deposition of it in the pits created in a natural way by current waters or artificially by man, in the tertiary salt silts.

In the present paper we shall discuss exclusively the old diluvial flora, found on the sandy grey silts in the nearest neighbourhood of the body of the rhinoceros, in the level lying »in situ«, immediately on the natural surface of the salt silts.

3. Description of the diluvial flora accompanying the rhinoceros

From among the large quantity of plant remains excavated so far, which had been brought here in the diluvial period by current waters and which originally came undoubtedly from the more or less dry slopes situated in the neighbourhood I shall mention here only the following:

1. Betula nana L. This dwarf birch of arctic origin appears most abudantly in the strata of silts surrounding the body of the rhinoceros (partly also in its interior). Aside from a huge quantity of whole and also of partly damaged leaves (see Table 1. fig. 5) very many of its typical winged fruits (nuts) and numerous bracts have been found. The largest leaf is 1·4 cm long.

2. Betula humilis Schrk. (Table 1. fig. 6) is much more rare than the preceding species. The leaf reproduced here on Table 1. is 1·2 cm long and 1 cm wide. It is a species of shrub-birch of north-eastern origin, not growing nowadays on arctic tundra.

3. Salix reticulata L. (Tab. 1. fig. 7). Some excellently preserved leaves and some leaf-fragments have been found. The figured one is 1·2 cm long and 1 cm broad. It is an arcto-alpine species.

I do not mention other species of dwarf willows, which grew abundantly on the Starunia tundra, because owing to the well known difficulties in determining small leaves belonging to the species *Salix*, I consider it better to wait with their definition until more material is collected.

4. Dryas octopetala L. (Tab. 1. fig. 10). Four leaves of this arcto-alpine plant have been found. Three of them offer dimensions surpassing those of the specimens known from the other diluvial tundras in Poland.

5. Polygonum viviparum L. One leaf fragment with its characteristic nervation has been found; the species is arcto-alpine.

6. Polygonum lapatifolium L. This is a component of the actual flora of Poland, known also from the interglacial strata. Only one fruit. (Tab. 1. fig. 3).

7. Calluna vulgaris var. *hirsuta* Presl. One whole leaf, very characteristic of this shrub, has been found.

8. Vaccinium uliginosum L. The small leafed form of this shrub is, together with the leaves of the dwarf willows, a common plant of the Starunia tundra. Other species of *Vaccinium* (among others probably *Vaccinium priscum* Web.) shall be the subject of further studies.

9. Thalictrum alpinum L. (Table 1. fig. 9). This plant of arctic origin which in the flora of the Alps and Transylvania (?) has remained in a few outposts which are relicts of the glacial period, has been found in several very well preserved leaves. Their definition should be regarded as certain — on account of their very characteristic thick nervation. This species was not yet known in the fossil stage of the diluvial epoch.

10. Thymus sudeticus Borb. (Table 1. fig. 8). For the first time it was found in the diluvial tundra in Ludwinów near Kraków by A. Żmuda (1914); now it has been found again in the shape of two very typical leaves, in Starunia. It is a species of Carpathian origin, which came into the flora of arctic tundra from the neighbouring slopes of the Carpathians.

11. Armeria sp. (Table 1. fig. 2). Till now there have been found two fruit-calyces of this plant, one of which, presented in Table 1, is very well preserved, and has an untouched membrane spread among the sepals of the calyx. In spite of it, a definition of the species has proved impossible. Excluding *Armeria arctica*

Wallr., a genus wrongly defined in several diluvial floras in Europe (among others also that of Krystynopol in Poland), we meet serious difficulties when after reducing the number of possible species we want to decide whether it should be counted among the forms of the species *Armeria vulgaris* Willd (= *Statice Armeria* L.) or among the *Armeria alpina* (= *Statice montana* Miller.) Not wishing to discuss the problem now, I would only announce that I shall return to it once more in the larger study on the Starunia flora when — as I hope — I shall have at my disposal of a much larger number of remains of this critical plant. Then we will also take a stand with regard to the partly true remarks put forth lately by H. Gams[1].

12. *Phaca cf. alpina* Wulf. Two flower calyces with a very well preserved pistil probably belong here; but I am leaving the final decision till later.

13. *Taraxacum* sp. (Table I, fig. 1). There was found an involucrum and one very well preserved fruit belonging to it. The involucrum has a dimorphism of leaves characteristic for the genus *Taraxacum*. The dimensions of the inner ones are 12 mm and prove that the involucrum was small, more or less similar to those found nowadays on the smaller specimens e. g. *Taraxacum alpinum* or *Taraxacum palustre*. The outside leaves are about half as long as the inside ones and somewhat wider; unfortunately their tops are torn so that it was impossible to find their characteristic features.

The fruit, 5 mm long, with a short rostrum (3·5 mm) and a cuspis of considerable length (1·5 mm). In the upper part of the fruit itself (achaenium) there are distinct knobby points which pass over into bristles.

The determination of the species is very difficult. Of the species now living in Poland we may exclude with certainty *Taraxacum officinale* Web., *T. alpinum*, *T. palustre*, *T. pieninicum*, and *T. lecigatum* — the question however if our Starunia form belongs to some of the northern species now living (section V would possibly come into consideration here d. i. *Taraxaca parvula*, or section VIII *Taraxaca borealia*), or if it be a different species altogether and

[1] H. Gams: Plantaginaceae, in the work: G. Hegi: Illustrierte Flora von Mittel-Europa, Vol V., Munich 1926, pp. 1890 and 1893.

now non-existent — will have to remain for a time at least unanswered.

14. *Carices* sp. variae. Very abundantly and well preserved fruits, often with perigynia, shall be the subject of special study, as well as many other seeds and fruits of Monocotyledonous and Dicotyledonous plants which have been entirely omitted from this sketch.

Speaking of the negative characteristics of the Starunia flora we should note that no fruits of the species *Potamogeton*, *Myriophyllum*, *Ceratophyllum*, *Nymphaea* and *Nuphar* have been found till now — which would prove that the remains of fossil plants belonging to land flora were deposited on the bottom of current waters. The absence of tree pollen stated in the preliminary study of the grey silt also bears a connection with this fact.

Resuming shortly all that we know to-day about the diluvial flora accompanying the rhinoceros in Starunia we can state the following: it is a land flora with the character of tundra, with many shrubs, with a predominance of dwarf birches (*Betula nana*), and small-leafed willows. Its flora shows a mixture of arctic elements with alpine ones. The conditions of existence of the plants indicate that at the time the climate in Starunia must have been cold, similar to that of the present-day tundra, living to-day in the far north of Eurasia[1].

4. The biological character and the age of the flora of the tundra in Starunia

The geographical situation of the diluvial tundra in Starunia (the bottom of the valley of Ropiszcze, 402 m above sea level, about 24° longitude and about 49° latitude) is interesting in so far as it is the only place in Europe where the tundra of the arctic-alpine type lies at a considerable distance from the maximal area of the diluvial northern glacier. In the north there are about 160 km dividing Starunia from the traces of end-moraines of the greatest glaciation, situated on the Polish plain; in the direction of Krystonopol there are about 200 km and in the

[1] While this note was being printed two perfectly preserved spruce needles were found.

north-east about 120 km separating Starunia from the area of the maximal line of the glacier near Dobromil. This fact in itself lends the Starunia-tundra an exceptionally important place in the series of analogical florae, none of which in Europe lie at such a great distance from the front of the glacier. Starunia therefore is the most important, strongest prof of the classical hypothesis of Nathorst about the arctic character of the glacial climate and its large area in Europe at the time of the greatest glaciation.

As far as we may judge to-day, the great distance of the Starunia tundra from the front of the diluvial glacier found its biological expression primarily in the fact that contrary to identical flora of the tundra in Krystynopol [1]) and in Ludwinów near Kraków the flora of that tundra strikes us with the exuberance of the height of the plants, especially the large size of their leaves which with the same species found in the Krystynopol and Ludwinów tundras (in both places the tundra abutted on the glacier) are strikingly small. It has been proved so far for the following species: *Betula nana*, *Dryas octopetala*, *Polygonum viviparum* and *Salix reticulata*.

As far as the main question of the age of the Starunia tundra inside of the Polish diluvial epoch is concerned, it seems most probable that it should temporarily be considered as a periglacial phenomenon, belonging to the greatest diluvial glaciation, i. e. to the period of glaciation *Cracovien*, which according to the views of certain Polish geologists is to be regarded as contemporary with the alpine glaciation *Riss*, and which according to J. Lewiński corresponds to the alpine glaciation *Mindel*. This problem however will not be decided, until accurate geological and paleontological research in Starunia and its nearer and farther environs are finished.

Explanation of Plate 1.

1. *Taraxacum* sp.
   a. involucre × 1½.
   b. fruit.
2. *Aconeria* sp. × 7.
3. *Polygonum lapatifolium* × 4.

[1]) W. Szafer: Eine Dryas-Flora in Krystynopol. Bull. de l'Acad. d. Sciences, Cracovie 1912.

4. *Saxifraga* sp. (?) × 5½.
5. *Betula nana*
   a. leaves × 2.
   b. bracts (variability) × 3.
   c. fruits × 3.
6. *Betula humilis* × 3½.
7. *Salix reticulata* × 4.
8. *Thymus sudeticus* × 3.
9. *Tholidrum alpinum* × 3½.
10. *Dryas octopetala*
    a. × 3.
    b. × 5.

IV. *The Second Woolly Rhinoceros from the Diluvial Strata of Starunia*

by

J. STACH

1. The diluvial fauna accompanying the rhinoceros just excavated

The research conducted on the territory of ozocerite in Starunia by the Polish Academy of Sciences with the idea of finding in the walls of the Mammoth shafts the remains of the rhinoceros whose fore part had been discovered there in 1907, was animated by the hope of finding in the neighbourhood of the shaft remains of other animals of the glacial epoch, which would enable us to reconstruct a fuller picture of the contemporary fauna and conditions of its existence. The hope was fulfilled, and as a result of the research a magnificent specimen of a young female woolly rhinoceros (*Coelodonta antiquitatis* Blum.) was found in an almost perfect external condition and a large part of the skeleton of another specimen of rhinoceros and abundant remains of contemporary fauna, especially insects.

There are many technical difficulties connected with the washing out of these remains from the silts saturated with crude oil; the process is very slow and requires the patience and careful work of several people. In the material that has already been separated there are many water insects, e. g. beetles (*Coleoptera*) of the genus *Helophorus* and *Cymatopterus* and others, *Hemiptera*

of the genus *Carex*; there are also land beetles, e. g. the *Aphodius* living in the excrements of vertebrate animals and other beetles *Carabidae*, *Curculionidae* and *Cerambycidae*, further *Locustidae*, *Lepidoptera*, and *Diptera* especially numerous of the genus *Hilara*, and finally spinners. It would be too early however to draw any conclusions from the remains which have till now been washed out of a few specimens of silt: the more so, since only a very accurate determination by specialists will enable us to judge whether the preserved remains belong to forms already extinct, like the mammoth, the woolly rhinoceros and many other diluvial mammals, or to species which still exist in the present-day fauna. It will be necessary to ascertain whether these forms have not formed different races, with a different scale of variability than that of the now living, and to determine the geographical range of their present-day distribution.

All that we can state temporarily concerning these remains is that they belong to specimens which lived in the same region and at the same time as the rhinoceros now found and that the current waters were the factor which caused the intermixing of forms so vastly varied in ways of life and environment, and which also gathered them together with the remains of diluvial plants in the immediate neighbourhood of the body of the rhinoceros.

2. The position of the rhinoceros in the ground and the introductory work of preservation

The present paper is reduced to presenting the observations made concerning the specimen of the rhinoceros, the most magnificent specimen of diluvial fauna excavated at the end of 1929 in Starunia.

The preparation of a cast representing the position of the body in the layers of the ground, and further the work of the preparer, F. Kalkus, who is skinning the rhinoceros, prior to mounting the specimen in natural position under the direction of the author, did not permit the beginning of an accurate study of the skin, certain parts of the muscular system, the skeleton, some sex organs, and some preserved remains of visceral organs which unfortunately were almost wholly destroyed underground.

In this preliminary note we shall present shortly the results of only those observations which concern the external appearance of the preserved body, and especially of the parts hitherto unknown, or considered controversial by various scientists in the reconstruction of the animal; further we shall touch upon the problem of conditions in which the rhinoceros lived, the probable catastrophe which befell the specimens of large diluvial animals found in Starunia and the causes of the preservation of their bodies.

The specimen of the rhinoceros was found on the 23rd of October 1929 at a distance of 3.30 m. from the »Mammoth shaft«, in the wall of a side gallery leading from that shaft at a depth of 12.5 m. The body of the animal lay on its back so that the hind part of the body lay somewhat lower than the front part; and the head supported by a considerably stretched-out neck protruded, with the snout part, above the upturned almost naturally stretched hind limbs, somewhat higher than shown on the enclosed photograph of the cast. When first uncovered, the whole right side and the back of the animal were totally undamaged with the exception of a part of the neck and the snout and permitted the hope that the left side of the body would be preserved just as well. After the author of this paper had taken accurate measurements of the uncovered parts the specimen was protected in the wall of the gallery until the time of completing a new wider shaft which would make possible the excavation of the animal in the position in which it had been found.

After the complete excavation of the body there appeared unfortunately the damages of the skin on the left side of the head and the neck, a breaking off of the front and hind limb and finally a large hole in the front part of the stomach through which probably the intestines must have flown out soon after the death of the animal. Sparse remains of these intestines were found on the left side near the specimen at a distance of about one meter and a half from it.

Above the body of this specimen of the rhinoceros at a small distance above its feet there protruded out of the wall of the gallery remains of a skeleton of another rhinoceros quite devoid of the soft parts, however. The direction of the position of these bones was similar to that of the body of the first rhinoceros i. e.

the axis of the body ran parallel with the direction of the gallery toward the South-East. Of these remains the fore part of the skull, several vertebrae, and broken ribs and part of the bone of the fore limb were brought in.

More accurate observations on the preservation of the body were possible only after the body of the animal had been brought to the surface through the new shaft on December 17, 1929 and transported on December 22 to the laboratory of the Physiographical Museum of the Polish Academy of Sciences.

3. External appearance of the present specimen of woolly rhinoceros and remarks concerning its reconstruction

The body of the excavated specimen is covered with a skin entirely devoid of hair. This hair, separated from the skin, was embedded in the silt adjoining the body of the animal especially in the back parts. After separating it from the soil it may be noticed that it is light and fine, tangled and gathered into small tufts among which one finds occasionally darker and coarser hairs. The surface of the skin is rough because it is covered with very numerous tiny protuberances, under which the tufts of hair had been embedded in oblique cavities. After the skin had been soaked and cleaned, all these cavities appeared very distinctly and consequently enabled us to recognise the distribution of hair on the skin. The density of the distribution of these cavities on the skin and their dimensions differ in various parts of the body; they are especially large in the back of the head, which might lead us to the conclusion that the woolly rhinoceros had something like a mane, perhaps somewhat similar to that of wild boars. In the lower parts of the sides of the body there are visible lines of shorter and longer scars, traces of injuries probably sustained in fights with other rhinoceroses.

The head when seen from the better preserved right side of the profile looks at first glance different from the head of the specimen found in Starunia in 1907. The cause lies chiefly in the smashed and pushed in parietal bones on the front part and also the lack of the occipital bone, in consequence of which the skull was foreshortened and the profile contour changed considerably near the base of the frontal bone because its back part, which with the woolly rhinoceros rises highly and characteristically, had got lost. The pressure of the strata of soil pressed closer the lower jaw whereby the row of teeth in that jaw slipped from the row of the teeth of the upper jaw toward the centre of the snout cavity and the lower jaw was lifted up. Consequently the profile of the head looks much thinner and on the whole much smaller which might lead us to the wrong conclusion that this specimen is younger than that excavated in 1907. In reality things are just the reverse, because while the specimen of 1907 had all its permanent premolar teeth in the jaw bones under the roots of the corresponding milk teeth, in the present specimen there were only a very few milk premolar teeth, very much used: and those indicate, in accordance with skull measurements, which could be directly compared, that the skull of the present specimen is somewhat longer than that of the previously excavated one. So, according to the measurements of Niezabitowski[1], the distance from the front corner of the eye to the front surface of the snout is in the first specimen 36 cm., in the second 42·5 cm.: the distance from the corner of the eye to the back angle of the nose 24·5 cm. in the first specimen, 27 cm. in the second: the distance from the base of the ear to the snout 65 cm. in the first specimen and the same in the second.

Since the distance from the end of the nasal bone to the protuberance of the frontal bone was 32 cm. in the first specimen and from the frontal protuberance to the top of the superior curved line of the occipital bone 48 cm., then though we cannot in this present specimen obtain direct measurements on account of the smashing of the occipital bone if we add the number of 48 cm. to the number expressing the distance from the front end of the nasal bones to the frontal protuberance which is 37 cm., we shall obtain the sum of 85 cm., while this length and the largest length of the skull was 80 cm.

It was impossible to get directly the size of the first specimen because of the lack of the whole body. Niezabitowski

[1]) Niezabitowski E., Nosorożec włochaty (*Rhinoceros antiquitatis* Blum., *tichorhinus* Fisch.). Wykopaliska staruńskie. Kraków. 1914. Nakł. Muz. im. Dzieduszyckich.

tried to compute it indirectly from the measurements taken from the skeleton of the rhinoceros found in the collection of the Academy in Munich. The relation of the length of the skeleton (300 cm.) to the length of the skull (78 cm.) is 3·8 and since the length of the skull of the first specimen of the Starunia rhinoceros is 80 cm., the product of $80 \times 3{\cdot}8 = 304$ cm. which would approximately give the length of this specimen, and after a corresponding correction had been added to these measurements to account for the soft parts of the body, we might accept 335 cm. for the whole length of the animal.

If to test those values we accept the fact that the specimen just excavated had a head 5 cm. longer, then if we multiply the number $85 \times 3{\cdot}8$ — we shall obtain as a product 323 cm. and if we add 30 cm. for the soft parts we obtain the final result of 353 as length. In reality the length of the recently excavated specimen, measured with an arc along the side line, i. e. from the snout to the ear, then at the side of the neck and the body to the parallel line from the base of the tail, amounts to 326 cm. which is the figure obtained from the computations. The exact length of this specimen of rhinoceros measured after the skin had been taken off, from the fore end of the nasal bones along the forehead and spine to the base of the tail amounts to 358 cm. and together with the tail 409 cm.

Because of the almost complete destruction of vertebrae and neck muscles and quite a considerable lack of skin on the left side of the neck from the shoulder to the eye, the pressure of the soil directed from the left side in a slightly turned direction along the axis of the skull caused a shifting of the skin in some spots of the skull, which is more evident on the right side but only in the vicinity of the nostrils and ear. The upper lip elevated considerably on this side, filled up with soft parts the cavity under the nasal bones and lent to the nasal cavity the shape of a strongly closed aperture bent under a right angle. The top of this angle facing the front and top of the snout is 35 cm. away from the center of the eye opening and 7·3 cm. from the lower rim of the upper lip: the shorter arm of the angle falling vertically is 3 cm. in length, the horizontal one on the other hand running parallel to the lip is 7·5 cm. long. Along the left side of the head the position of the nasal opening was more natural but more strongly compressed. After the skin had been lifted and soaked in salt water, the nasal opening appeared in the shape of a quite wide aperture, the ends bent down, the fore end of the aperture lying nearer to the side part of the upper lip than the back end. The sub-dorsal nasal cartilage was well preserved: the cartilage lost almost nothing of its elasticity and in the section is of a whitish colour.

The lips were partially damaged but there remained those parts however which may supply important details for the delineation of the appearance of snouts of the woolly rhinoceros. The lifting of the upper part along the right side of the head caused too great a protuberance of it toward the front, mainly 5·5 cm. in length before the lower lip, and as a result the profile of the snout from this side resembles the profile of the head of the rhinoceros found in 1877 near the tributary of the river Jana and termed by Schrenck[1] probably erroneously as *Rhinoceros Merckii* Jäger. This profile coincides also with the one which was drawn by primitive man in his drawing of the diluvial rhinoceros on the wall of the cave of Font-de-Gaume, in the valley of Beune in Dordogne. On the left side of the head of the present specimen the protuberance of the upper lip toward the front is not evident at all whereas from the right side the profile of the snout is rounded, on the left side it falls obliquely along the straight line from the front and the top to the back and the bottom in such a way that the jagged upper lip covers directly the edge of the lower lip.

In examining the snout straight from the front, it is seen that the lips seemingly meet, not protruding in the middle part of the snout only because of the twisted parts of the lower jaw, the line of the snout opening runs very obliquely from the right side of the head toward the left. Before skinning, the breadth of the frontal area of the snout between the frontal nostril edges amounted in measuring with tape to 27 cm., under the base of the horn, with arc, to 20 cm., and in the central narrowest part to 13·5 cm.: the breadth of the snout opening from one corner to another measured with tape amounted to 35 cm.

[1]) Schrenck L. Der erste Fund einer Leiche von Rhinoceros Merckii Jaeg. (Mém. Ac. Sc. St. Pétersbourg, VII. Sér. T. XXVII. 1880).

The picture of the natural position of the lips and the probable appearance of the front part of the animal's snout could be obtained only after lifting of the skin from this part of the head, wherein there was revealed distinctly the damage to the upper lip in the central part. After the lips are parted it can be seen that the lower lip passes from the sides of the snout into the front part not like an oval but suddenly at almost a right angle, consequently there are formed in this place at the right and left side of the lips sharp protuberances which fall, when lips are closed, into corresponding cavities in the upper lip. The front part of the lip, slightly bent on the outside in the shape of a bow, is supplied along the whole of the length of the bow with a relatively sharp edge. The string of this bow from the top of one side protuberance to the second is 15 cm. longer than the line parallel to it, at a distance of 3 cm. from the front edge of the lip to the inside of the snout. The lower lip from the inside of the mouth cavity to the front narrows, therefore, at first gradually, but near its front edge it again widens, which corresponds also, in the skeleton, to the shape of the front end of the lower jaw. The length of the side edges of the lower lip, measured with a tape, from the side of the snout to the center of the side protuberance amounts to 7·8 cm., and the front part from the center of one protuberance to the second 19·5 cm. The length of the whole lip amounts, therefore, to 35 cm. The thickness of the skin of the lower lip measured near the side appendage amounted to 2·8 cm. The specimen of the rhinoceros excavated in 1907 lacked the lower lip — the present specimen permits us to suplement these lacks.

Only the side parts remained from the upper lip. They protrude slightly above the side edge of the lower lip and on the border of passing into the front part they posress greater indentions corresponding exactly to the side appendage of the lower lip. The length of the side parts of the upper lip amounts to 9·2 cm. In the front part the upper lip is damaged over a considerable area, if however we measure from the side indention to the vertical line conducted from the top of the nasal bone, i. e. to the center of the front part of the lip, then the half of the front part of the lip amounted to 13 cm., and the whole upper lip from one corner of the snout to the other 26 cm. The

muscles in the upper lip are strongly developed especially near the corners of the snout: this would tend to show a considerable mobility of the lips.

After the skin had been properly filled out from the inside, the shape of the snout, formerly greatly compressed, changed a great deal and strongly resembles in appearance the snout of the white rhinoceros (*Ceratotherium simum* Burch.), to-day almost totally extinct. It is therefore very wide in the front part of the upper lip, from the base of the horns in profile slightly arched, convex, passes almost at right angles in to the side parts, which are very short. It does not possess the growth on the upper lip, which had already been determined by the former researches on the heads of the rhinoceroses found in Siberia and the first rhinoceros found in Starunia.

Since all the soft parts were dried on the heads of the Siberian specimens and strongly compressed on the head of the first rhinoceros found in Starunia, the restorations of the snout and lips of the woolly rhinoceros which were patterned on these specimens in the reconstructions undertaken by various authors were not good. Passing over the Brandt[1] drawing in which the author drew erroneously the finger-like appendage on the upper lip of the woolly rhinoceros, other authors [(Niezabitowski[2], Hoyer[3])] draw the lips in the shape of thick rolls meeting almost evenly, and the line of the snout from the front of the nasal bones is made short in profile and falls sharply towards the lower lip. Hilzheimer[4] maintains regarding the lush reconstruction of the form of the woolly rhinoceros undertaken in 1924 that the upper lip must have protruded at least 10 cm. in front of the lower lip, especially in the other specimens whose nasal bones grow out considerably to the front and bottom. He bases this contention chiefly on the drawings made by primitive men

[1] Brandt J. F. Observationes ad Rhinocerotis tichorhini historiam spectantes. (Mém. Ac. Sc. St. Petersbourg. VI. Sér. Sc. nat. T. V. 1849).

[2] Niezabitowski E, Nosorożec włochaty (Rhinoceros antiquitatis Blum., tichorhinus Fisch.). »Wykopaliska staruńskie«. Kraków, 1914. Nakł. Muz. im. Dzieduszyckich.

[3] Hoyer H., Części miękkie głowy nosorożca i skóra mamuta. Ibidem.

[4] Hilzheimer M., Eine neue Rekonstruktion von Rhinoceros antiquitatis Blbch., zugleich ein Beitrag zur Morphologie, Biologie und Phylogenie dieses Tieres. (Neues Jahrbuch f. Mineralogie, Beilage-Band I. 1924).

and on the greater extent of the upper lip as compared to the lower in the rhinoceros found near the river Jana and the first Starunia rhinoceros. On the photographs of the reconstructions made by Hilzheimer the protrusion of the upper lip is not evident at all.

Since the upper lip is larger than the lower, which was noticed by earlier investigators and since the upper lip is amply muscled and possesses greater mobility, it could protrude in its front part above the lower lip by a few centimeters, especially when the head was bent considerably. Against its constant protuberance, which was considerable in the opinion of Hilzheimer bespeaks the fact that the respective indentions of the upper lip fit exactly the side elevations of the lower lip and are distinctly determined, consequently the front part of the upper lip passing under the corner into side parts could not also be parted so much from the front of the lower lip. I judge that the upper part of the upper lip lying in the centre of the height between the end of the nasal bones and edge of the lips, curved slightly. Probably, therefore, this curving was delineated by primitive man not all too correctly on the drawing of the rhinoceros in the cave of Font-de-Gaume. The outlines of the rhinoceros drawn on the piece of shale excavated in the cave »grotte du Trilobites« near Arcy-sur-Cure in the department Yonne, appeared much better with regard to this detail.

In connection with the problem of the protuberance of the upper lip there appears indirectly the arming of the head of the rhinoceros with the nasal horn. Hilzheimer judges that with the growth of the fore end of the nasal bones, the nasal horn connected with them bent outwards more from the vertical line towards the axis of the skull and formed with it an open angle, as it was drawn by prehistoric man, whereas in the reconstruction it is placed vertical to the axis of the skull. The horn could lower itself considerably in this way because the woolly rhinoceros was not a steppe animal and did not graze on low grass, besides such a placing of the horn would be only an obstacle. According to Hilzheimer the strongly protruding upper lip shows that the rhinoceros lived like the elk in the damp forests where he fed on the leaves of the trees. This is borne out by the finding in 1907 in the vicinity of Starunia of oak, willow, poplar

and hazel leaves. Remains of the true diluvial flora, chiefly willows and warped birches (*Betula nana*) and also abundant grasses and mosses separated from the silts surrounding the body of the rhinoceros show, however, as presented by Prof. Szafer in the botanical part of these notes that in the times when the now excavated rhinoceros lived, there existed in these regions only extensive tundra.

The two horns of the now excavated rhinoceros fell off and have successfully resisted all attempts to find them in the surrounding silts up to the present. There have remained only very distinct traces in the skin which permit the exact marking of the dimensions of the bases of horns and their distribution. The base of the first nasal horn is wide oval-shaped; it is turned with its wider end toward the back of the skull and with the sharper end it reaches the beginning of the nasal bone. From the surface of the skin it delineates itself sharply, due to a distinct raising and across the center of it there passes from the rear end to the front end a convexity in the shape of a roll 1 cm. wide. This roll as well as the whole area occupied by the horn base is distinctly delineated on the nasal bones due to the existence of large and numerous wart-like bone appendages. The length of the horn base measured with tape amounts to 27 cm., the width on the front end to 12 cm., the largest width at a distance of 16 cm. from the front end of the base to 19·4 cm. In the first Starunia specimen the length is 24 cm. and the width 16 cm. The shape and measurements of this base approach very much the base of the nasal horn of the first rhinoceros found in Starunia — it is only 3 cm. longer but has the same width.

At a distance of 4 cm. beyond the nasal horn base there is the base of the frontal horn. It differs from the nasal horn base in that there is a concavity in the skin and the shape is more or less deltoid. The front angle of this deltoid is almost a right angle, the back very sharp; the length of the deltoid amounts to 19 cm., and the width to 16 cm. The place moved vertically in the vicinity of the front corner of the eye to the axis of the head strikes beyond the centrally indented top of the side arms of the deltoid. The base of the frontal horn differs from the base of the frontal horn of the first specimen found in Starunia because it is of a somewhat different shape and

is smaller, whereas the present specimen has the base of the nasal horn 8 cm. longer than the length of the forehead horn base. With the first specimen it was only 1 cm. longer. The width, on the other hand, of the nasal horn base of the present specimen is 3·4 cm. larger than the length of the base of the frontal horn; it is different with the first specimen where the width of the nasal horn base is 3 cm. smaller than the bases of the frontal horn. Since the bases of the frontal horn of the Siberian specimens differ greatly one from another and from the bases present in the Starunia specimens, therefore, the shape and size of the frontal horn underwent probably great variations, possibly greater than the nasal horn. The nasal horn must have been larger than the frontal horn, as it is with the now living rhinoceroses which are armed with two horns. Judging also from the drawings of primitive man as well as from the horns found in Siberia and horns of the now existing white rhinoceros the horn was probably slimmer than is now delineated in reconstructions and as justly remarked by Hilzheimer it was placed on nasal bones under an open angle to the axis of the skull.

The eye region on the right side of the head was marvellously preserved. The dermal folds under the eye are evident on the pressed skin of the head only slightly, but after the skin had been lifted and soaked they appeared distinctly and give an interesting picture of deeper and shallower wrinkles so characteristic to the eye of the rhinoceros and especially white rhinoceros. The five more distinct folds under the eye, partly bending bow-wise under it, and another five pass in a half-circle above the upper lid. The more numerous but smaller and shallower wrinkles gather from all sides towards the eye opening. The length of this opening is slight, 4 cm., corresponding to the comparatively very small eyes of the rhinoceros. It passes obliquely in such a way that its fore end lies nearer the frontal surface of the head than the back falling toward the bottom, which remains doubtlessly in connection with the constant bend of the head of the woolly rhinoceros. The center of the eye opening is 4·5 cm. away from the beginning of the nasal bone, 28 cm. away from the ear base and 21 cm. (as measured with tape) from the line passing through forehead along axis of the head. The eye itself was well protected by a bone framework

which strongly projected along the top, front and bottom. The present specimen possesses only remains of an eyeball in the eye cavity on the right side of the head. The back of the eye part, on the left side, was greatly damaged as regards the bone framework and the skin.

The ear was not so well preserved; it exists only on the right side of the head; on the left it is entirely lacking. The ear is placed in a quite wide protuberance, encircled from the front and the top with three dermal folds distinctly visible before the preparation of the skin. The lower part of the auricle is closed to the height of 4 cm. in the shape of a pipe, slightly narrowed at the top with a basis of 31·5 cm. in external circumference and the top of 24 cm. of external circumference. At the height of 4 cm. the pipe changes into a spoon-like part 24 cm. long. The outer edge of this spoon is very well preserved all the way up to the top of the ear; it is very slightly arched, 1·2 cm. thick at the pipe and thinner toward the top. The central edge of the spoon-like part of the ear is in its lower part torn and at the top entirely lacking. The spoon-like part of the ear which has remained near the outer edge has on its internal surface a width of 4·7 cm., on the external surface a width of 6·5 cm. Along the internal surface of the auricle there are to be seen on the part preserved from the bottom, three thickened dermal rolls. The reconstructed ear auricle of the present specimen of the rhinoceros has the shape of a pipe, closed from the bottom to the height of 4 cm., then cut and changing into a leaf-like part, broadening out elliptically, and narrowing again under the top.

The ear of the present specimen differs from the ear of the first Starunia specimen only in its upper part, which above the ring-like lower part, narrows at once toward the top and ends sharply. The dimensions of both are very similar; the ring-like part of the present specimen is 1 cm. higher and the whole length is 4 cm. greater. It is not impossible, however, that the ear of the first specimen had undergone considerable changes. I found that in the period of the cleaning of the present specimen and its preparation for the cast which lasted six days, it could not be protected sufficiently by means of damp cloths and that the ear auricle underwent a considerable contraction. It regained its elasticity and shape after a longer soaking in a basin with salt

water. Considering that the first rhinoceros was exposed for ten months after its excavation to fresh air, remarkable changes might have occurred to the shape of the ear.

The ear of the specimen from Jana was dried and perhaps for that reason almost shorter by half (13·8 cm.). Its shape however was similar, because it was elongated, broadening towards the centre and then again it grew narrow and ended quite abruptly in a blunt end.

The neck of the present specimen of rhinoceros suffered the greatest damages; it lacks namely on the left side a piece of the skin (about 25 dm²) from the back edge of the eye beyond the shoulder-blade and from a height of about 10 cm. below the neck line, to a distance of several centimeters from the lower throat line. The muscles of the throat underwent complete destruction and considerably smashed pieces only have remained of the neck vertebrae. However the skin on the right side of the neck — a very important part for the reconstruction of this part of the animal—has been preserved. While in attempts at the reconstruction of the appearance of the head of the woolly rhinoceros one could depend on rather abundant skulls of this animal and on the heads preserved with the soft parts in a more or less complete way — the data concerning the neck of the woolly rhinoceros was furnished for the first time by the specimen excavated in 1907 in Starunia.

Then it was noticed for the first time that in the middle part of the neck-length there was a small bulgy protuberance having no connection with the bony protuberances of the vertebrae. A similar protuberance on the neck of the white rhinoceros was described at about the same time by Roosevelt [1]. Aside from this neck-protuberance at a distance of about 44 cm. from the occiput there was in the Starunia specimen — according to Niezabitowski — a shoulder blade hump bearing a close connection with the very long spinous processes of the vertebrae of this part of the neck.

The present specimen possesses very distinct humping of the skin on the neck, distributed in the following manner:

[1]) Roosevelt Th., The Square-mouthed Rhinoceros. (The American Museum Journ. T. XI, 1911).

At a distance of 84·5 cm. from the beginning of the nasal parts, if we measure with an arc, and 91 cm. if we measure with tape, we can see in the lifted and soaked skin the spot to which the top of the occiput reached. Behind it there is a small concavity and at a distance of 6 cm. of this indentation lies the top of the first humping of the skin, very short, since it is only 11 cm. long. Directly after the third lowering of the first protuberance, the skin begins to elevate itself again into the second protuberance which is almost twice as long as the first (21 cm.). Its top at about half its length is 22 cm. away from the occipital crest. Immediately behind this protuberance there is the third elevation, 29 cm. long, whose top, lying in the middle, is 46·5 cm. away from the occiput. Directly after this elevation there is a fourth protuberance whose top is 30 cm. distant from the last mentioned top and 76 cm. from the occiput.

The number and the distribution of these humps would in consequence seem different from those of the rhinoceros excavated in 1907. In reality there is a total accord, only the first relatively slight hump was overlooked there, and the fourth one was not preserved with the earlier specimen. Therefore the determination alone of these humps is different. The first of them is the top of a constant neckfold directly behind the occipital bone existing commonly with various rhinoceroses and which becomes more noticeable when the animal's head becomes lifted. This fold passes probably at a lower place towards the bottom of the neck through very wide wings of the atlas bone protruding out of the sides of the neck. The second of these elevations which was determined with the first specimen as a neck-hump lies at exactly the same distance (22 cm.), from the occipital bone as with the first specimen. The third elevation which with the former specimen lies at a distance of 44 cm. from the occipital bone coincides totally, as far as its position is concerned, with the one existing with the present specimen 46·5 cm. away from the occiput — only its determination was erroneous. It was not a suprascapular elevation, but a hump built quite similarly to the former. The fourth or the highest elevation, 76 cm. away from the occiput, is a suprascapular elevation.

In the opinion of Prof. Hoyer, the neck hump was probably filled during the life time of the woolly rhinoceros with fatty

tissue. It is impossible, unfortunately, to prove the truth of this supposition, because the soft parts of the neck were completely destroyed in the present specimen. I could only find that right in the central line of the neck there passes, closely connected with the skin, a considerable thickening whose width may be sensed by the hand, when we press the skin from the sides. This thickening begins under the first elevation behind the occipital bone, runs under the first and the second neck humps and ends before the suprascapular elevation. The width of this stripe, also distinctly visible from underneath the skin, is under the first elevation 5 cm., then it grows gradually up to 16 cm. under the second neck hump, where the thickness is the greatest and amounts to 3 cm. Under the microscope one can see in this stripe crossed lengthwise and crosswise fibres of connecting elastic tissue of the ligamentum nuchae. Probably below both of these humps there existed on the neck dermal folds, which appear even to-day very distinctly with present-day specimens of rhinoceros, in the shape of shoulder blade folds. Since the shaping of the back part of the skull with the white rhinoceros is similar to that characteristic of the woolly rhinoceros, then probably with the woolly rhinoceros also, whose head was certainly hanging at a considerable angle from the level — the lifting of the head must have taken place chiefly by means of an oscillating upward motion of the neck with but a small diminution of the angle of the bend of the head. Probably the neck hump must have protruded considerably with this motion.

The suprascapular elevation and the line of the back. The erroneous designation in the case of the first Starunia specimen of the second neck hump as a suprascapular elevation and the too strong protuberance of the whole neck in the contour of the rhinoceros drawn by prehistoric man, has caused the suprascapular elevation to be shifted too far to the front in some reconstructions. The lack of a preserved extension (behind the neck-hump) of the body of the woolly rhinoceros has rendered almost all reconstructions of this part of the rhinoceros unsuccessful. The well-known drawing of the diluvial rhinoceros of the cave in Font-de-Gaume on which prehistoric man drew the contours of the animal with a strongly slanting line of the back influenced

the reconstructions. This error appears specially blatant in the drawing made in 1911 by Abel[1]).

There are, it is true, in a few museums, skeletons of the woolly rhinoceros more or less complete, however their mounting is almost always erroneous in various details. Attempts at reconstruction of the body of the rhinoceros would perhaps have been more successful as regards the back part of the animal, unknown heretofore, had they been based rather on the appearance of present-day living specimens of other species of rhinoceroses, and especially on the white rhinoceros, which in many features is the most similar.

Therefore then the suprascapular hump is elevated above the line of the fore limbs, similar to present-day rhinoceroses: then it falls distinctly in order to rise at the beginning of the lumbar vertebrae, though not so high. The top of the wave is short here, and it falls soon, in order to rise once again in the environs of the sacrum from which it runs on with a steep arch towards the base of the tail. This dorsal line would be much more distinct and easy to determine, were it not for the rather considerable deformation of the body of the animal in the soil, and its position, on the back, in a curved bend. Even so, the place could be seen, where the suprascapular hump rose and where its dorsal line fell after the animal had been excavated and skinned. In the last reconstruction of the woolly rhinoceros made by Hilzheimer in 1924 all these elevations in the dorsal line are distinctly noticed, however in somewhat exaggerated dimensions, especially the lumbar elevations have been shifted too far to the front, and the whole body was reconstructed too short, too concentrated in the placing of its limbs.

The tail. It is quite interesting that although all the attempts at the reconstruction of the woolly rhinoceros took into account the drawing of this animal left by prehistoric man, none of them yet presented the tail form as it had been drawn by primitive man and which incidentally coincides best with the real shape of this part of the body of the animal. The tail, very well preserved with the present specimen, has on the bottom side 49 cm (all measurements taken with tape) the sides of its junction, which

[1]) Abel O., Grundzüge der Paläobiologie der Wirbeltiere. Stuttgart 1912.

run obliquely upwards, are 14 cm. each, the width at the top is 15·5 cm. at the base, and the circumference 29 cm. At a distance of 11 cm. from the base of the tail its width is 11 cm., and its circumference 22·3 cm.; at a distance of 27 cm. the circumference is 14·5 cm.; at a distance of 3 cm. from the end of the tail the circumference is 5·5 cm. Consequently the tail is broad at its base, somewhat flattened in the direction from the top of the body towards the end, with an external surface less, and the front surface more, curved, whereby at the side there is a distinct sharp line of the joining of these two arches. This width and this flattening grow gradually smaller towards the middle of the tail; at about $^{1}/_{3}$ of the distance from the base of the tail the flattening disappears, and the section of the tail nears a circle.

The flattening of the tail on a considerable length and the relatively deep traces of the bases of hairs appearing distinctly on its side and upper surfaces indicate that the tail of the woolly rhinoceros was probably naked from the bottom, for about half of its length: from the top and the sides it was covered with hair, which was at first short, grew longer towards the end of the tail and enclosed the bottom part of the tail. The longest hair appeared however probably along the side edges of the tail, which caused the shaping of a sort of flat, fan-like tuft, with which the animal slapped strongly towards its stomach — as is done by present-day rhinoceroses.

At a distance of 6·5 cm. from the bottom base of the tail there is the anus, 9 cm. in diameter.

Below, at a distance of 2 cm., lies the top junction of the vaginal opening, fairly wide open. The length of this opening is 12·5 cm. and its lower, bow-like junction is at a distance of 30 cm. from the tail base. In the depth of the sinus urogenitalis there is visible the entrance to the vagina, which has a length of 7 cm. and there is, 1·5 cm. below, the meatus urinarius with a diameter of 2 cm. Finally 4 cm. lower, in an arched junction is the clitoris.

The back part of the body of the rhinoceros is splendidly preserved and enables us to identify positively the sex of the excavated specimen. It has an important bearing on the question, for after the preparation of the skeleton it will permit us to determine which of the characteristics or variations appearing in the shape of the bones, for instance the pelvis, or in the skull may be regarded as characteristics connected with the sex of the mammals and which may bear on the individual or racial variations.

At a distance of 34 cm from the lower junction of the vaginal opening there protruded in the excavated specimen in the vicinity of the womb and the groin a fold on which, after the skin had been soaked, appeared somewhat damaged teats. They are like two, quite thick, three-cornered folds, from which each passed at the top into a wart, unfortunately, damaged. The length of the base of each of these folds measured 10 cm., width 8 cm. and height measured on the side of the fold 9 cm. At the base of these folds under the skin, there remained a compressed tissue of the milk gland.

The navel with all the details is wonderfully preserved: its front at a distance of 43 cm. from the teats. The length of the navel amounts to 12 cm.; the width is 9 cm.

The line of the abdomins profile coincides with the dorsal line. It passes more or less parallel to the back line, and is not so curved from the front toward the back as is pictured in some reconstructions, which are based too exactly on the drawing of the rhinoceros preserved in the Font-de-Gaume cave.

All the limbs are preserved quite well externally. However, the bones are in the main broken, especially in the upper parts Also, in the left side of the body, the fore and hind limbs became separated from the skeleton and soft parts and were attached to the rest of the body by the skin only. The bone breakages caused certain changes in the position of the soft parts. The disappearance of a considerable part of fatty tissue and compressing of the muscles caused a certain slenderness of the limbs and a sharp delineation, on the skin, of the ligaments and outlines of bones.

The right fore limb was concealed in the body beyond the elbow joint: the left was broken in this part. The length of the fore arm amounted to 49 cm., and the distance from the centre of the carpal joint to the top of the middle digit is 35 cm. The circumference of the metacarpus in the slenderest spot, namely at a distance of 14·5 cm. from the sole, measured 37 cm. The

under area of the foot from the edge of the middle digit to the back edge was 20 cm., and from the centre of the edge of the external digit to the centre of the edge of the inside digit 19·5 cm.

The length of the right hind limb from the centre of the knee joint, to the front bend in the tarsus amounted, in a straight line, to 55 cm., and from this spot to the top of the middle digit 31·5 cm. The circumference of the crus at a distance of 24 cm. from the top of the heel bone (calcaneus) measured 53 cm., in the tarsus through the heel bone 55 cm., and below in the slenderest spot, that is at the joining of the metatarsus with the digits, 32 cm. This spot is 16·5 cm. away from the top of the middle digit, measured along the skin. The length of the foot from the top of the middle digit along the central line of the sole to its back edge amounts to 16 cm. and the width from the centre of the external digit to the edge of the inside digit is 14 cm. The sole of the hind limb is quite considerably smaller (almost $^1/_4$) than the sole of the fore limb and the thickness of the joint at the joining of digits is also less.

All digits lacked hoofs — but it can be clearly traced to where the horn reached, because there remained rolls and also, after the skin had been soaked, the borders of the horn could be seen.

The external damages to the body of the rhinoceros are slight and the now excavated specimen of the woolly rhinoceros will be, doubtlessly, the most complete to enter a museum for some time to come. A thorough research will enable us in a great measure, to eliminate the difficulties which heterofore made it difficult to reconstruct faithfully the appearance of this diluvial animal.

4. Preservation of the soft parts of the body of the rhinoceros

The parts under the skin were much worse preserved than the surface of the body.

In so far as it will be possible to determine the boundaries of the strongly compressed muscles and to differentiate them, it will be possible then to investigate from the muscle placement only some parts, perhaps those of the fore legs from the elbow joint, then the muscles of the whole back limbs and the right side of the body from the right half of the chest.

Of the internal parts of the body there remained only an insignificant part. Through the opening in a side of the front part of the abdominal cavity, under the left fore leg, the rest of the tangled intestines found near the body of the animal was swept out by current waters. In their place the water conducted into the cavity a considerable amount of fine river mud which filled it from the anus opening to the inside of the mouth cavity. Of the internal parts there remained only the tongue, a part of the throat, the palate, — parts which were thoroughly studied in the first Starunia specimen by Prof. Hoyer, also pieces of intestines filled with river mud and perhaps some parts of the sex organs.

5. The skeleton of the rhinoceros and the meaning of a thorough research on the Starunia rhinoceros for the problem of the races of woolly rhinoceros

The skeleton of the now excavated specimen of rhinoceros cannot be put together entirely. In many parts the bones are broken and in some parts, e. g. in the shoulder blades and the skull, so smashed that after the soft parts were taken away, they crumbled into bits. In some parts, for instance in the neck, they are lacking entirely. At any rate, the very preparation, joining and mounting of these bones will demand a long and painstaking introductory work, before a thorough research of the skeleton parts can be undertaken.

In spite of thorough studies of various parts of the woolly rhinoceros skeleton by different authors, the results of the studies of the Starunia rhinoceros skeletons may have an important, basic, meaning for the problems of the races of this species. The hitherto described skeletons of the woolly rhinoceros, mainly skulls, came from places of a wide area of distribution of this species, from the Atlantic, through the whole of central and northern Europe (except Scandinavia) then through north and central Asia to North America, inclusively. These bones belonged to animals which did not live simultaneously, but often at different times at great intervals in the long diluvial period. It is not to be wondered at then that there exist among these skulls certain differences, with regard to which, however, it is hard to decide

whether they are to be attributed to individual variation or to geographical and whether they arose in the same period or in different periods.

On the other hand, the researches conducted in the territory of Starunia supplied three specimens of the woolly rhinoceros which lived doubtlessly in the same vicinity and at the same period. Each of the specimens was of a different age; the 1907 specimen was the youngest, the most completely preserved specimen, just excavated, was somewhat older, and the oldest is the specimen of which only skeleton parts have come down to us, also just excavated. The sex of the just excavated specimens is absolutely correctly determined. A thorough comparison of the skeleton parts of these specimens will determine permanent characteristics and also the variations, especially in connection with sex and with height, it will also in a great measure, permit to establish the shape of the species of the woolly rhinoceros, characteristic for the Starunia area during a certain period of time. Through this it may supply certain directness which will facilitate the orientation in the bone material of this animal, coming also from other areas. Probably it will be necessary to define the Starunia specimens as a race with which — as a group of strictly defined characteristics, with a certain known quantity, as it were, — it will be possible to compare all other remains of the woolly rhinoceros. I would suggest, then, for this race the name of *Coelodonta antiquitatis staruniensis* n. sp.

The just discovered rhinoceros is not only a priceless and unique museum specimen, as a mounted specimen of the diluvial animal, which lived tens of thousands of years ago, but together with other remains of mammals of this species excavated in Starunia it supplies a certain basis for scientific research about diluvial rhinoceroses.

6. Factors which caused the collection and preservation of the rhinoceros remains in Starunia

There remains for our consideration the problems of the considerable number of the animal bodies, well preserved on such a small area of several square metres, as is the area of the present researches in Starunia.

The great abundance of the rhinoceroses found there in relation to remains of other vertebrate animals, supplies material for reflection. Among the mass of diluvial animals the woolly rhinoceros was not a rare specimen as is shown by his remains, known in many places of an extensive area of his distribution. However he was not as common as for instance his co-inhabitant, the mammoth. And yet, judging from the remains of the animals found up till now in Starunia, it could be supposed that the woolly rhinoceros was at a certain time a common animal in these areas and living in groups, which is not the case with the rhinoceroses now existent. There must have been then on the present area of Starunia, conditions favourable to the existence of the rhinoceros. They may have been the parts of tundras with abundant vegetation, hidden in quiet valleys at the foot of the Carpathians, where the animals found not only abundance of food but also protection from the cold northern winds. Doubtlessly there was abundance of water — the springs of salt water which must have existed then as they do to-day, were probably enticing to the animals since the salt played such an important part in conserving the body of these animals.

But just as to-day, the valleys eroded deeply by the waters with the high steep edges were dangerous traps for the animals. Especially when after sudden violent storms the great masses of waters flowing swiftly from the near high elevations, in one moment raised the level of the small streams to a considerable height, sometimes of several metres. At such times the animals which had not found well protected places lost their lives in the turbulent waters. The waves lifted their bodies and carried them to places where the flow of the water, spreading out, lost its carrying strength.

Also in winter these valleys were sometimes dangerous for the animals when the huge masses of snow carried by the violent winds, in time of snow blizzards, snowed in the animals and closed for a long time the entrance to the valleys, especially for the large heavy animals. The bodies of the fallen animals snowed under by the succeeding snow storms, did not disintegrate quickly. Only when the snows melted, did the process of decay set in on the spot where the animal had fallen or the larger waters carried away the bodies and had strewn it on the banks or sand shoals.

of the activity of the salt was the abundant appearance of it on the skin after the excavated body of the rhinoceros had been kept in a dry place, showing that the salt had collected in the skin in such an amount. The cooperation of the crude oil is evident by the abundant outflow of it from the broken bones and also by the layer of thin ozocerite, appearing here and there on the skin. It is possible that the silt containing the condensed crude oil vapours acted here as a factor excluding the destructive activity of the decaying bacteria, the salt being a factor impermeating the skin and preserving it. In preserving the bodies there may have been still a group of other factors so far undetermined.

There still would remain the problems of establishing the period of time in which the specimens of the rhinoceros found in Starunia lived and died. The woolly rhinoceros is a species whose remains known from the areas in Germany were defined as dating from the time of glaciation Riss, as well as later glaciation Würm, and the time of the sovereignty of the tundra. The extent of the distribution of the woolly rhinoceros contracts further slowly from the west and finally the woolly rhinoceros becomes extinct in Europe and only in Siberia lives still for quite a long time. Judging from the remains of food found in the mouth of the specimens excavated there it finds food not only in grass, willows and shrub birch, (probably *Betula fructicosa*) but also *Vaccinium* and thin young branches of coniferous trees such as *Picea* cf. *obovata*, *Abies* cf. *sibirica* and *Larix* cf. *sibirica*.

Explanation of tables 2—10.

2. The right side of the head of the rhinoceros before soaking the specimen in water.

3. 1. The left side of the head of the rhinoceros before soaking the specimen in water. 2. Front of the snout of the rhinoceros before soaking the specimen in water. 3. Front of the snout of the rhinoceros after soaking and lifting the skin. — The missing part of the upper lip is marked white.

4. 1. The soaked skin lifted from the right side of the head of the rhinoceros. 2. The right side part of the snout in the skin. — The sharply drawn elevation in passing from the side part to the front of the uper lip. 3. Indentations in the upper lip corresponding to the elevations in the lower lip.

5. 1. The web of wrinkles around the right eye in the soaked skin. 2. Oblique passage of the eye aperture of the right eye. 3. Traces of the frontal horn in the soaked skin. 4. Right ear after soaking of the skin.

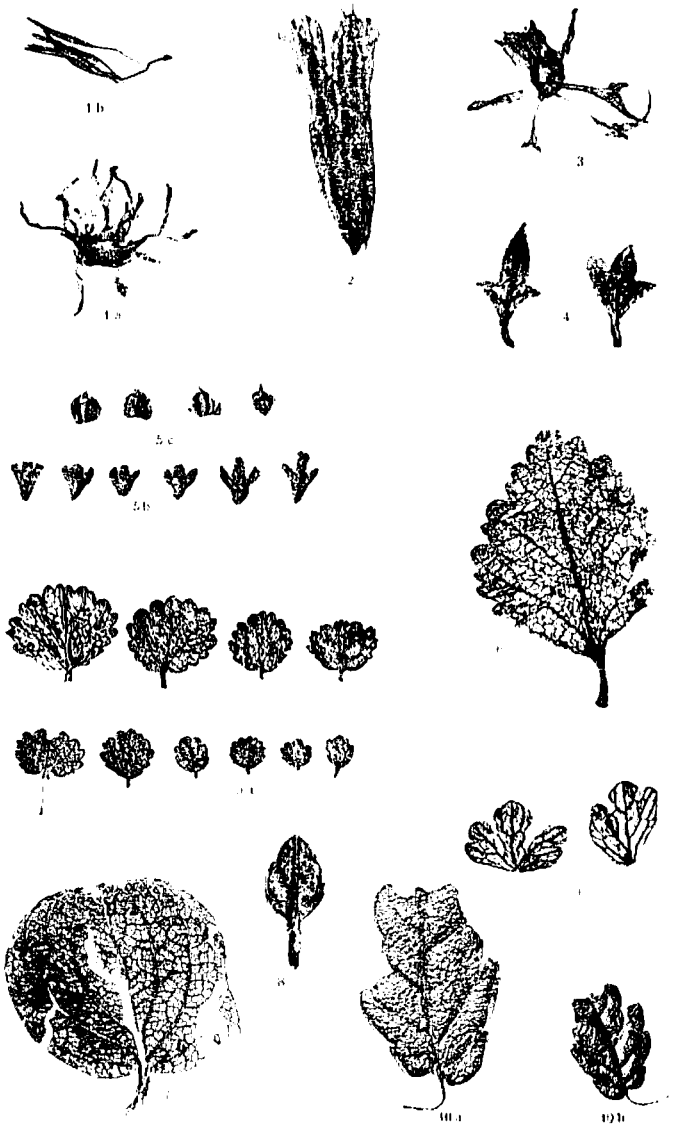
6. 1. Back of the rhinoceros before soaking the specimen in water. — From the side there are visible the strips of muscles of the broken off hind leg. 2) The tail and vaginal opening before soaking of the rhinoceros in water. — Slanting photo from the side. 3. The vaginal opening after soaking and lifting the skin.

7. 1. The navel after soaking and lifting the skin. 2. The scars on the skin, reminders of the battles of the rhinoceros, in the lower parts of the sides of the body. 3. The sole part of the rhinoceros hind limb before soaking in water. 4. The skin of the top part of the fore limb after soaking and lifting the skin. — Distinct traces of the horn of the hoofs visible.

8. 1. The back part of the right side of the body of rhinoceros before soaking in water. 2. The back part of the right side of the rhinoceros before soaking in water.

9. 1. Photo of the sketch in natural size according to which the rhinoceros will be mounted. — Reconstruction of Prof. J. Stach, the mounting of rhinoceros by F. Kalkins. 2. Outlines of the diluvial rhinoceros drawn by prehistoric man on the wall of the Font-de-Gaume cave in the valley of the river Beune in Dordogne. According to X. Breuil. 3. Outlines of the fore part of the bodies of two dilavial rhinoceroses drawn on shale, by prehistoric man, excavated in the cave »grotte du Trilobite« near Arcy-sur-Cure in the department of Yonne. — Below a supplemented drawing by X. Breuil. 4. Reconstruction of woolly rhinoceros by Hilzheimer in 1924. 5. Reconstruction of woolly rhinoceros by Prof. H. Hoyer in 1914. 6. Photo of the cast of the now excavated rhinoceros showing his position in the earth. These casts in natural size can be obtained after consulting Prof. J. Stach, director of the Physiographic Museum of the Polish Academy of Sciences, Cracow, Slawkowska 17.

10. Roentgenogram of the foot part of the fore limb of the rhinoceros



W. Szafer

J. Stach

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J. Stach

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J. Stach

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J. Stack

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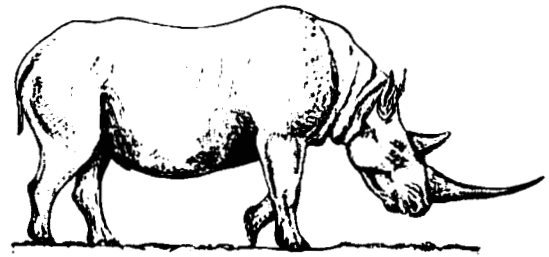
J. Stach

J. Stach



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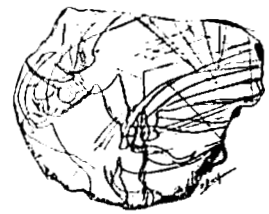

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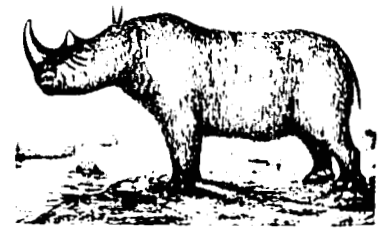

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