NARRATIVE OF THE POLISH-MONGOLIAN PALAEONTOLOGICAL EXPEDITIONS 1963—1965

(PRZEBIEG POLSKO-MONGOLSKICH EKSPEDYCJI PALEONTOLOGICZNYCH 1963—1965)

(Plates I—IV)

Abstract. — Polish-Mongolian Palaeontological Expeditions to the Gobi Desert and Western Mongolia were organized in 1963—1965, by the Palaeozoological Institute, Polish Academy of Sciences in Warsaw, and Biological Research Institute, Academy of Sciences of the Mongolian People's Republic in Ulan Bator. The organization of the expeditions, including: elaboration of scientific programme, terms of cooperation and leadership, division of costs, preparations for the expeditions, transport, workers, equipment, methods of field work and staff of the expeditions are described. The detailed courses of three successive expeditions and their scientific results are given.

INTRODUCTION

The first palaeontological investigation of the Gobi Desert was undertaken by American scientists. In the years 1922—1930, the American Museum of Natural History in New York organized five successive expeditions to Mongolia, known as the Central Asiatic Expeditions, under the leadership of R. C. ANDREWS. These expeditions worked on the territory now belonging to the Mongolian People's Republic (Outer Mongolia) and the People's Republic of China (Inner Mongolia). They assembled a collection of Cretaceous dinosaurs and Cretaceous and Tertiary mammals of great scientific value. The results of the Central Asiatic Expeditions were published in a series entitled "Natural History of Central Asia" (e.g. BERKEY & MORRIS, 1921; ANDREWS, 1932, and others), and in a long series of smaller papers, which are still being published in "American Museum Novitates" and in "Bulletin of the American Museum of Natural History".

A summary of the results of these expeditions is beyond the scope of the present paper. It should, however, be remembered that they carried out pioneering work in territory never before visited by a palaeontologist, and that they collected material which contributed greatly to our knowledge of the history of reptiles and mammals of Central Asia.

A second series of palaeontological expeditions to Mongolia was organized by Soviet palaeontologists. In 1941, the Committee of Scientific Affairs of the Mongolian People's Republic approached the USSR Academy of Sciences with a proposition to organize a palaeonto-

logical expedition to the Gobi Desert. Before the Institute of Palaeontology of the USSR Academy of Sciences could undertake the organization of such an expedition, the Second World War intervened.

The project was taken up again after the war, and three successive Soviet expeditions, under the leadership of J. A. EFREMOV, were sent to Mongolia in 1946, 1948 and 1949. These expeditions worked in the regions covered by the American expeditions 20 years before, and also explored some new territories.

The area most interesting palaeontologically, discovered by the Soviet expeditions, was the Nemegt Basin in Southern Gobi. In this basin, they came across a great cemetery of Upper Cretaceous dinosaurs, obtaining 10 complete skeletons of carnivorous and duckbilled dinosaurs (EFREMOV, 1948, 1954, 1955, 1963; MALEYEV, 1955*a*, 1955*b*; ROZHDESTVENSKY, 1952, 1957*a*, 1957*b*). They also discovered an area of exposed Paleocene beds, which yielded a rich fauna of mammals. Another new region of palaeontological interest, discovered by the Soviet expeditions (ROZHDESTVENSKY, 1954), was the Dzereg valley in Western Mongolia, where they came across a very rich deposit of Pliocene mammals, the Altan Teli beds. The scientific results of these expeditions are published in various Soviet and Chinese palaeontological journals (Trudy Mongolskoy Kommissyi, Trudy Paleontologitscheskogo Instituta, Paleontologitscheskiy Zhurnal, Vertebrata Palasiatica). The collected material is of great value, both as a scientific collection and as museum exhibits.

In 1959 and 1960, the Academies of Sciences of both the Soviet Union and the People's Republic of China organized joint palaeontological expeditions to the Chinese territory of Mongolia (Inner Mongolia), under the leadership of ROZHDESTVENSKY and CHOW (CHOW & ROZHDESTVENSKY, 1960; ROZHDESTVENSKY, 1961). They assembled a valuable collection of dinosaurs and Tertiary mammals, which are being elaborated by Soviet and Chinese palaeontologists.

A third series of palaeontological expeditions to Mongolia was organized by the Polish Academy of Sciences and the Academy of Sciences of the Mongolian People's Republic. In 1963, 1964 and 1965 three Polish-Mongolian Expeditions carried out excavatory work in Southern Gobi and Western Mongolia (KIELAN-JAWOROWSKA & KOWALSKI, 1965; KIELAN-JAWOROWSKA, 1966).

The idea of organizing the Polish-Mongolian Palaeontological Expeditions to Mongolia was born in the Palaeozoological Institute of the Polish Academy of Sciences, during the Assembly of the representatives of the Academies of Sciences of the People's Democracies,

held in Warsaw in March, 1961. The instigator of this project was Professor ROMAN KOZŁOWSKI, doyen of Polish palaeontologists. Professor Kozłowski's project was well received by the authorities of both Academies. In September of 1961, an official delegation of the Polish Academy of Sciences, with Professor KOZŁOWSKI as a member, went to Ulan Bator, to sign an agreement on scientific co-operation between the two Academies. The signed agreement foresaw the organization of joint Polish-Mongolian Palaeontological Expeditions over a 3-year period. When the delegation returned to Poland, the first author, as head of the Palaeozoological Institute, Polish Academy of Sciences, was charged with the task of organizing the expeditions on the Polish side, and was also authorized to undertake the scientific leadership. Organization on the Mongolian side fell to the second author, an assistant of the Biological Research Institute, Mongolian Academy of Sciences (Director of the Institute 1963—1964, Prof. DAVADZHAMS; in 1965, Prof. SHAGDARSUREN).

ACKNOWLEDGEMENTS

The Polish-Mongolian Palaeontological Expeditions to Mongolia constituted a collective effort, not only of all members of the expeditions, but also of a large group of people, who, although not actually taking part in them, contributed greatly to the scientific success of the expeditions by virtue of their help and kindness.

Grateful acknowledgements are due to the Authorities of the Polish and Mongolian Academies of Sciences, for taking the decision to organize the expeditions with a full understanding of their importance; to Prof. H. JABŁOŃSKI, Scientific Secretary of the Polish Academy of Sciences at the time the expeditions were being organized, and Prof. I. MALECKI, Vice-Scientific Secretary, as well as to Prof. SHYRENDYB, President of the Academy of Sciences, Mongolian People's Republic, and Vice-President Prof. CEREV.

The authors also express their special gratitude to the initiator of the Polish-Mongolian Palaeontological Expeditions, Prof. R. KOZŁOWSKI, who gave freely his ideas and advice throughout the whole period.

Taking part in the three successive Polish-Mongolian expeditions were 22 persons from the Polish side and 12 — from the Mongolian. It was thanks to the great effort of all the members of the expeditions, their industry, endurance and good team spirit in difficult field conditions, that the expeditions were able to obtain important results. Three years of working together in the field, in the difficult climatic conditions of the Gobi Desert, forged close links of friendship between the Mongolian and Polish members, essential for good working co-operation between the two sides. Thanking all the members without exception, the first author wishes to express her special gratitude to Dr. J. KULCZYCKI and Prof. K. KOWALSKI, who from the Polish side led the expeditions in 1963 and 1964 respectively, and to Mr. M. KUCZYŃSKI, B. Eng., who was in charge of the technical organization of the expeditions. Thanks are also due to Dr. R. GRADZIŃSKI, Dr. J. LEFELD and Mr. W. SKARŻYŃSKI for the permission of publishing their photographs.

ORGANIZATION OF THE EXPEDITIONS

Elaboration of the scientific programme

The scientific programme of each of the three expeditions was prepared by the Palaeozoological Institute, Polish Academy of Sciences, and sent (a few months in advance) to the Academy of Sciences of the Mongolian People's Republic for their consideration. Then, after the arrival of the Polish members of the expedition, the scientific programme was discussed by the Polish and Mongolian groups, with the participation of the authorities of the Academy of Sciences of the Mongolian People's Republic. At the end of the meeting, the leaders of both sides signed a protocol setting down the agreed scientific programme.

Terms of co-operation and leadership

Both sides, the Polish and Mongolian, had equal rights, independent of the number of members taking part in an individual expedition, or the cost incurred by a particular side. The leadership of each expedition consisted of two persons, that is the leaders of the Polish and Mongolian sides, and all the decisions were taken jointly. The leader of all three expeditions from the Mongolian side was DOVCHIN. KIELAN-JAWOROWSKA, while undertaking the scientific

leadership of all three expeditions on the Polish side, did not take part in the 1963 expedition, and only visited the one in 1964. The Polish leaders in the field in 1963, 1964 and 1965 were respectively: J. KULCZYCKI, K. KOWALSKI and Z. KIELAN-JAWOROWSKA.

Division of costs

Each side covered the costs of travel and subsistence of their members in the field. The Polish side supplied the three expeditions with all the excavatory tools and conservation and packing material. The cost of employing workman for field work was shared equally by the Polish and Mongolian side in 1964, while in 1965, the Mongolian side bore 90% of the cost, and the Polish side 10%. In 1963, transport costs in Mongolia were divided equally between the two groups, while in 1964 and 1965, Poland covered 70% of the costs, and Mongolia 30%.

Preparation for the expeditions

As the sites of the palaeontological excavations in Mongolia are all in uninhabited regions, tens and sometimes even hundreds of kilometres from the nearest settlements, the expeditions had to be completely self-sufficient. That is why the preparation of the expeditions from the technical side, especially for the Polish group, was a big organizational problem. All the Polish camping equipment, excavatory tools, food for the whole period, petrol and trucks were assembled in Poland, and dispatched to Mongolia by train, two months before the beginning of each expedition. This equipment arrived to Ulan Bator at the beginning of May, and was received by the Mongolian group. The Mongolian Academy of Sciences put at the disposal of the expeditions a shed and a place for storing equipment, so that after each expedition, a large part of the Polish equipment could remain over winter in Ulan Bator. Equipment and food supplies for the Mongolian group were prepared in Ulan Bator.

The Polish members of the expeditions travelled to Ulan Bator by plane. The first two weeks were usually spent in Ulan Bator, repacking the equipment and preparing the trucks for the road. Usually only part of the packing materials could be taken on the first journey from Ulan Bator to the field, and so after the field camp had been established, the trucks returned to Ulan Bator for the rest of the materials.

In 1964 and 1965, when the expeditions carried out important excavatory work in the Nemegt Basin, an additional store for equipment and a provisional store for collected fossil material were established in the capital of the Southern Gobi province (aymak) — Dalan Dzadgad, which was about 400 km from the excavation site.

Transport

As the expeditions carried out work in desert terrain, difficult of access, excavating dinosaur skeletons weighing several tons, one of the most important organizational problems was the securing of suitable means of transport. Motor transport was used throughout. In the desert only two types of trucks were used: a four-ton Polish truck (the Star 66), with a 3-wheel drive, and a two and a half-ton truck, Soviet production (Gaz 63), with a 2-wheel drive. For quicker transport, a small Soviet jeep-type car (Gaz 69) was used. In addition, for transporting equipment and collected specimens in the steppe and semi-desert, the following trucks were used: a four-ton truck, Polish production (Star 25), an eight-ton truck, Czech production (Tatra 111), and an eight-ton Soviet truck (Zil). In 1963, the Polish and Mongolian groups had one truck each. In 1964, the Mongolian group had one truck, the Polish group, two. In 1965,

the Mongolian group had two trucks, the Polish group, four (three of which were brought from Poland, one being hired in Ulan Bator). In addition, the Polish group provided one truck for the transportation of equipment, and the Mongolian group, two trucks with trailers, for the final transportation of the collected materials.

In 1965, a crane was hired to load and unload the crates with fossils in Dalan Dzadgad and Ulan Bator.

Workers

The expedition of 1963 did not engage any workers. In 1964, for excavatory work in the Nemegt Basin, four workers were hired for the period 10 June — 9 July. In 1965, for work in the Nemegt Basin, six workers were employed from 10 June to 13 August, and two labourers for work in the Dzereg valley (Western Mongolia) for a period of ten days. On account of the considerable amount of physical work involved, all the members of the expeditions had to take part in this.

Equipment

It seems pointless to give a list of all the equipment which would take up some 10 pages. The camping equipment, as a rule, did not differ from normal equipment in general use. During the 1963 expedition, it appeared that the European tents used by the Polish group, did not always withstand the strong Gobi winds. Because of this, the next expeditions had tents made on the Mongolian model, from sail canvas, without a floor, and with two thick vertical duralumin poles connected under the roof by a duralumin rod. For excavatory work in the field, the expedition used classical excavatory tools. As an example, the tools used in 1965 consisted of, among others: 20 pickaxes, 20 picks, 33 spades, 40 hammers, 100 chisels of various sizes, 50 paint brushes, 50 scrapers, 1 hand-pulley, 2 mechanical pullies (on the trucks), a set of carpentry and locksmith tools. For the conservation and packing of the skeletons, 120 litres of liquid polystyrene were used, 2 tons of plaster, 150 sq. metres of canvas, 75 kg cellulose paper, 300 kg of wood shavings, 200 sq. metres of corrigated cardboard, 5 cubic metre boards for crates, 70 kg nails, 100 ready made crates. In 1965, 14,000 litres of petrol were taken from Poland for the three Polish trucks.

Method of field work

The Cretaceous mammals and lizards at Bayn Dzak, the finding of which was a special interest to our expeditions, occur in a horizontal sandstone layer, exposed over a wide area. The weathered sandstone forms an area covered with nodules, that is, concretions of strongly cemented rock, resistant to weathering. Because of the small size of the fossils that were being looked for, and their great scarcity, it was necessary to search for them on hands and knees, examining the nodules of strongly cemented sandstone with a magnifying glass. The sediment in which the fossils were embedded was not suitable for washing, as the mammalian skulls are preserved only in more strongly cemented sandstone. It is quite possible that washing and screening the sand, the product of weathering of sandstone, would yield single teeth or even jaw fragments. However, due to difficulty with the water supply and the limited means of transport, washing and screening could not be undertaken.

Excavation of dinosaur skeletons was carried out in the following way. If the bones happened to be preserved in a well exposed horizontal layer, a tentative calculation had to be made as to the size of the skeleton and then a trench dug around it. Excavation followed, working from the trench inwards. When the protruding part of the skeleton happened to be in a vertical

section, then it was necessary first to remove the layer of rock above it, which was possible only if it did not exceed 2—3 metres in thickness. As the bones were uncovered, they were soaked with thin polystyrene, sometimes together with the embedding rock. The rock was cleared from the bones only to an extent which would permit convenient transportation. When a skeleton was uncovered, its scheme was made in the scale 1 : 10, and individual bones numbered both on the drawing and on the specimen. For those parts of the skeleton which could not be freed from the surrounding rock, or those which were very fragile, so-called monoliths were made. First, a wooden frame was built around the element to be collected as a monolith (such as a skull or pelvic girdle), the specimen was covered with plastic folio or a big layer of wet cellulose paper, and the empty spaces in the frame were filled up with plaster. When this had dried, the lid was nailed on to the frame, the bottom of the monolith detached from the ground and the whole overturned 180°. The first procedure was repeated, namely any protruding bones were soaked in polystyrene, covered with plastic folio and the remaining space filled up with plaster. Then a lid was nailed on, the top and bottom respectively were marked and the monolith was ready for transportation. The heaviest monoliths made during the expeditions weighed 2.5 tons. Often the skeletons were found in an area inaccessible to motor transport, so that the ground had to be levelled to make a road along which the monoliths could be pulled. The monoliths were pulled along such roads on wooden boards, while the blocks of rocks containing bones were pulled on improvised sledges, made out of sheets of metal obtained from petrol drums.

Collections

During three years of field work, collections of Cretaceous and Tertiary vertebrates were assembled, weighing, together with packing, about 35 tons. Materials collected during the 1963 and 1964 expeditions were sent to Warsaw and were provisionally catalogued in the collections of the Palaeozoological Institute, Polish Academy of Sciences (abbreviated as Z. Pal.). As foreseen under the terms of the agreement between the Polish and Mongolian Academies of Sciencies, after being elaborated, these collections are to be divided between the two Academies. In connection with this, many of the numbers of the specimens collected in 1963 and 1964, described in the papers of the series "Results of the Polish-Mongolian Palaeontological Expeditions", will be changed in future, as part of these specimens will retunr to Ulan Bator.

The collection of the 1965 expedition has been divided in Ulan Bator between the Polish Academy of Sciences and the Academy of Sciences of the Mongolian People's Republic. Thus, the numbers of the specimens collected during the 1965 expedition, housed in the Palaeozoological Institute of the Polish Academy of Sciences, are definite.

Staff of the expeditions

Polish side: *Mongolian side:*

1963

Doc. Dr. J. KULCZYCKI — palaeontologist, leader of the Polish group
M. KUCZYŃSKI, B. Eng. — technical leader
Doc. Dr. H. MAKOWSKI — geologist
Dr. A. SULIMSKI — palaeontologist
D. WALKNOWSKI, B. Sc. — driver

D. DASHZEVEG, B. Sc. — palaeontologist
N. DOVCHIN, B. Sc. — palaeontologist
R. BARSBOLD, B. Sc. — geologist
CEVEGZAV — zoologist
KHORLOO — driver
KHOSBAYAR — geologist

1964

M. BORSUK-BIAŁYNICKA, B. Sc. — palaeontologist
Dr. R. GRADZIŃSKI — geologist
G. JAKUBOWSKI, B. Sc. — palaeontologist

Prof. Dr. K. KOWALSKI — palaeontologist, leader of the Polish group
M. KUCZYŃSKI, B. Eng. — technical leader
Dr. J. LEFELD — geologist
W. MACZEK — technical assistant and driver
T. MARYAŃSKA, B. Sc. — palaeontologist
W. SKARŻYŃSKI — technical assistant
Dr. A. SULIMSKI — palaeontologist
D. WALKNOWSKI, B. Sc. — driver
Moreover, Prof. Dr Z. KIELAN-JAWOROWSKA visited the expedition

D. DASHZEVEG, B. Sc. — palaeontologist
N. DOVCHIN, B. Sc. — palaeontologist
KHALTAR — technical assistant
KHORLOO — driver

1965

Dr. R. GRADZIŃSKI — geologist
J. KAŹMIERCZAK, B. Sc. — palaeontologist
Prof. Dr. Z. KIELAN-JAWOROWSKA — palaeontologist, leader of the Polish group
Dr. H. KUBIAK — palaeontologist
M. KUCZYŃSKI, B. Eng. — technical leader
Dr. J. LEFELD — geologist
Dr. M. ŁEPKOWSKI — medical doctor
Doc. Dr. J. MAŁECKI — palaeontologist
T. MARYAŃSKA, B. Sc. — palaeontologist
A. NOWIŃSKI, B. Sc. — technical assistant
Dr. H. OSMÓLSKA — palaeontologist
E. RACHTAN — driver
W. SICIŃSKI — technical assistant
W. SKARŻYŃSKI — technical assistant
D. WALKNOWSKI, B. Sc. — driver

R. BARSBOLD, B. Sc. — geologist
D. DASHZEVEG, B. Sc. — palaeontologist
N. DOVCHIN, B. Sc. — palaeontologist, leader of the Mongolian group
DZHAMBA — driver
ERDENIBULGAN — technical assistant
GALSAN — technical assistant
NAMSRAY — technical assistant
SHOMOODORZH — driver

The first Polish-Mongolian Palaeontological Expedition, organized in 1963, was of a reconnaissance character and did not carry out excavatory work. The aim of the expedition was to examine some of the localities previously visited by the American and Soviet expeditions, to search for new outcrops yielding Cretaceous and Tertiary vertebrates and to fix sites for future exploration. An additional aim was to get acquainted with local conditions, so that the next expeditions could be properly equipped.

On 24 March 1963, the equipment for the Polish group was sent by rail from Warsaw to Ulan Bator, where it arrived on 7 May and was unloaded and stored by the Academy of Sciences of the Mongolian People's Republic.

On 26 May, a five-person Polish group flew from Warsaw to Moscow and on to Ulan Bator, where they arrived on 30 May. Between 31 May and 3 June, meetings in which a detailed programme of reconnaissance was finalized, were held in Ulan Bator between the Polish group, the authorities of the Mongolian Academy of Sciences and the Mongolian members of the expedition. It was decided that the expedition would work in two regions, at first in the province (aymak) of South-Eastern Gobi, and then in Southern Gobi. On 2 June, an advance party comprising SULIMSKI, WALKNOWSKI and a Mongolian guide, left in one truck for Dalan Dzadgad, the capital of the Southern Gobi aymak. They carried part of the equipment and food and deposited it in Dalan Dzadgad, where they established a base for the second stage of the expedition. This group returned to Ulan Bator on 5 June.

The preparations having been completed, on 7 June all the members of the expedition left in two trucks for South-Eastern Gobi (Text-fig. 1). On 9 June, the expedition arrived at the capital of the South-Eastern Gobi aymak, Saynd Shand, and on 11 June in Dzoon Bayn. Here they left part of the equipment, and established an operational base for the expedition. On 12 June the expedition proceeded to Tushleg, Sherlin and Khar Teg, and the next day to Khangil Cav. In all these places there are exposures of Upper Cretaceous sandy and clayey sediments. In Khangil Cav and Khar Teg numerous fragments of dinosaur skeletons, tortoise shells and pelecypods were found. On 14 June, the expedition went to Khamarin Khural, where Upper Cretaceous beds occur, with a poor concentration of fossil remains, and on 15 June to Bayn Shireh (MALEYEV, 1954, 1956; EFREMOV, 1954), where they pitched camp and remained till the 21st of the month. In the sandy sediments of Bayn Shireh are several layers with a rich concentration of dinosaur bones (fragmentary skeletons), tortoise shells and fish remains. The camp at Bayn Shireh was wound up on 21 June, and the expedition continued on to Khuvsugul, and on the following day to Gua Teg. Here is an outcrop of Tertiary sandstone, presumably of Oligocene age, unknown to previous expeditions. A bone-bearing layer, rich in the remains of large tortoises, in a good state of preservation, was discovered here.

On 24 June, the expedition proceeded south-east, in the direction of the Mongolian-Chinese frontier, the road leading through Dzamyn Sayr and the abandoned settlement of Sulan Kher. On 25 June, they reached the frontier, camping at Khulst Hill, a sandstone exposure of unknown age (?Oligocene) with indeterminate remains of mammals (see also DASHZEVEG, 1965).

The return journey led through Sulan Kher and Dzamyn Sayr. On 21 June, the expedition reached Chatan Bulak, where it divided, the Mongolian group going to the western exposure of Ergelyeen Dzo (synonyms: Erghil Dzo and Ardyn Obo), the Polish group going to the eastern part of the same exposure (MATTHEW & GRANGER, 1925*a*, 1925*b*; OSBORN, 1923, 1924*b*; BELAYEVA, 1952*a*; GROMOVA, 1952*a*, 1952*c*; KONZHUKOVA, 1954; TROFIMOV, 1952*a*; DASHZEVEG, 1964). Between 28 June and 4 July, both groups searched for fossils in the Oligocene deposits of Ergelyeen Dzo. A large concentration of mammalian and tortoise remains was found there. On 5 July, the collections and equipment were prepared for dispatch to Ulan Bator. The following day, MAKOWSKI and a Mongolian driver went with part of the collections to Ulan Bator. The rest of the expedition returned to Gua Teg, to recover a large tortoise skeleton (see MŁYNARSKI, 1968) which was discovered some days before.

On 9 July, the expedition returned to Ulan Bator, where they remained till the 13th of the month. The Polish group hired a Gaz 63 truck with a Mongolian driver, as the Polish Star 25 truck with 2-wheel drive was unsuitable for desert terrain (Southern Gobi), the destination of the second stage of the expedition.

On 20 July, both groups set out in two trucks from Ulan Bator, arriving at Dalan Dzadgad

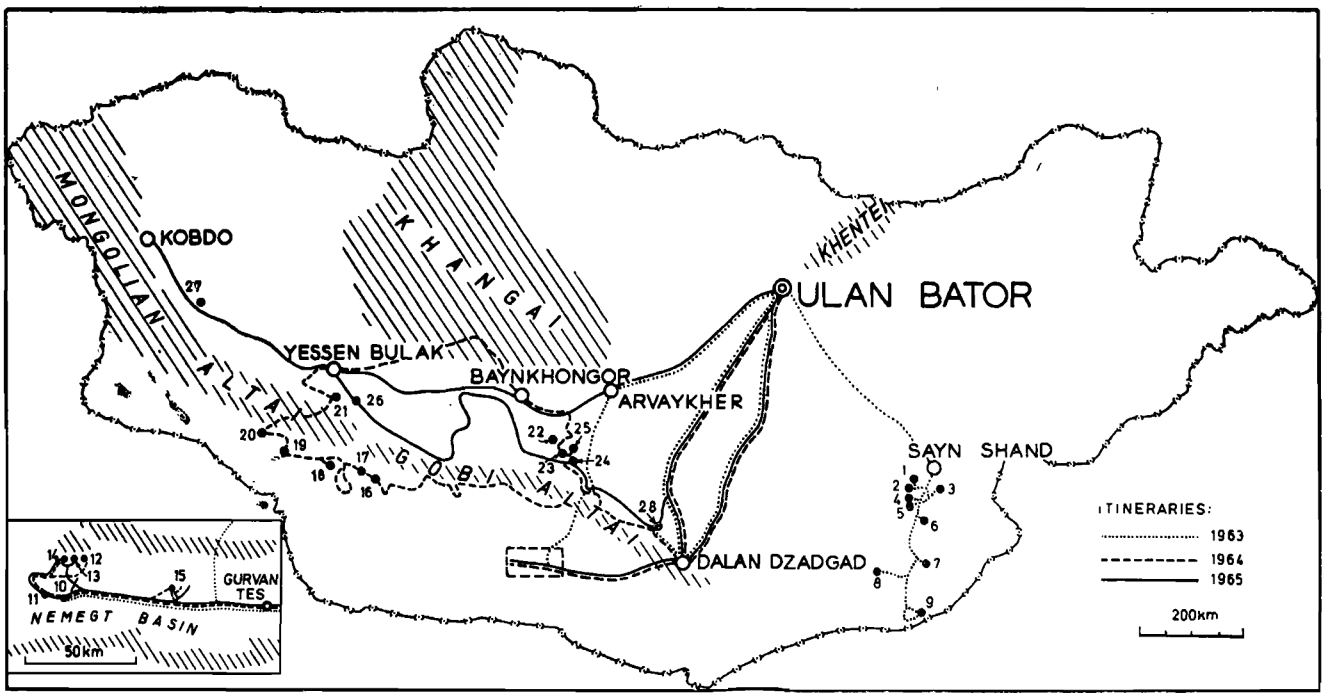

Fig. 1

Itineraries of the Polish-Mongolian Palaeontological Expeditions

1 Tushleg, *2* Sherlin, *3* Khamarin Khural, *4* Khongil Tsav, *5* Khar Teg, *6* Bayn Shireh, *7* Gua Teg, *8* Ergelyeen Dzo, *9* Khulst, *10* Naran Bulak, *11* Tsagan Khushu, *12* Altan Ula II, *13* Altan Ula III, *14* Altan Ula IV, *15* Nemegt, *16* Ulan Ganga, *17* Narin Bulak, *18* Khatan Khayrkhan, *19* Boogneen Gol, *20* Khaitch, *21* Khalyun, *22* Buylstyeen Khuduk, *23* Tatal Gol, *24* Shand Gol (Hsanda Gol) and Loh, *25* Ondai Sayr, *26* Begger Noor, *27* Altan Teli, *28* Bayn Dzak (Shabarakh Usu) and Khashaat (Gashato).

on the 23rd. The next day, they proceeded further to Bayn Dzak (referred to in American literature as Shabarkh Usu), where both the American (BERKEY & MORRIS, 1927; GRANGER & GREGORY, 1923; OSBORN, 1924*a*; GREGORY & MOOK, 1925; GILMORE, 1933) and Soviet expeditions (NOVOZHILOV, 1954) had worked (see also LEFELD, 1965; GRADZIŃSKI *et al.*, 1968). 25—26 July were spent searching for fossils in the exposures of Cretaceous sandstone (Djadokhta Formation), probably of Coniacian-Santonian age. Dinosaur eggs and fragmentary skeletons of *Protoceratops andrewsi* were found there.

It is interesting to note that the beds yielding *Protoceratops* sp. have been discovered by MORRIS in 1923 (unpublished Field note-book, VII — courtesy of the American Museum of Natural History) at Tugruk (Tuguru-gu), situated about 25 km NW from Bayn Dzak. Tugruk was visited by DASHZEVEG and NIKOLOFF in 1964 (see NIKOLOFF & HUENE, 1966) who reported this locality as situated 47 km NW from Bayn Dzak. Tugruk was not visited by our expeditions.

On 27 July, the group left for Khashaat (Gashato), where they stayed till 29 July, investigating the Paleocene sediments (see MATTHEW & GRANGER, 1925*c*; MATTHEW *et al.*, 1929; TROFIMOV, 1952*b*; FLEROV, 1957*b*; WOOD, 1942). The Paleocene beds at Khashaat are now extremely poorly exposed, and our expedition could find there only a few, indeterminate mammal remains.

The expedition returned to Dalan Dzadgad on 29 July, where they collected petrol and completed their equipment before setting out for the Nemegt Basin on 1 August. As mentioned above, in the Nemegt Basin, are large exposed areas of Upper Cretaceous and Lower Tertiary sediments, exploited intensively by the Soviet expeditions (EFREMOV, 1954, 1955; ROZHDESTVENSKY, 1949, 1952, 1954*a*, 1957*a*, 1957*b*) (cf. also GRADZIŃSKI *et al.*, 1968, Text-fig. 1).

The Lower Tertiary beds of the Nemegt Basin, outcropping in the localities Naran Bulak, Ulan Bulak and Tsagan Khushu, have been referred to by Soviet palaeontologists as being of Lower Eocene age (NOVOZHILOV, 1954). The assemblage of the Lower Tertiary fauna, described from these beds by FLEROV (1952*a*, 1952*b*, 1957*a*), GROMOVA (1952*a*) and TROFIMOV (1952*b*), as well as the mammalian fauna found in the same sections by the Polish-Mongolian Expeditions in 1963 and 1964, show great similarities to that occurring in the Paleocene beds of Khashaat, proving that without doubt the Khashaat beds and the Lower Tertiary beds of the Nemegt Basin are contemporaneous, as already has been mentioned by the first author (KIELAN-JAWOROWSKA, 1967). The Lower Tertiary beds of the Nemegt Basin and of Khashaat are provisionally referred to in the present paper as being of Paleocene age, though it cannot be excluded that they are of Lower Eocene age.

Our expedition of 1963 spent 3—6 August in Naran Bulak and Ulan Bulak, searching for mammals in the Paleocene outcrops. In Naran Bulak, a well preserved, incomplete skull of a pantodont (KIELAN-JAWOROWSKA, 1968*a*) and fragmentary mandibles with teeth of a representative of Dinocerata were found.

The Upper Cretaceous sandy sediments of the zone of *Saurolophus angustirostris* ROZHDESTV., *Dyoplosaurus giganteus* MALEYEV and *Tarbosaurus bataar* (MALEYEV), being of Campanian or Maastrichtian age, outcrop in the Nemegt Basin at Tsagan Khushu, Nemegt and Altan Ula. Of these localities, the Polish-Mongolian Expedition visited only the Tsagan Khushu outcrops in 1963, finding numerous remains of dinosaur skeletons and tortoise shells.

On 6 August, the group left the Nemegt Basin and were back in Ulan Bator in 11 August, where the expedition ended. On the 23rd of the month, the Polish group left Ulan Bator, arriving to Warsaw on the 31st.

1964 EXPEDITION

After the 1963 expedition, part of the Polish equipment was left over the winter in Ulan Bator. New equipment for the 1964 expedition was sent by rail from Warsaw on March 14, 1964, arriving on 7 May in Ulan Bator, where it was received by the Academy of Sciences of the Mongolian People's Republic.

On 21 May, the Polish members of the expedition, eleven in all, left Warsaw by plane and arrived on 25 May in Ulan Bator. The next few days, till 2 June, were spent in Ulan Bator. During this time, meetings were held between the leaders of the Polish and Mongolian groups and the authorities of the Mongolian Academy of Sciences, to fill in the details of the plan for the 1964 expedition. It was decided that the first period would be devoted to work in the Nemegt Basin (see Text-fig. 1), while the second would be spent in Bayn Dzak (Shabarkh Usu). While at Bayn Dzak, part of the expedition would carry out a reconnaissance of the region south of the Gobi Altai range, country previously unexplored by palaeontologists.

Between 26 May and 2 June, the Polish and Mongolian groups were busy preparing the equipment and trucks for the road. The Polish group hired a trailer for one of their trucks, thanks to which they were able to take most of the equipment with them.

The Polish and Mongolian groups left Ulan Bator on 2 June. 6 June the expedition arrived at Dalan Dzadgad, where a store for the equipment was set up. 8 June, they left Dalan Dzadgad for the Nemegt Basin (GRADZIŃSKI *et al.*, 1968, Text-fig. 1 and others). In the Nemegt Basin at Gurvan Tes, the last setlement on the way to the work site, four workers were engaged and taken to the field. 11 June the expedition arrived at Naran Bulak, where the first camp was established. From 12—17 June, the members of the expedition explored the Paleocene outcrops at Naran Bulak and Ulan Bulak. Mammalian remains (Dinocerata and Insectivora — numerous fragments of *Pseudictops*; cf. SULIMSKI, 1968) and fish remains were found. On 15 June, the two Polish trucks returned to Ulan Bator, to take back the trailer and collect the rest of the packing material, petrol and food. On the 18th of the month, part of the expedition went to Tsagan Khushu, about 8 km distant, to examine the Upper Cretaceous sediments occurring there. As the place seemed very promising, a sub-camp was established at Tsagan Khushu, and from 19 June — 2 July work was carried out simultaneously at Naran Bulak and Tsagan Khushu. 21 June, KIELAN-JAWOROWSKA, who had been in Mongolia since the 13th of that month, arrived in Naran Bulak in a Gaz 69, accompanied by a Mongolian driver and interpretor.

22 June, at Naran Bulak, KOWALSKI came across a lense of sand full of bone fragments of small mammals *(Eurymylus, Palaeostylops, Prionessus)*, unknown previously from this area, but described from the Paleocene beds of Khashaat (MATTHEW & GRANGER, 1925*c*; MATTHEW *et al.*, 1928, 1929; WOOD, 1942). On subsequent days, the members of the expedition at Naran Bulak continued work on the exploitation of this lense, while the geologists, GRADZIŃSKI and LEFELD, made a topographical map of the area and geological sections.

Meanwhile at Tsagan Khushu several dinosaur skeletons, or their fragments were recovered. The most important of these findings were: complete hind legs with a pelvic girdle of *Tarbosaurus* sp. found by DOVCHIN, an almost complete, very well preserved skeleton (7 m long) of *Tarbosaurus bataar* (MALEYEV) (see MALEYEV, 1954, 1956; ROZHDESTVENSKY, 1965), lying on its flank (Pl. II), found by JAKUBOWSKI an incomplete skeleton of a small (about 2.5 m long) ornithomimid dinosaur, consisting of a flattened, but well preserved skull, incomplete pelvic girdle, complete hind limbs and tail, found by SKARŻYŃSKI, and an almost complete, though poorly preserved skeleton of a large specimen (5 m long) of ornithomimid dinosaur, found

by KIELAN-JAWOROWSKA. In addition, a layer full of tortoise shells was found at Tsagan Khushu, numerous single bones and fragmentary skeletons of various dinosaurs, crocodiles (see KONZHUKOVA, 1954), fish, pelecypods and fossil wood being also excavated.

In June, three reconnaissance trips were made to various parts of the Nemegt Basin, to decide upon localities and horizons most suitable for exploration. On 23 June, DOVCHIN, GRADZIŃSKI, KIELAN-JAWOROWSKA, KOWALSKI and the driver drove to the Upper Cretaceous outcrops of Altan Ula. In the exposed area of Central Altan Ula, called by our expeditions Altan Ula II (see GRADZIŃSKI *et al.*, 1968, Text-fig. 1), they come across traces of the so-called "Dragons' grave", where the Soviet expeditions found seven partial skeletons of *Saurolophus angustirostris* ROZHDESTV. (EFREMOV, 1954, 1955; ROZHDESTVENSKY, 1952, 1954*a*, 1957*b*).

Then the group continued to the west, visiting the outcrops of Altan Ula III. On 25—26 June, the same group made a reconnaissance of the Upper Cretaceous beds at Nemegt, where they investigated the so-called „Nemaya tolshcha", unfossiliferous red sandstones, occurring in the eastern part of the outcrops, called by our expeditions the Lower Nemegt Beds (GRADZIŃSKI *et al.*, 1968), and a series of yellowish sandstone, yielding numerous dinosaur remains (Upper Nemegt Beds), resting upon the Lower Nemegt Beds. On the 29th, DOVCHIN, JAKUBOWSKI, KIELAN-JAWOROWSKA, KOWALSKI and the driver went by jeep on a reconnaissance of the south-western part of the Nemegt Basin. They came across outcrops of red sandstone, reminiscent of the lower beds at Nemegt. No traces of bone remains were found there.

1 July, the two Polish trucks returned from Ulan Bator with a supply of plaster, boards and petrol. The next day, KIELAN-JAWOROWSKA left for Ulan Bator, where she met with the President of the Academy of Sciences of the Mongolian People's Republic, Prof. SHYRENDYB, to give him a report on the work already accomplished by the expedition and to discuss plans for the next expedition in 1965.

In the Nemegt Basin, the camp at Naran Bulak was struck and all the members transferred to Tsagan Khushu, where work had begun on the packing of a large ornithomimid skeleton and on making monoliths of the *Tarbosaurus bataar* skeleton. As the latter skeleton was found high up, on the southern slope of the outcrops it was necessary to construct a road, so that the truck could get as near as possible to the skeleton. From 4—6 July, GRADZIŃSKI, JAKUBOWSKI, MARYAŃSKA and WALKNOWSKI travelled, by Star 66, to the central outcrops of Altan Ula (Altan Ula II), and then on to the western outcrops (Altan Ula IV). These latter had never previously been exploited by any expedition. The way to the western outcrops of Altan Ula led through several kilometres of sand dunes which were very difficult to transverse. These western outcrops appear to be very rich. During a short stay, the tail fragment of a large armoured dinosaur, two skulls of *Tarbosaurus* sp. and numerous single bones of various dinosaurs were found.

9 July, both skeletons at Tsagan Khushu (*Tarbosaurus bataar* and ornithomimid dinosaur) were finally packed and loaded onto the truck. On this day, DASHZEVEG found in the southern part of the Tsagan Khushu outcrops a layer of Paleocene sandstone yielding a fauna of small mammals, similar to that previously found at Naran Bulak. In the evening, the Mongolian members conveyed the workers back to Gurvan Tes and proceeded to Dalan Dzadgad, to take part in the celebrations of the Mongolian national holiday, nadom.

On 10 July, LEFELD and MACZEK left with a truck-load of the collections for Ulan Bator, and the other Polish members of the expedition drove, in a Star 66, to Altan Ula, to finish the excavation of the specimens which had previously been found there. That day the camp at Tsagan Khushu was hit by an unusually strong sand storm, which overturned all the tents.

12 July, the expedition struck camp at Tsagan Khushu and the Polish group proceeded

to Nemegt, leaving, on the way, a part of the collected material at Naran Bulak. On the 13th, a camp was established at Nemegt, in the same place where the Soviet expedition had pitched theirs. The next day, the Mongolian group returned from Dalan Dzadgad, and KUCZYŃSKI, SKARŻYŃSKI and WALKNOWSKI left for Naran Bulak, to pick up the collections there and take them to Dalan Dzadgad. They returned on 17 July to Nemegt with a food supply and packing material from the expedition's store at Dalan Dzadgad. The period 15—22 July was spent looking for fossils at Nemegt. Numerous single dinosaur bones were found. BORSUK-BIAŁYNICKA found the skeleton of a small *Tarbosaurus* sp. which was lying on its flank, rather strongly weathered and depressed. The recovery of this skeleton and the construction of monoliths took up most of the time.

On 23 July, LEFELD and MACZEK returned from Ulan Bator with plaster and a supply of boards. The Mongolian group left for Dalan Dzadgad, where they were to wait for the Polish group. From 24—26 July, work was finished on recovering the skeleton of the small *Tarbosaurus*. On 27th of the month, the Polish group struck camp in Nemegt and proceeded to Dalan Dzadgad, where they met with the Mongolian group.

The collection from Nemegt was left in Dalan Dzadgad. A supply of petrol was obtained, and on 30 July both groups travelled on to Bayn Dzak, pitching their camps above the Flaming Cliffs. 31 July, at the foot of the Flaming Cliffs, KOWALSKI found the skull of a Cretaceous mammal (SIMPSON, 1925, 1928*a*, 1928*b*; GREGORY & SIMPSON, 1926), and on the same day fragments of *Protoceratops andrewsi* were found. On the 1 August, the whole expedition went to Khashaat, to explore Paleocene outcrops, however, without many results. Only in one place indeterminate remains of mammals and tortoises were found.

2—3 August, further exploration was carried out at Bayn Dzak. SKARŻYŃSKI came across a big nest of dinosaur eggs, single bones of reptiles being also found. Between 4—29 of that month, the expedition worked in two independent groups. One (under SULIMSKI and DASHZEVEG) remained at Bayn Dzak, while the other consisting of KOWALSKI, DOVCHIN, GRADZIŃSKI, KUCZYŃSKI, MARYAŃSKA, WALKNOWSKI and KHORLOO, went in two trucks to the region south of the Gobi Altai range.

The course of work in Bayn Dzak

Between 4—29 August, the group stationed at Bayn Dzak concentrated on searching for Cretaceous mammals and lizards in the field of concretions at the foot of the Flaming Cliffs (see GRADZIŃSKI *et al.*, 1968, Text-fig. 29). LEFELD, during this period, carried out observations on the stratigraphy of the area (LEFELD, 1965). In 1964, 9 fragmentary skulls and jaws of Cretaceous mammals (Multituberculata and Insectivora) were found at Bayn Dzak (see KIELAN-JAWOROWSKA, 1968 *b*), as well as some 15 skulls of small lizards (see also GILMORE, 1943). 4 August, SULIMSKI and JAKUBOWSKI found a nearly complete skeleton of an ankylosaurid dinosaur of the genus *Pinacosaurus* (Pl. I, fig. 2) (GILMORE, 1933; see also MALEYEV, 1954), in a very good state of preservation, as well as the hind limbs and pelvic girdle of an unidentified armoured dinosaur. In addition, 2 skulls of *Protoceratops andrewsi*, a skeleton of a protoceratops with skull (GRANGER & GREGORY, 1923; GREGORY & MOOK, 1925; BROWN & SCHLAIKJER, 1940) and numerous single bones and fragments of skeletons of various dinosaurs were collected.

13 August, JAKUBOWSKI and a Mongolian driver left by truck for Ulan Bator, with part of the collection, returning to Bayn Dzak on the 20th.

The course of the western reconnaissance

On 4 August, the reconnaissance group left Bayn Dzak in two trucks for Bulgan, and then continued on to the south-west, crossing the Gobi Altai range on the following day. On the 8th, having covered 600 km from Bulgan, they found a hilly exposure of red sandstone, called Ulan Ganga, situated at a height of 1400 m (see Text-fig. 1). The area of surface exposed was about 25 sq. km. The outcropping beds represented sands and sandstone of a very vivid red colour, interbedded with grey sandstone and a conglomerate of limestone concretions. Numerous bones of small mammals were found here, mostly rodents of Oligocene age. In the lower parts of the outcrops, there were bones of large mammals, strongly mineralized and cracked. A few rhinocerotid jaw fragments were found among them (see BORSUK-BIAŁYNICKA, 1968).

At a distance of 25 km west of Ulan Ganga, the group came across salty swamps, marked on the map as Narin Bulak, the proper name, in the opinion of the Mongolian members of the group, being Zaram Bulak. North-west of the Zaram Bulak swamps there are clayey outcrops, situated at a height of 3008 m, at the foot of the Kharaat Ula range. On 9 August, the outcrops were explored. The remains of small insectivores, rodents and lagomorphs of Oligocene age were discovered here, among them one bigger specimen, a representative of Cylindrodontidae. The Zaram Bulak outcrops seem to be poor in fossil remains.

Traveling farther to the west, the group came to the village Zakhuy, situated on the outskirts of a great oasis of poplar woods and streams. On 10 August, DOVCHIN with a Mongolian guide went on a reconnaissance, south-east over the Endrengyeen Nuroo Range, to a wide plane, covered with scrub of dried saksaul. This is a waterless, pebbly desert, which stretches all the way to the Chinese frontier. The next day, they started on the return journey. Having recrossed the Endrengyeen Nuroo Range, they came on a small outcrop, situated 20 km east of Tsagan Derseen Khuduk. This is an outcrop (10 m high) of white sands and sandstone, interbedded with marls, yielding scarce and poor mammal remains. DOVCHIN found part of an ungulate tooth and some unidentifiable remains of other mammals and tortoise.

On the 12-th, the journey led westwards, to the foot of the picturesque granite mountains Khatan Khayrkhan. New outcrops were discovered a few kilometres east of the Khatan Khayrkhan Range, at a height of about 1200 m, in the sayr called Ulan Sayr. However, the exposure was called Khatan Khayrkhan by our expedition, as this was the name given on the map. It is a large exposure of Oligocene sediments, with a rich fauna of small mammals. Several hundred small specimens, belonging to numerous species of rodents, insectivores and lagomorphs, were collected in an interval of a few hours. It was the richest Oligocene outcrop encountered on the western reconnaissance. Next, the group proceeded further west, arriving in the evening at the foot of the Adz Bogd Mountains, at a place marked on the map as Altai. However, the Altai village has moved south and at present is situated in a different area, in its place is a cattle breeding-station called Buyn. 16 August, at Bungin Gol, 7 km from the settlement of Buyn, there is a large outcropping area, at a height of 2100 m. An Oligocene outcrop of red clay, gravel and sandstone yielded fauna of small mammals, while in a layer of brown clay, somewhat higher, infrequent, unidentified bones of large mammals were found. The next outcrop visited by the reconnaissance group, was situated 60 km west from Buheen

Gol, and called Khaytch, after the name of a spring, somewhat lower down. From this spring, a deep gorge stretches north-west, its right-hand wall made of metamorphic rock, its left, of Oligocene sediments. The 17 August, was spent exploring the Khaytch Oligocene sediments, which proved to be very poor in fauna. Infrequent bones, belonging probably to representatives of the families Cericctodontidae and Ctenodactylidae, as well as fragmentary bones of larger

mammals and lagomorphs were found. The next exposure examined was situated 15 km further south. This was an outcrop of brown clay, in which no fauna was found.

The next day, the group recrossed the Gobi Altai Range. On the northern side of the Gobi Altai, in one of the lower situated valleys, they came across a large (over 60 km in length), red outcrop, stretching from west to east, situated north of the village Khalyun, at the foot of Tayshireen Ula Range. 18—19 August were spent searching for fossils in this outcrop, which is at a height of 1700 m.

For the next days, the reconnaissance party passed through territory not interesting from the viewpoint of vertebrate palaeontology, arriving at Yessen Bulak. From Yessen Bulak, the journey continued eastwards through the districts of Dzag and Naryeen Tel. On 25 August, the reconnaissance party turned south and passing over a small mountain range, came to the Lake Valley. Along the northern slope of the valley, there are Oligocene outcrops. Exploration began at the most western outcrop, Buylstyeen Khuduk, situated at a height of 1600 m. This is the western part of the outcrops of the Hsanda Gol Formation. In this exposure, only some unidentifiable bone fragments were found. Not far to the south, is an Oligocene outcrop yielding typical Oligocene fauna (Cylindrodontidae, small artiodactyls and rodents). Further south in the same sayr are outcrops of Miocene sediments (brown clay and coarse sandstone), belonging to the Loh Formation (OSBORN, 1924*a*; GROMOVA, 1952*b*; BELAYEVA, 1952*b*). The concentration of bone remains in the sediments of the Loh Formation appears to be very low, only a rhinoceros tooth and fragments of tortoise shells were found. 26 August was spent exploring the Oligocene exposure of Tatal Gol (MATTHEW & GRANGER, 1923*a*, 1923*b*, 1924*a*, 1924*b*; GROMOVA, 1952*a*; VINOGRADOV & GAMBARYAN, 1952), which is a big series of red clay outcrops, cut obliquely by a 6 m thick layer of lava. About 600 partial skulls and jaws of small mammals were recovered here. On 27 August, the reconnaissance party moved eastward to the Hsanda Gol Sayr, 20 km distant from Tatal Gol, where there are large Oligocene outcrops of the same age as those in Tatal Gol. In the highest part of these outcrops, are poorly exposed Miocene sediments (greenish clay) of the Loh Formation. Nex day, the journey led north to the Onday Sayr outcrops, known from the American expeditions. Numerous remains of flora, fish and invertebrates were found. On 29 August, the members of the reconnaissance party returned to Bayn Dzak.

Further course of the expedition, after the two groups had united

On 31 August, the Mongolian group struck camp and proceeded to Dalan Dzadgad. One of the Polish trucks, loaded with collections, left Bayn Dzak for Dalan Dzadgad. KUCZYŃSKI, SULIMSKI, SKARŻYŃSKI, JAKUBOWSKI and WALKNOWSKI accompanied the collections, the first three remaining in Ulan Bator to prepare the equipment and collections for dispatch to Poland. JAKUBOWSKI and WALKNOWSKI returned to Bayn Dzak on 5 September, where the search for mammals and lizards had continued. On the 6th, the camp at Bayn Dzak was struck and, in turn, the expedition's store at Dalan Dzadgad. On 10 September, the members of the expedition arrived back in Ulan Bator with the rest of the collections. The Polish members of the expedition left Ulan Bator in three groups, respectively on the 14th, 19th and 26th of the month. The last group was back in Poland by 30 September.

1965 EXPEDITION

A considerable part of the equipment, including two trucks, had remained in Ulan Bator after the 1964 expedition. Additional equipment was sent from Warsaw on 10 April (including one extra Star 66 truck, a supply of petrol etc.), arriving in Ulan Bator on 7 May. On 13 May,

a delegation from the Polish Academy of Sciences, led by Prof. I. MALECKI, flew from Warsaw to Ulan Bator, to sign an agreement on co-operation between the Mongolian and Polish Academies of Sciences, for the years 1965 and 1966. The first author was among the members of the delegation. Between 17—19 May, talks were held between the Polish delegation and the authorities of the Mongolian Academy of Sciences, during which the programme of the 1965 expedition was discussed. It was foreseen that the expedition would divide into two groups and work simultaneously in two regions. One group would work all the time in the Nemegt Basin, and the other, for the first month, in Bayn Dzak; then both groups would meet in the Nemegt Basin, a small group proceeding to the Dzereg Valley in Western Mongolia (see Text-fig. 1).

The Polish members of the expedition arrived at Ulan Bator in two groups, on 19 and 26 May respectively. Preparation of the equipment and trucks for the road continued until 30 May. The Polish group hired a Tatra 111 truck, for transporting part of the equipment to the Nemegt Basin, and a Gaz 69 jeep, for short reconnaissances. During this time, the Mongolian members were occupied loading their two trucks for road. On 1 June, the Polish

group and part of the Mongolian group (leader DOVCHIN) left Ulan Bator for Dalan Dzadgad. The second Mongolian group (leader DASHZEVEG) went straight from Ulan Bator to Bayn Dzak, where they were to be joined by a Polish group. On 3 June, the Polish group arrived in Dalan Dzadgad, a store for the expedition was established and some of the equipment and petrol was deposited there. Between 5 June and 8 July, the expedition worked simultaneously in two regions: Bayn Dzak and the Nemegt Basin.

The course of work in Bayn Dzak

5 June, a five-person Polish group (KAŹMIERCZAK, LEFELD, MAŁECKI, the leader OSMÓLSKA and SICIŃSKI) left Dalan Dzadgad by Star 25 for Bayn Dzak, where they met the Mongolian group that had arrived earlier. The Mongolians (DASHZEVEG, ERDENIBULGAN, GALSAN and SHOMOODORZH) had already pitched camp on the steppe above the Flaming Cliffs. The Polish group set up their camp at the foot of the cliffs. Between 6—24 June, the members of the expedition searched for Cretaceous mammals and lizards in the field of concretions, at the foot of the Flaming Cliffs, which was called by our expedition the Main Field. During this period, two journeys were made to Khashaat (Gashato) to look for Paleocene mammals, but without success. At Bayn Dzak, a nest of 8 dinosaur eggs, 1 large and 2 smaller skulls of *Protoceratops andrewsi*, another skeleton of *Protoceratops* and numerous single bones of reptiles were found. The result of 3 weeks, almost daily searching of the Main Field, by several persons, yielded 5 specimens of mammals. Exploration was also carried out at a site called the Ruins, which is a monodnok-like hill of Cretaceous sandstone, situated at the foot of the main precipice at Bayn Dzak, 2.7 km west of the Main Field. One lower jaw of insectivore and lizard skulls were found. On 20 June, the Polish camp was moved up to the steppe, above the Flaming Cliffs. On 24 June, KIELAN-JAWOROWSKA, KUCZYŃSKI and WALKNOWSKI arrived in Bayn Dzak from the Nemegt Basin. KIELAN-JAWOROWSKA remained in Bayn Dzak, while the other two continued on to Ulan Bator with a part of the collected material. On 26 June, Prof. CEREV, Vice-President of the Academy of Sciences of the Mongolian People's Republic, visited the group at Bayn Dzak. The period 26 June — 4 July was spent in searching for mammals and lizards on the Main Field, at the Ruins and at a newly discovered small field of concretions called the Volcano, 4.7 km west of the Main Field, and situated at the foot of a volcano-shaped hill. At the Volcano, 3 insectivore skulls, as well as some skulls of small lizards, 2 skulls of small crocodiles (cf. MOOK,

1924), a nest of small, elongated dinosaur eggs (9 cm long, 3 cm wide) and single dinosaur bones were found. In the Ruins, further specimens of mammals and lizards were recovered. In all, during 1965, 16 specimens of mammals were recovered at Bayn Dzak, some almost complete skulls, the rest fragmentary lower and upper jaws. Five further specimens were later revealed in the laboratory, during the preparation of sandstone nodules from Bayn Dzak.

On 5 July, KUCZYŃSKI and WALKNOWSKI returned from Ulan Bator, followed the next day by a new Mongolian member of the expedition, the geologist BARSBOLD. The following day, the Polish group struck camp in Bayn Dzak, and accompanied by BARSBOLD, proceeded to the Nemegt Basin by way of Dalan Dzadgad. The Mongolians struck camp at Bayn Dzak on 6 July and went to Dalan Dzadgad to celebrate nadom, their national holiday. On the 8th, he Polish group from Bayn Dzak arrived to Altan Ula IV.

The course of work in the Nemegt Basin

On 5 June, a ten-person Polish group (GRADZIŃSKI, KIELAN-JAWOROWSKA, KUBIAK, KUCZYŃSKI, ŁEPKOWSKI, MARYAŃSKA, NOWIŃSKI, RACHTAN, SKARŻYŃSKI and WALKNOWSKI) left Dalan Dzadgad for the Nemegt Basin. The Mongolian group (led by DOVCHIN) remained behind to engage workers. The following day, the Polish group arrived at the Gurvan-Tes salt-mine, where the Tatra 111 truck was unloaded and the equipment carried by it stored. The Tatra was sent back to Ulan Bator. The two Polish Star 66 trucks continued on their way into the Nemegt Basin, arriving on the 7th at the western outcrops of Altan Ula (Altan Ula IV). The last part of the journey, led through a stretch of sand dunes and many hours were spent looking for a road through them. On arriving at the outcrops of Altan Ula IV from the western side, a search was made for a suitable road, down to the bottom of the gullies. As the first results proved unpromising, the first camp was set up on the flat surface of the pediment above the western edge of the Cretaceous precipice. One of the biggest problems of working at Altan Ula was the water supply. The nearest well was 40 km away through sand dunes; every 3—5 days a truck covered the journey to the well, bringing back a 600 litre supply of water.

On 8 June, a preliminary exploration of the Upper Cretaceous sandstone outcrops was undertaken. The following day, the Mongolian group drove to the camp accompanied by 2 workers from Dalan Dzadgad. They brought with them the Gaz 69 jeep, hired by the Polish group. The same day, a gently sloping ravine was found and down this it was possible to drive from the pediment eastward, to a field spread out at the bottom and of the Altan Ula gorge and gullies. A road was built in this ravine.

On 10 June, WALKNOWSKI and RACHTAN drove the Star 66 back to Dalan Dzadgad.

Two days later, DOVCHIN went by Gaz 63 to Gurvan Tes somon-village, about 40 km southwest of the Gurvan Tes salt mine, to hire workers. He returned 2 days later with 4 workers.

Between 10—23 June, the Upper Cretaceous beds of Altan Ula IV were explored, the most important findings being: an almost complete skeleton of a huge sauropod, about 20 m long (see Pl. III), found by GRADZIŃSKI in the northern part of the outcrops, a pelvic girdle of a large quadrupedal dinosaur, found by KUCZYŃSKI not far from the camp, and a partial backbone of a carnivorous dinosaur found by DOVCHIN. In addition, numerous single bones of various dinosaurs were found. The pelvic girdle found by KUCZYŃSKI was taken as a monolith, its weight about 2.5 tons.

During this time, two reconnaissance trips were made by jeep. On 10 June, a party of five persons went to Altan Ula III, where SKARŻYŃSKI found an incomplete skeleton (preserved in blocks of sandstone) of a large *Tarbosaurus* sp., about 12 m long. This skeleton was left

for future excavation. On 15 June, five persons left for two days reconnaissance at Nemegt, where KUCZYŃSKI found a fairly complete sauropod skull, 60 cm long. It was impossible to recover it at once, owing to the lack of suitable tools, as it was lying under a thick layer of sandstone. On 19 June, KUCZYŃSKI, SKARŻYŃSKI and WALKNOWSKI drove the Star 66 to Gurvan Tes, to collect some of the equipment left there, and on the way back, they stopped off at Nemegt and excavated the sauropod skull.

On 23 June, KIELAN-JAWOROWSKA, KUCZYŃSKI and WALKNOWSKI went by Star 66 to Bayn Dzak, KIELAN-JAWOROWSKA remaining there, while the two others continued on to Ulan Bator, conveying the first part of collections. At the same time, the hired jeep was sent back to Ulan Bator.

On the next day, the group under GRADZIŃSKI, which remained at Nemegt, moved camp to the open area at the exit of the main gorge of Altan Ula (Pl. I, fig. 1). The new camp was only 15 minutes journey from the sauropod skeleton. The period 25 June — 7 July was occupied with excavation of the sauropod skeleton and its transportation. This skeleton was found on a high ledge, in an area of gullies, inaccessible to motor transport. The nearest point reached by the trucks was about 580 m from the site. Transporting this skeleton, which weighed together with surrounding rock about 12 tons, was a considerable technical problem. Only some bones could be covered with plaster on the spot. The majority of bones, embedded in hard sandstone, had to be transported on sledges, improvised from empty petrol drums. At the site of the waiting trucks, a carpenter's shop was set up, where crates were made for individual bones. By the 7 July, the recovered sauropod had been transported to the trucks, but the task of packing and loading still remained. While the main work in this period was concentrated on the excavation of the sauropod skeleton, a group of five persons left for 2 days of exploration at Tsagan Khushu. Here GRADZIŃSKI and SKARŻYŃSKI found the skeleton of a large *Tarbosaurus* sp., excavation being left for a later period.

On 8 July, the Polish group from Bayn Dzak arrived at the camp in Altan Ula, accompanied by the Mongolian geologist Barsbold, in the new Gaz 63 truck, hired by the Polish group. For the next five days, all the Polish members of the expedition were together at the camp in Altan Ula. On the 9th, KIELAN-JAWOROWSKA found at Altan Ula III complete fore limbs and shoulder girdle of enormous size (limbs 2.5 m long) of an unknown carnivorous dinosaur, belonging evidently to a new family of theropod dinosaurs (see Pl. IV, fig. 1). 9—11 July were spent excavating and packing the fore limbs of the carnivorous dinosaur at Altan Ula III, and packing and loading the sauropod skeleton onto the trucks. This sauropod skeleton alone took up 35 crates, many of them weighing over 1 ton.

On 12 July, the Polish group divided once again, 5 persons leaving for Western Mongolia. The following people remained in the Nemegt Basin, till the end of the expedition: GRADZIŃSKI, KIELAN-JAWOROWSKA, LEFELD, MARYAŃSKA, MAŁECKI, NOWIŃSKI, ŁEPKOWSKI, RACHTAN and SICIŃSKI from the Polish side, and BARSBOLD, DOVCHIN, NAMSRAY and DZHAMBA from the Mongolian, together with 6 workers. Between 12—28 July, work continued at Altan Ula, and the trucks were constantly in use, transporting the crates with the collections to Dalan Dzadgad.

During this time, two *Tarbosaurus* skeletons which had previously been found (one at Tsagan Khushu, and one at Altan Ula III) were recovered. In addition, an incomplete skeleton of a large *Tarbosaurus*, found by RACHTAN in the northern part of the Altan Ula III outcrops, was excavated, and numerous fragmentary skeletons of various dinosaurs were found. The most important of these were: a pelvic girdle of a *Tarbosaurus*, a lower jaw of a *Tarbosaurus*, an incomplete small skeleton (without skull) of an ornithomimid dinosaur,

the latter found by SICIŃSKI, and the fragmentary skeleton of a large ankylosaurid dinosaur, found by LEFELD (see MALEYEV, 1952, 1954, 1956).

On 23 July, five persons went for 3 days to Tsagan Khushu and Naran Bulak to search for Paleocene mammals. Infrequent fragments of small mammals (Notoungulata, Insectivora and Lagomorpha), tortoise shells and crocodile teeth were found.

During the stay in Altan Ula, about 18 tons of fossil remains were collected and sent either to Dalan Dzadgad or to Ulan Bator.

On 28 July, the Polish and Mongolian camps at Altan Ula were wound up and the expedition moved to Nemegt, where it remained till 17 August.

27 July, DOVCHIN left for Ulan Bator with part of the collections to report to the Mongolian Academy of Sciences on the work of the expeditions, and to arrange for transportation of the collections from Dalan Dzadgad to Ulan Bator.

The first days in Nemegt were spent on preliminary exploration of the terrain, during which numerous single bones and fragments of dinosaur skeletons were found. On 31 July, MARYAŃSKA came across a well preserved skeleton of a large *Tarbosaurus*, about 14 m long (see Pl. IV, fig.2) not far from the camp; KIELAN-JAWOROWSKA found in a western sayr the skull and a considerable part of the skeleton of a small dinosaur, belonging to a new family of Ornitishia, and MAŁECKI came across in the north-west of the outcrops, part of the skeleton of a large *Tarbosaurus*. On the same day, SKARŻYŃSKI, NOWIŃSKI and BARSBOLD left to explore the Lower Nemegt Beds, considered hitherto as unfossiliferous, and found there fragmentary skulls of small lizards. During the stay in Nemegt, exploration of the Lower Nemegt Beds was undertaken many times in the hope of finding the remains of mammals. However, with the exception of lizards, egg shells and bone fragments of small dinosaurs, nothing else was found. 1—2 August, the skeleton of the small dinosaur of the order Ornitishia was recovered. BARSBOLD came across an incomplete skeleton of a small *Tarbosaurus*, near the camp, and MAŁECKI discovered a pelvic girdle of a large ornithomimid in a block of sandstone, also near the camp. In addition, he found the posterior limbs and some vertebrae of another ornithomimid dinosaur.

2 August, four persons left for Tsagan Khushu, for a further 2 days exploitation of the Paleocene beds there. They recovered some mammal, tortoise and crocodile remains which were rather scarce.

Between 3—11 August, the large *Tarbosaurus* skeleton, found by MARYAŃSKA, and a small *Tarbosaurus*, found by BARSBOLD, were excavated. On the 7th, DOVCHIN returned from Ulan Bator. On the 10th, work was begun on the excavation of the large, incomplete skeleton of a *Tarbosaurus* found by MAŁECKI. As this specimen was 6 km from camp, a truck was continually in use, transporting tools and packing material. However, on 11 August, the truck allotted to this task broke down, and as all the other trucks were on the way between Nemegt and Dalan Dzadgad, it was impossible to recover the whole skeleton, only one hind limb and part of the pelvic girdle being obtained.

On 12 August, MARYAŃSKA, NOWIŃSKI, ŁEPKOWSKI and SKARŻYŃSKI travelled to Dalan Dzadgad to prepare the fossils left there for final transportation to Ulan Bator. On the 13th, the Mongolian camp was struck, DOVCHIN and NAMSRAY left for Dalan Dzadgad, travelling of Gurvan Tes, to take the Mongolian workers home. Of the Mongolian members, only BARSBOLD remained until the Polish group wound up their camp on 17 August. They arrived in Dalan Dzadgad on 19 August. A crane was hired to help with the loading, which took two days to complete. The expedition finally left Dalan Dzadgad on 21 August, arriving in Ulan Bator on the 23rd.

The course of work in Western Mongolia

On 12 July, a five-person Polish group (KAŹMIERCZAK, KUBIAK, KUCZYŃSKI, the leader OSMÓLSKA and WALKNOWSKI) left by Star 66 for Western Mongolia. They arrived in Dalan Dzadgad on the 14th, where they met the Mongolian group led by DASHZEVEG (ERDENIBULGAN, GALSAN and a driver). On 21 July, they arrived to Begger Noor (RAZUMOWSKA, 1946), and the first camp was pitched near the Oligocene outcrops there. The next two days were spent in exploration. However, the Oligocene beds proved to be very poor, only a single cylindrodontid teeth being found. On 24 July, they came across Miocene outcrops (ROZHDESTVENSKY, 1954*b*) and the camp was moved to this site (GRADZIŃSKI *et al.*, 1968; Text-figs. 31—32). 24—26 July were spent searching for fossils in these outcrops, the remains of mastodonts (KUBIAK, 1968; see also BELAYEVA, 1952*b*), rhinocerotids and artiodactyls were recovered. On 26 July, KUCZYŃSKI and WALKNOWSKI went to Yessen Bulak, where they obtained permission from the local authorities for the whole group to enter the Dzereg valley, an area under quarantine. On 28 July, the Oligocene outcrops in the southern part of the Begger Noor Basin were examined and one cylindrodontid skull was found.

On 29 July, the camp at Begger Noor was struck, and the Polish and Mongolian groups proceeded farther west, arriving at Altan Teli two days later, where they set up their next camp. On 1 August, the bone-bed layer in the Pliocene sediments of Altan Teli was found (ROZHDESTVENSKY, 1954*b*; GRADZIŃSKI *et al.*, 1968, Text-figs. 33—35) and excavation was begun. Between 3—11 August, with the help of two workers (hired), 20 crates of fossils were collected at Altan Teli, mainly rhinocerotids of the genus *Chilotherium*, equids, gazellae and one rodent skull of *Pararhizomys hipparionum* (cf. KOWALSKI, 1968). About 1.5 km west of the

outcrops with mammalian fauna, in the same bone bed, tortoise remains were found (MŁYNARSKI, 1968). The 13th was spent in packing the specimens, some rhinocerotid skulls being taken as monoliths. On this day, the Mongolian group struck camp and proceeded to Ulan Bator, followed 3 days later by the Polish group. On 17 August, the collection from Altan Teli was stored in Ulan Bator and the Polish group returned to Dalan Dzadgad, to help with the transportation of the collection from the Nemegt Basin. However, the Star 66 of this group broke down and could not make the return journey to Ulan Bator. WALKNOWSKI and KUBIAK remained at Dalan Dzadgad, while the other members of the group returned in an other Polish truck to Ulan Bator. On 26 August, a new wheel was sent by plane from Ulan Bator for the damaged Star 66; WALKNOWSKI and KUBIAK, in the repaired truck, joining their colleagues in Ulan Bator on the 29th.

The period 23—31 August was spent in the Mongolian capital. A commission was formed consisting of KIELAN-JAWOROWSKA, OSMÓLSKA and GRADZIŃSKI on the Polish side, and SHAGDARSUREN, DOVCHIN and DASHZEVEG on the Mongolian, to divide the collected material between the Mongolian and Polish Academies of Sciences. On 31 August, the Polish share of the collections and their equipment were sent by train to Warsaw. The Polish members of the expedition left Ulan Bator in two groups on 1 and 3 September, arriving back in Warsaw on 3 and 6 September, 1965.

RESULTS OF THE EXPEDITIONS

During three years of field work, the Polish-Mongolian Palaeontological Expeditions assembled a collection of dinosaurs and mammals of a total weight of about 35 tons.

Among the most important scientific results are:

1. A collection (complete and incomplete skulls, fragments of jaws and mandibles) of Cretaceous mammals — insectivores and multituberculates — from the Upper Cretaceous beds, Djadokhta Formation at Bayn Dzak.

2. A collection of small Paleocene mammals (Insectivora, Lagomorpha and Notoungulata) from Naran Bulak and Tsagan Khushu in the Nemegt Basin, not previously known from this area.

3. A collection of Pliocene mammals and tortoises, known to Soviet expeditions, but not examined yet, from Altan Teli, Western Mongolia.

4. An almost complete skeleton of a large sauropod from the Upper Cretaceous beds of Altan Ula IV, Nemegt Basin, and an almost complete sauropod skull from the Upper Cretaceous beds at Nemegt.

5. Two ornithomimid skeletons with skulls from the Upper Cretaceous beds at Tsagan Khushu, Nemegt Basin, as well as some fragmentary ornithomimid skeletons from Altan Ula IV and Nemegt.

6. A collection of Upper Cretaceous armoured dinosaurs. This collection includes an almost complete skeleton with a very well preserved skull of *Pinacosaurus* sp. from Bayn Dzak and numerous more or less fragmentary skeletons of various armoured dinosaurs from Bayn Dzak and Nemegt Basin.

7. A skull and fragmentary post-cranial skeleton of a comparatively small dinosaur, belonging to a new family of the order Ornitishia.

8. Very large fore-limbs (length 2.5 m) and pelvic girdle of a representative of a new family of theropod dinosaurs, from the Upper Cretaceous beds of Altan Ula III, Nemegt Basin.

9. Six incomplete carnivorous dinosaur skeletons (from 4 to 14 m long), probably belonging to *Tarbosaurus bataar* (MALEYEV), from the Upper Cretaceous, in the Nemegt Basin.

10. A collection of about 30 lizard skulls and 2 crocodile skulls from the Upper Cretaceous beds (Djadokhta Formation) at Bayn Dzak.

11. Five new sites of Oligocene outcrops with mammalian fauna, discovered by the expeditions in the region south of the Gobi Altai Range.

12. Observations carried out by the geologists of the expeditions on the stratigraphy and sedimentation of the Upper Cretaceous beds of the Nemegt Basin and Bayn Dzak.

Palaeozoological Institute
of the Polish Academy of Sciences
Warszawa, November 1966

Biological Research Institute,
Mongolian Academy of Sciences
Ulan Bator, November 1966

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Photo: R. Gradziński

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Photo: J. Lefeld

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Excavation of a skeleton of *Tarbosaurus bataar* (MALEYEV) at Tsagan Khushu in 1964 17

Photo: R. Gradziński

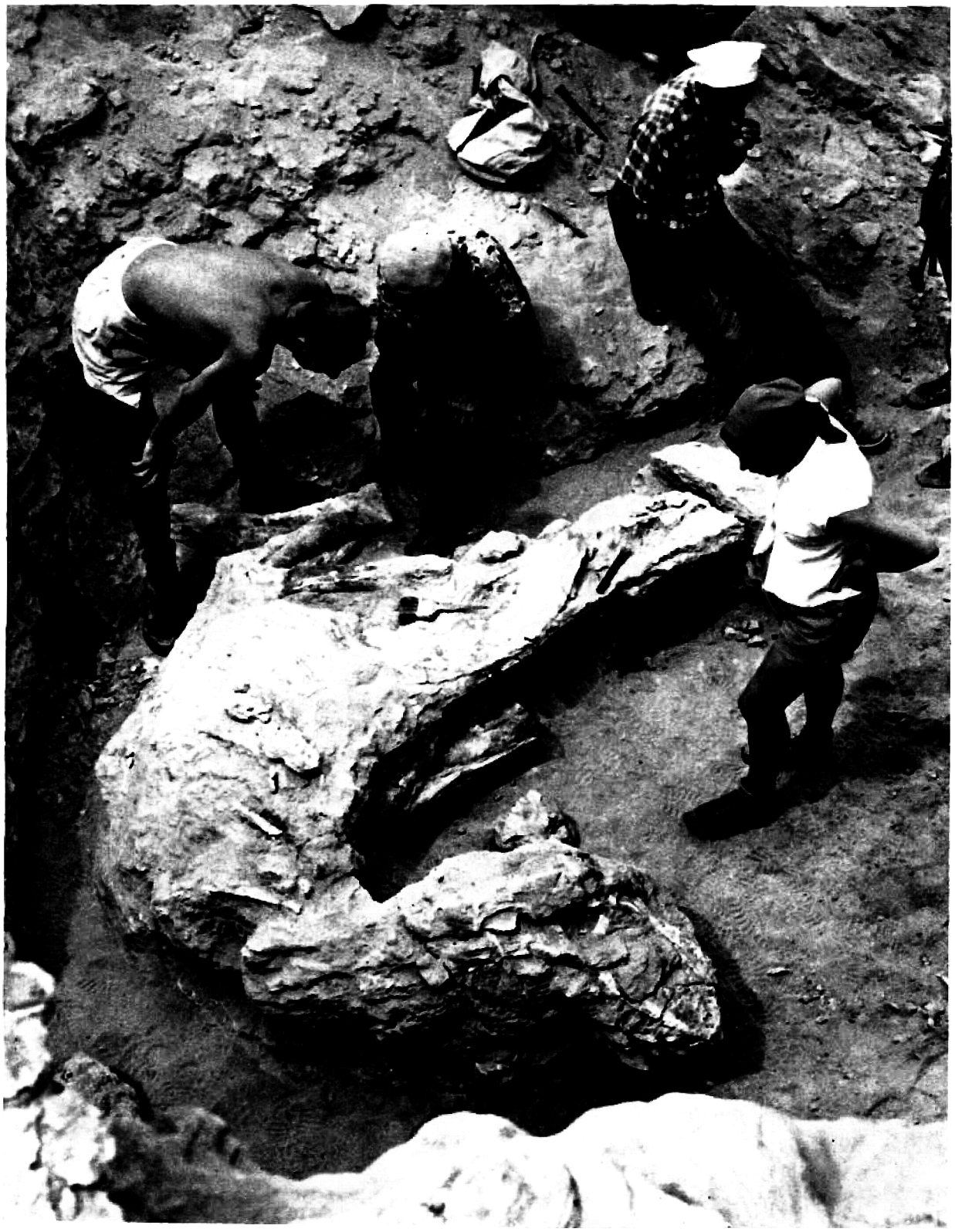

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Photo: W. Skarżyński

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Photo: R. Gradziński

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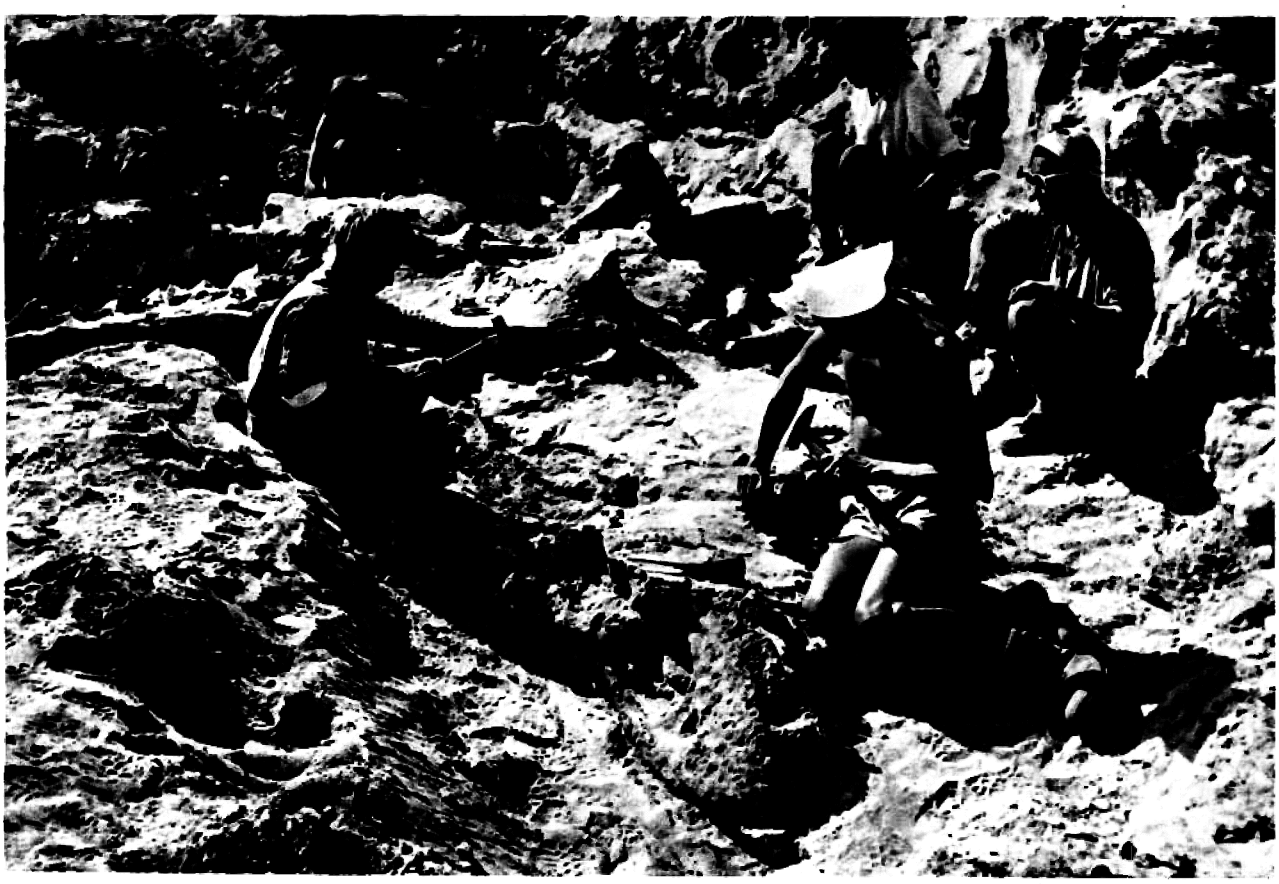

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