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PALAEONTOLOGIA AFRICANA

ANNALS OF THE
BERNARD PRICE INSTITUTE
FOR
PALAEONTOLOGICAL RESEARCH
UNIVERSITY OF THE WITWATERSRAND
JOHANNESBURG

VOLUME IX 1965

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REPORT OF THE HONORARY SCIENTIFIC DIRECTOR FOR THE YEAR ENDED MARCH 31, 1965

Accommodation

The year under review has been an outstanding one in the history of our Institute, which had its inception as a Foundation of Dr Bernard Price twenty years ago and became an Institute under its present title fifteen years ago. Throughout these years one of the major problems has been that of accommodation. Collections of fossil material have grown apace. The Institute has increasingly become a magnet attracting overseas and South African research workers to visit it, sometimes for months on end, in order to study in detail specific parts of its collections. The size of its scientific library has grown continuously, greatly by exchanges for its own publications, particularly its series of *Palaeontologia Africana*. And, finally, its sphere of activities has been enlarged beyond that of Karroo reptiles and Pleistocene mammalia, with which it was originally mainly concerned, to embrace both fossil plants and fossil invertebrates, so that it is now truly an Institute for Palaeontological Research in the fullest sense of the term.

Twenty years ago the Institute was housed in a smallish military hut kindly placed at its disposal by the Bernard Price Institute of Geophysical Research within the grounds of the University of the Witwatersrand. In 1951 it moved into two larger huts which were part of the temporary accommodation set aside for the University's Oral and Dental Hospital. A few years later these huts were filled almost to overflowing, and the Board of Control considered, together with the University Council, various plans for the erection of a new building on the University campus to meet at least some of the existing and foreseeable needs for adequate accommodation. It became evident, however, that the static building fund available from the Bernard Price bequest was quite inadequate to meet the rapidly soaring costs of building and, moreover, that the erection of small individual structures on the campus was contrary to the University's general programme of expansion.

The problem appeared to be insoluble. In 1963, however, the University re-assessed the whole position of hostel accommodation for its students and, in so doing, offered to the Institute possession of the building known as Douglas Smit House, which up to that time had been a hostel for Bantu students. This building had been made available to the University through the generosity of the Johannesburg City Council; it has been made available to us because of the interest which is being displayed in the work of the Institute.

Certain structural alterations and additions have been made to the fabric of the building which is constructed in such a manner that it will carry yet further additions when they become necessary. The Institute thus has, for its present needs, ample space for storing its collections, for administrative and research offices, for a small display museum, for development and preparation of specimens, for its library, its laboratories and dark-rooms, and space for lectures to students. Within the building, too, is a self-containd flat for occupation by a curator. At last, all the University's palaeontological research—vertebrate, invertebrate and botanical—can be carried on in the same building, with a common library and common services.

The transfer of the Institute's possessions from the huts to the new premises demanded intensive organization and much detailed planning, as well as a very considerable output of physical effort. In this connexion, it is impossible to sing too high a note of praise to Mr. J. W. Kitching, who converted himself into a slave to the Institute and particularly during the month of December worked from early morn to midnight in order to meet the University-imposed dead-line for the complete clearing of the huts. Many of the problems encountered during the course of building operations also fell to him and were competently solved.

The Rubidge Collection

The Institute has, from its inception, maintained close contact with Dr S. H. Rubidge, of Wellwood, Graaff Reinet who, from his personal interest in the subject and entirely at his own costs, has built up at his home a fabulous collection of Karroo fossil reptiles and amphibia which includes a considerable number of types and other figured specimens. In order to safeguard this collection for the future, Dr Rubidge has offered its scientific curatorship to the Institute in exchange for provision by him at Wellwood of certain facilities which, in effect, will give the Institute a field station in the centre of a prolific fossil-producing area. The collection itself will remain at Wellwood. This partnership between the Institute and Dr Rubidge and his successors in title is a source of gratification to us. An account of this collection follows this report in the present issue of *Palaeontologia Africana*.

Researches

In brief, the Institute can now be accepted as composed of the following divisions of research:

Quaternary Vertebrates (under Prof. R. A. Dart).

Karroo Vertebrates (under Dr A. S. Brink).

Palaeobotany (under Dr Edna P. Plumstead).

Invertebrate macro- and micro-fossils (under Dr G. Hart), with Dr Brink as Assistant Director.

The divisions under Drs Plumstead and Hart have been transferred physically from the University's Department of Geology building. For co-ordinated research into both the geology and palaeontology of the Karroo and other fossiliferous systems, which has economic as well as purely scientific aims, the Institute is now more fully equipped than at any time in the past.

A. *Quaternary Mammalia*

The Institute is the appointed guardian of the palaeontological aspect of the Sterkfontein caves, which are now the property of the University of the Witwatersrand and are, with the property surrounding them, a proclaimed National Monument. But the chief of our interests in this field is centred on the bone-bearing deposits at the Makapansgat sites, where the Institute has enjoyed sole rights of excavation, and where it has a well-equipped field station. From this area the collection at the Institute contains some 100,000 catalogued bone specimens; and it is estimated that the many tons of as yet undeveloped breccia at its disposal may possibly yield another million specimens.

Professor Dart has five rooms in the new building as offices, laboratory and store-rooms. His work appears to have proceeded without the upsets normally associated with a change of headquarters and is, of course, closely bound up with that of the Institute for the Study of Man in Africa. Preparation of material for study is done by trained Bantu workers whose wages are paid from funds allocated to Professor Dart for the purpose by the C.S.I.R. and other outside organizations. The environment in which this essential work of preparation is performed is much more pleasant and spacious than in the old huts.

It is the palaeo-anthropological work of Professor Dart and his associates that particularly draws numbers of overseas scientific visitors to the Institute and has focussed the attention of grant-giving bodies on its operations with gratifying results. Although the world-famous specimens of early hominids from the cave deposits of the Krugersdorp area are housed in the Transvaal Museum in Pretoria, the Institute's collection contains the original "Taungs baby" and a number of important skull and other fragments from the Makapansgat deposits in addition to the worked bone, teeth and horn tools on which Professor Dart founded his descriptions of an "osteodontokeratic culture".

B. *Palaeontology of the Karroo System*

As already indicated, the assembling within one building of vertebrate studies, of palaeobotanical investigations, and of micropalaeontological work on Karroo fossils, has opened up a new vista for research on the history of Karroo times in Southern Africa. In addition, detailed sedimentological studies are being made by workers attached to the University and by others. To understand more fully the mode of origin of a body of sediments some 25,000 feet thick preserved in a continental basin whose longest known diameter is at least 800 miles and to appreciate the conditions under which vertebrates, invertebrates and plants lived during the 100 million or so years that this sedimentation was

being effected demand such a conjoint palaeontological-geological study. And this large so-called Karroo basin is merely one of several basins of the same age scattered through Southern Africa, each of which should be subjected to similar intensive study. It must not be forgotten that these basins are the repositories of our coal resources and that other hydrocarbons may occur within them; consequently, our investigations have a potential economic importance.

Continuation of the work on Karroo vertebrates has to some extent been hampered by the operation attendant upon the change of domicile. Dr Brink has, however, devoted as much time as he could spare from administrative and supervisory duties to the preparation of descriptive papers for inclusion in a new volume of *Palaeontologia Africana* which it is hoped to produce as a 20th anniversary number. Miss Mendrez, of Paris, worked in the Institute for some months on a collection of Whaitsiid skulls, including 12 specimens borrowed from the Rubidge collection. She has returned to Paris and is now busy writing up her observations and conclusions in a doctoral thesis, an abstract of which she will send to us for publication.

Field collecting of Karroo vertebrates has not been entirely neglected during the year. During May, Mr J. W. Kitching accompanied Dr N. J. Hotton, of Washington, D.C., in an examination of outcrops of the upper part of the *Cistecephalus*-zone, of the *Lystrosaurus*-zone and of the *Procolophon*-zone in the area lying between Graaff Reinet and Middelburg, C.P. Dr Hotton's major interest was in the detailed stratigraphy of these beds; but a rich haul of fossils was made. Dr H. D. le Roex, of the Anglo-Transvaal Mining Company, drew our attention to the existence of bones on the farm Nooitgedacht in the Springfontein district, O.F.S., belonging to Mr C. W. Hill. Mr Kitching arranged to spend ten days there and collected a number of important specimens from the *Lystrosaurus*-zone, including one giant skull of the type genus and a number of baby skulls with partial skeletons.

The fossil plant collections of the University are now transferred from the Geology Department to the Institute. They include the Leslie collection, the much larger Le Roex collection, and all the material gathered through the efforts of Dr Plumstead. For a considerable portion of the year under review she has been overseas, attending Congresses and working through various collections of South African Karroo plants and allied materials from other continents, partly assisted financially by the C.S.I.R. Her work, as well as that of Dr George Hart on spores and other micro-organisms, and that of Mr P. Ryan on sedimentary features of the deposits, is throwing additional light on the history of the Karroo basin and the origin of its hydrocarbons. The study of the sediments themselves over their enormous outcrop is an immense task. Many hundreds of measurements of the direction of current-bedding, in successive horizons, have to be taken within a small area; size grading of the grains within these sediments has to be calculated; and conclusions have to be drawn concerning the directions and mode of transport of the material and the sources from which it was derived. This field of study has attracted but spasmodic attention

in the past, but it is essential for proper understanding of the Karroo system. Financial support is being provided for it by one of the major mining groups.

C. *Invertebrate Palaeontology*

Investigations undertaken, both in the past and at present, by the Geological Survey and certain of the museums have yielded a considerable quantity of data concerning the macro-fossils of the various marine sediments found in South Africa that are chiefly of Devonian, Cretaceous, Tertiary and Quaternary age. Less, however, is known of the micro-fauna and micro-flora of these deposits, a field of study which may prove to be of economic importance. The first work of this nature within the University was that on foraminifera done some years ago by Dr Yvor Smitter, now of New York. The foundation within the Department of Geology, with the assistance of mining groups, of a unit for micro-palaeontological work under Dr George Hart permitted more intensive study to be made of both outcrop and borehole material. Miss de Gasparis of Italy is working in the Institute particularly on the foraminifera of the marine Cretaceous rocks of Zululand, where prospecting for sources of oil is being undertaken. In addition, Mr R. Pienaar is undertaking a study of the phytoplankton of the same rocks. Both lines of study in the Zululand rocks are being financed by one of the major mining groups.

In addition to various papers, Dr Hart has written for publication a text-book entitled "The Systematics and Distribution of Permian Miospores".

Teaching

It is of moment to draw attention to the close collaboration between the Institute and the Department of Geology of the University. The prime function of a research organization is to undertake research; but the results of such research, if they are to be of benefit to others than the researcher, must be communicated. This communication can be effected through the printed word; but it can also be made through the spoken word. The University student, particularly the post-graduate student, should be given the opportunity of acquiring specialist knowledge at first-hand from the research worker. It is therefore a matter for congratulation that workers in the Institute are enabled to partake in the teaching activities of the University and thus play a role in the training of the scientists of the future. Current policy thinking is opposed to the total separation of research from teaching and of teaching from research.

The Future

Palaeontology is a discipline that embraces the study of those life forms that have inhabited the earth prior to the present day and, as such, depends for its progress on the discovery of remains of such life forms in rocks of various ages. Its first requisite, therefore, is the systematic collection of fossil material for

examination, a task that demands adequate provision for transport and field living, which the Institute is fortunate to possess. This material, be it of animal or vegetable origin, can be classified and compared with already known forms whose place in the geological succession has been determined. If studied solely as morphological specimens, fossils are of interest primarily to the systematist and biologist. In conjunction with stratigraphical evidence, however, they throw considerable light upon such subjects as the procession of life forms in time and the condition in which the beings they represent probably lived and certainly died and were buried. Important conclusions regarding the mode and time of deposition of the material that formed the rocks in which they are found can be logically deduced, conclusions that may be of practical value. It is this broad aspect of the implications of palaeontological studies that the Institute has continually in view and, with its new "set up", it can scarcely lose sight of it while men and money are available. Palaeontology is no longer merely a study of dead fragments; it is a study of once-living organisms, of the environment in which they lived, of their rise and fall, and of their interrelationships and interactions. It is a study of *life* through six hundred million years, a "social science" in the broadest sense.

THE RUBIDGE COLLECTION OF FOSSIL KARROO VERTEBRATES

By S. H. Haughton, F.R.S.

Wherever palaeontologists interested in fossils from the strata of the Karroo system discuss the systematics and evolutionary importance of Permian and Triassic vertebrates they perforce have to consider the facts that have been revealed by studies of the hundreds of specimens forming what is known as the "Rubidge Collection".

Housed in the family home on the farm Wellwood in the district of Graaff-Reinet, Cape Province, this magnificent collection has been gathered together by the enthusiasm and generosity of one man—Sidney H. Rubidge, farmer and Honorary Doctor of Science of the University of the Orange Free State. Among those who deserve the honoured title of "amateur", one who pursues a hobby for pure love and without thought of material gain, Dr S. H. Rubidge must rank very high.

The name Rubidge was not by any means unknown to Science before Sidney added lustre to it. Among the associates of, and collaborators with, Andrew Geddes Bain—the "father of South African geology"—was Dr Richard Nathaniel Rubidge, who had come in 1821, at the age of two years, with his father to South Africa from Wales, beginning his South African life in Grahamstown. He became the leading medical doctor in Port Elizabeth and was a co-founder of the Provincial Hospital in that city. He was also an ardent botanist as well as an enthusiastic collector of fossils, especially of the Cretaceous fossils of the Uitenhage basin. He sent collections, from both the Cretaceous and Karroo beds, to London and also had papers on various aspects of South African geology published by the Geological Society of London, of which he was a Fellow, including one of the occurrence of gold in dolerite dykes at Smithfield in the Orange Free State and another in which he gives his own interpretation of the relations of the various formations in the Ceres area. Some of the fossils, both plants and invertebrates, in these collections became types of new species.

This Dr R. N. Rubidge was an uncle of S. H.'s father (also named Richard) and the grand-nephew relates, in his modest reminiscences published in 1956 in the Bulletin of the South African Museums Association, the memories of his father concerning this "professional-clad figure, frock-coated and starch-shirted" searching the ridge adjacent to the house on Wellwood in quest of "inlaid bones". To reach Wellwood from Port Elizabeth required a journey by ox-wagon occupying ten days. One hundred years later it takes but a few hours by car.

The founder of the present collection was born on May 31, 1887. After matriculating in his eighteenth year he was, as he records, "put to farming" with manual labour associated with the business of breeding Merino sheep as his chief occupation for the next twelve years. As a schoolboy he had seen his father pick up a slab of shale in which was embedded a fossil bone; this aroused

his curiosity. His father told him "this is thousands and thousands of years old"; but he could find no answer at that time to the problem of how hard bone became mixed with hard stone. When, as a farmer, he began to "ride the ranges", in addition to keeping a sharp look-out for predators among the sheep grazing within their fenced areas he found, and took home with him, more stones with embedded bones.

The most important part of the collection, however, can be said to have its beginning in 1934. Dr Rubidge, in a letter to the author, has described the story of this episode in the following manner: "Several years elapsed, and in fact I had entirely forgotten about the earlier interest—and most probably it would have remained forgotten had I not been blessed with a little daughter endowed with a lively curiosity. To this child Peggy must justly be ascribed all of whatever credit may be attached to the origin, or founding, of the 'Rubidge Collection' of fossils. Peggy was ten years of age and was spending her 1934 Easter holidays with some of her school friends at home when one Sunday morning she enquired: 'Daddy, what are fossils?' To hide my ignorance I replied: 'Let us go for a picnic at the gravel ridge and then see if you can find any.' Soon after arriving at the site many outcrops were discovered and a large rock was brought home which revealed what appeared to be three parallel bones at its extreme tip and which later proved to be the slightly weathered front teeth of a toothy skull."

The excited father spent his spare time for the next month in "knocking away the matrix with a large carpenter's hammer and a broad steel chisel" (a primitive method of development compared with present-day techniques) and finally exposed to view the anterior half of the large Gorgonopsian skull that Broom, in 1936, made the type of a new genus and species *Dinogorgon rubidgei*. This was the spark needed to kindle into flame the latent fires of enthusiasm. Rubidge states that he had now found an interest that obsessed him, although he felt bound in honour to give first place to "the curatorship and upkeep of an old estate dating back to the original British Settlers" to which he had succeeded and to the need for "placing work and duty before any personal inclination that I might desire to follow instead".

This "work and duty" took up most of his time, and opportunities to undertake the journeys necessary in a search for fossils were few and far between. However, he enlisted the co-operation of the late C. J. Kitching, an energetic overseer of road construction who by reason of his occupation had his week-ends free "to go fossil-hunting". In this he had the assistance of four young sons, the eldest of whom, James, has since then acquired international fame as a collector of fossils *par excellence*. C. J. Kitching would, with his family, range far and near by car during week-ends, collect everything that he or they could see, and carry his finds back to Wellwood for inspection. Dr Rubidge would make an appraisal of the finds, valuing them according to a rough and ready but mutually acceptable classification, and exchange the rocks for a cash disburse-

ment, both parties to the transaction feeling that they had been adequately rewarded.

Robert Broom first visited Rubidge in April, 1934, and maintained contact with him to the date of his death in 1951. Rubidge was greatly impressed with Broom's erudition and was strengthened in his desire to collect and preserve by encouragement that he received from this savant and the assurance from him that he was undertaking a worth-while task. Broom made known to the world of science, in numerous publications, the many hitherto unknown genera and species that were annually being added to the collection as a result of field-work by Rubidge himself, by one or more of the Kitching family, or by their conjoint efforts. He paid many visits to Wellwood and maintained a frequent exchange of letters with the owner of the collection, which was visited by a number of renowned palaeontologists from overseas countries. It was a source of pleasure to Dr Rubidge that one of them, Prof. D. M. S. Watson, should write: "There is no parallel to the building up, in some ten years, of so magnificent a series of fossil reptiles, essentially from one set of rocks, by any one man who is actively engaged in the management of a difficult farm".

From the time of its foundation, the Bernard Price Institute for Palaeontological Research has maintained close contact with Dr Rubidge, a contact made easier by the fact that its chief Field Officer, Mr James Kitching, has been closely associated from boyhood with the building-up of the collection. During the past ten years or more, Dr Rubidge has freely made available to scientists working either permanently or temporarily in the Institute treasures from his store for development and detailed study. In his enthusiasm for making known to the world the existence of new species of Karroo vertebrates, Broom was inclined to remove from a specimen just sufficient matrix to disclose what to him were diagnostic features. The proper development of many of the specimens to a stage at which morphological features of one can be closely compared with those of another is a tedious and skilled task, one that can effectively be undertaken only in a properly equipped laboratory. The opportunities that Dr Rubidge has afforded the Institute for this detailed work and study of specimens highly treasured by him have greatly enhanced the scientific value of these specimens and further placed the world of Science in his debt.

It is a source of pride to the Institute, its Board of Control, and its officers, that Dr Rubidge has arranged for yet closer collaboration between him and them. The Rubidge Collection, with his approval and that of his son who will succeed to the ownership, will be permanently and adequately housed at Wellwood. The Institute will exercise scientific control over it, prepare and maintain proper catalogues, and see that its integrity is preserved. Study of individual specimens will be subject to the Institute's supervision. Provision will be made at Wellwood for field headquarters for the Institute's staff. For its part, the Institute gives the assurance that it will do its utmost to arrange that the collection will be a lasting tribute and memorial to a South African who enthusiastically devoted himself, his thought and his competent energy to the preservation of

one part of his country's scientific treasures without thought of material gain. Dr Rubidge himself has written: "I value not what I have done. I set much greater store by the fact that, because I have done it, others following where I shall have been forced to leave off may, in their turn, advance the science of palaeontology even further and to much greater heights of scientific achievement".

Some idea of what he has done may be gleaned from a perusal of the following list of type and described specimens in the collection. It must be emphasized that this is merely a list of the described and figured specimens—the Pièces d'Honneur, as it were, of the collection; there are, in addition, some hundreds of specimens that await preparation and classification and that will add to the sum total of our knowledge of what is, essentially, a local fauna within the history of the Karroo vertebrates. It is, in effect, from the district of Graaff-Reinet and the adjoining districts of Murraysburg and Richmond that the bulk of the collection was gathered in perforce hurried visits to "productive patches" that had not previously been searched by others. The number and variety of forms picked up at the surface on these visits go far to substantiate Rubidge's "boast" to Broom that his "home district" would prove to be the "most prolific" fossil-bearing area in the whole expanse of the Karroo strata.

Here follows a classified list, prepared by Mr James Kitching, of the type and described specimens in the collection, in the following standard order: Number : Generic and Specific name : Author : Family name : Collector : Date : Horizon : Locality : Brief description : Bibliographic reference.

R.C. 1 : *Dinogorgon rubidgei* Broom (gen. et sp. nov.) : Rubidgeidae : Peggy Rubidge and Frank Collins : April 1934 : *Cistecephalus*-zone : Wellwood : Anterior half of large gorgonopsian skull with lower jaw : Broom, R., 1936, *Ann. Transv. Mus.*, xviii, p. 373, fig. 19.

R.C. 2 : *Galerhinus rubidgei* Broom (sp. nov.) : Gorgonopsidae : S. H. Rubidge : 1934 : *Cistecephalus*-zone : Wellwood : Small skull with lower jaw : Broom, R., 1936, *Ann. Transv. Mus.*, xviii, p. 375, figs. 20, 21.

R.C. 3 : *Spondylolestes rubidgei* Broom (gen. et sp. nov.) : Procolophonidae : S. H. Rubidge : 1936 : *Cistecephalus*-zone : Bethesda Road : Small imperfect skull with lower jaw : Broom, R., 1937, *Proc. zool. Soc.*, p. 299, fig. 1.

R.C. 4 : *Galerhynchus rubidgei* Broom (gen. et sp. nov.) : Gorgonopsidae : C. J. Kitching : 1937 : *Cistecephalus*-zone : Blaaukrantz, Graaff Reinet : Small skull with lower jaw : Broom, R., 1937, *Proc. zool. Soc.*, p. 303, fig. 4.

R.C. 5 : *Procynosuchus delaharpeae* Broom (gen. et sp. nov.) : Procynosuchidae : Lorraine de la Harpe : — : *Cistecephalus*-zone : The Glen, Graaff-Reinet : Small skull without lower jaw : Broom, R., 1937, *Proc. zool. Soc.*, p. 314, fig. 14.

R.C. 6 : *Ictidosuchoides rubidgei* Broom (gen. et sp. nov.) : Ictidosuchidae : S. H. Rubidge : 1936 : *Cistecephalus*-zone : Wellwood : Two-thirds of small skull : Broom, R., 1937, *Ann. Transv. Mus.*, xix, p. 141, fig. 6A.

R.C. 7 : *Cyniscops rubidgei* Broom (gen. et sp. nov.) : Gorgonopsidae : S. H. Rubidge : 1937 : *Cistecephalus*-zone : Wellwood : Small skull without lower jaw : Broom, R., 1937, *Ann. Transv. Mus.*, xix, p. 143, fig. 4. (Not R.C. 74 from New Bethesda as listed in the bibliographical list of Haughton and Brink, 1954.)

R.C. 8 : *Palemydops rubidgeae* Broom (sp. nov.) : Endothiodontidae : Peggy Rubidge : 1937 : *Cistecephalus*-zone : Wellwood : Small anomodont skull : Broom, R., 1937, *Ann. Transv. Mus.*, xix, p. 143, fig. 6B, C.

R.C. 9 : *Dinanomodon rubidgei* Broom (gen. et sp. nov.) : Dicynodontidae : C. J. Kitching : Feb. 1938 : *Cistecephalus*-zone : Stylkrans, Graaff Reinet : Very large anomodont skull without lower jaw : Broom, R., 1938, *Ann. Transv. Mus.*, xix, p. 247, figs. 1, 2.

R.C. 10 : *Pelanomodon rubidgei* Broom (gen. et sp. nov.) : Cryptodontidae : C. J. Kitching : 1938 : *Cistecephalus*-zone : Kareelaagte, Graaff Reinet : Medium-sized anomodont skull : Broom, R., 1938, *Ann. Transv. Mus.*, xix, p. 249, fig. 3.

R.C. 11 : *Ictidosuchops* (*Ictidosuchoides*) *intermedius* (Broom) (sp. nov.) : Ictidosuchidae : C. J. Kitching : 7 Dec. 1938 : *Cistecephalus*-zone : New Bethesda river bed : Anterior half of skull : Broom, R., 1938, *Ann. Transv. Mus.*, xix, p. 257, figs. 1-3.

R.C. 12 : *Procynosuchus rubidgei* Broom (sp. nov.) : Procynosuchidae : S. H. Rubidge and party : 1938 : *Cistecephalus*-zone : Afrikanerskloof, Graaff Reinet : Small cynodont skull without lower jaw : Broom, R., 1938, *Ann. Transv. Mus.*, xix, p. 283, figs. 4-8A.

R.C. 13 : *Rubidgea atrox* Broom (gen. et sp. nov.) : Rubidgeidae : C. J. Kitching : 1938 : *Cistecephalus*-zone : Dorsfontein, Graaff Reinet : Very large gorgonopsian skull with lower jaw : Broom, R., 1938, *Proc. zool. Soc.*, p. 527, figs. 1, 2.

R.C. 14 : *Milleretta* (*Millerina*) *rubidgei* (Broom) (gen. et sp. nov.) : Milleretti-dae : (*a*) S. H. Rubidge and party : 1938 : *Cistecephalus*-zone : Wel-tevreden, Graaff Reinet : Small captorhinomorph skull with lower jaw : Broom, R., 1938, *Proc. zool. Soc.*, cviiiB, p. 535, figs. 1-4. (*b*) C. J. Kitching : 1940 : *Cistecephalus*-zone : Grootdriefontein, Murraysburg : Skull slightly smaller than R.C. 14(*a*).

R.C. 15 : *Millerinoides acutirostris* Broom (gen. et sp. nov.) : Millerettidae : S. H. Rubidge : 1938 : *Cistecephalus*-zone : Wellwood : Very small captorhinomorph skull with lower jaw : Broom, R., 1940, *Ann. Transv. Mus.*, xx, p. 71, fig. 1.

R.C. 16 : *Nanictocephalus richardi* Broom (gen. et sp. nov.) : Scaloposauridae : S. H. Rubidge : 1 Apr. 1938 : *Cistecephalus*-zone : Doornplaas, Graaff Reinet : Very small skull with lower jaw : Broom, R., 1940, *Ann. Transv. Mus.*, xx, p. 72, fig. 2C.

R.C. 17 : *Paracynosuchus rubidgei* Broom (gen. et sp. nov.) : Procynosuchidae : S. H. Rubidge and party : 1938 : *Cistecephalus*-zone : Grootdriefontein, Murraysburg : Small cynodont skull without lower jaw : Broom, R., 1940, *Ann. Transv. Mus.*, xx, p. 73, fig. 2A, B, D.

R.C. 18 : *Scaloposuchus rubidgei* Broom (gen. et sp. nov.) : Scaloposauridae : C. J. Kitching and party : 1939 : *Cistecephalus*-zone : Osfontein, Graaff Reinet : Small skull with lower jaw : Broom, R., 1940, *Ann. Transv. Mus.*, xx, p. 73, fig. 3A-C.

R.C. 19 : *Broomisaurus rubidgei* Broom (sp. nov.) : Gorgonopsidae : C. J. Kitching : 1938 : *Cistecephalus*-zone : Doornberg, Graaff Reinet : Medium sized skull without lower jaw : Broom, R., 1940, *Ann. Transv. Mus.*, xx, p. 75, figs. 4, 5.

R.C. 20 : *Hipposauroides* (*Hipposaurus*) *rubidgei* (Broom) (gen. et sp. nov.) : Ictidorhinidae : S. H. Rubidge : 1938 : *Cistecephalus*-zone : Wellwood : Small skull without lower jaw : Broom, R., 1940, *Ann. Transv. Mus.*, xx, p. 77, figs. 6, 7.

R.C. 21 : *Scylacocephalus watermeyeri* Broom (gen. et sp. nov.) : Gorgonopsidae : G. H. Watermeyer : 1938 : *Cistecephalus*-zone : Grootdriefontein, Murraysburg : Small skull with lower jaw : Broom, R., 1940, *Ann. Transv. Mus.*, xx, p. 79, figs. 8, 9.

R.C. 22 : *Dicynodon macrodon* Broom (sp. nov.) : Dicynodontidae : G. H. Watermeyer : 1938 : *Cistecephalus*-zone : Grootdriefontein, Murraysburg : Anomodont skull without lower jaw and with good tusks : Broom, R., 1940, *Ann. Transv. Mus.*, xx, p. 81, fig. 10A, B.

R.C. 23 : *Dicynodon cadlei* Broom (sp. nov.) : Dicynodontidae : S. H. Rubidge and party : Apr. 1938 : *Cistecephalus*-zone : Hoeksplaas, Murraysburg : Anomodont skull without lower jaw : Broom, R., 1940, *Ann. Transv. Mus.*, xx, p. 82, fig. 11.

R.C. 24 : *Aulacephalodon* (*Aulacocephalodon*) *rubidgei* Broom (sp. nov.) : Aulacephalodontinae : S. H. Rubidge and party : 28 Apr. 1938 : *Cistecephalus*-zone : Wimbledon, Graaff Reinet : Large dicynodont skull without lower jaw : Broom, R., 1940, *Ann. Transv. Mus.*, xx, p. 203, fig. 13.

R.C. 25 : *Platycyclops latirhinus* Broom (sp. nov.) : Cryptodontidae : S. H. Rubidge and party : 28 Apr. 1938 : *Cistecephalus*-zone : Wimbledon, Graaff Reinet : Anterior two-thirds of large anomodont skull : Broom, R., 1940, *Ann. Transv. Mus.*, xx, p. 85, fig. 14.

R.C. 26 : *Platycyclops rubidgei* Broom (sp. nov.) : Cryptodontidae : S. H. Rubidge and party : 11 Apr. 1938 : *Cistecephalus*-zone : Grootdriefontein, Murraysburg : Very large anomodont skull without lower jaw : Broom, R., 1940, *Ann. Transv. Mus.*, xx, p. 85, fig. 15.

R.C. 27 : *Nanictosuchus melinodon* Broom (sp. nov.) : Galesauridae : S. H. Rubidge and party : 1938 : *Cistecephalus*-zone : Klipfontein, Graaff Reinet : Small imperfect cynodont without lower jaw : Broom, R., 1940, *Ann. Transv. Mus.*, xx, p. 85, fig. 16.

R.C. 28 : *Pareiasaurus rubidgei* Broom (sp. nov.) : Pareiasauridae : C. J. Kitching : 1938 : *Cistecephalus*-zone : Oudeberg, Graaff Reinet : Large cotylosaur skull with lower jaw, cervical vertebrae and inter-clavicle : Broom, R., 1940, *Ann. Transv. Mus.*, xx, p. 157, fig. 1.

R.C. 29 : *Polycynodon* (*Octocynodon*) *elegans* (Broom) (gen. et sp. nov.) : Scaloposauridae : S. H. Rubidge and party : 10 Apr. 1938 : *Cistecephalus*-zone : Modderfontein, Middelburg : Anterior two thirds of skull with lower jaw : Broom, R., 1940, *Ann. Transv. Mus.*, xx, p. 160, fig. 3.

R.C. 30 : *Ictidosuchops baurioides* Broom (sp. nov.) : Scaloposauridae : S. H. Rubidge and party : 29 Apr. 1938 : *Cistecephalus*-zone : Zuurplaas, Graaff Reinet : Small skull with lower jaw : Broom, R., 1940, *Ann. Transv. Mus.*, xx, p. 163, fig. 6.

R.C. 31 : *Pelictosuchus paucidens* Broom (gen. et sp. nov.) : Scaloposauridae : S. H. Rubidge : 1938 : *Cistecephalus*-zone : Wellwood : Anterior two-thirds of skull : Broom, R., 1940, *Ann. Transv. Mus.*, xx, p. 164, fig. 7.

R.C. 32 : *Moschorhinus esterhuyseni* Broom (sp. nov.) : Whaitsiidae : D. Esterhuysen : 1939 : *Cistecephalus*-zone : Slopes of Compassberg, Graaff Reinet : Almost complete skull with lower jaw : Broom, R., 1940, *Ann. Transv. Mus.*, xx, p. 167, fig. 10.

R.C. 33 : *Rubidgea laticeps* Broom (sp. nov.) : Rubidgeidae : C. J. Kitching : 1938 : *Cistecephalus*-zone : Patrysfontein, Graaff Reinet : Large gorgonopsian skull with lower jaw : Broom, R., 1940, *Ann. Transv. Mus.*, xx, p. 173, fig. 15.

R.C. 34 : *Prorubidgea maccabei* Broom (gen. et sp. nov.) : Gorgonopsidae : C. J. Kitching : 1939 : *Cistecephalus*-zone : St. Olives, Graaff Reinet : Complete gorgonopsian skull : Broom, R., 1940, *Ann. Transv. Mus.*, xx, p. 169, figs. 11, 12. (*P. pugnax in errore.*)

R.C. 35 : *Leontocephalus cadlei* Broom (gen. et sp. nov.) : Gorgonopsidae : C. J. Kitching : 1938 : *Cistecephalus*-zone : Weltevreden, New Bethesda : Weathered anterior two-thirds of skull : Broom, R., 1940, *Ann. Transv. Mus.*, xx, p. 174, fig. 16.

R.C. 36 : *Dinanomodon gigas* Broom (sp. nov.) : Dicynodontidae : C. J. Kitching and party : 1938 : *Cistecephalus*-zone : Oudeberg, Graaff Reinet : Very large anomodont skull without lower jaw : Broom, R., 1940, *Ann. Transv. Mus.*, xx, p. 176, fig. 17.

R.C. 37 : *Dicynodon allani* Broom (sp. nov.) : Dicynodontidae : Allan McCabe : 1938 : *Cistecephalus*-zone : Wimbledon, Graaff Reinet : Complete anomodont skull : Broom, R., 1940, *Ann. Transv. Mus.*, xx, p. 177, fig. 18.

R.C. 38 : *Dicynodon trigonocephalus* Broom (sp. nov.) : Dicynodontidae : S. H. Rubidge : 1938 : *Cistecephalus*-zone : Klipfontein, Graaff Reinet : Medium sized skull without lower jaw : Broom, R., 1940, *Ann. Transv. Mus.*, xx, p. 182, fig. 24.

R.C. 39 : *Dicynodon calverleyi* Broom (sp. nov.) : Dicynodontidae : S. H. Rubidge and party : 1938 : *Cistecephalus*-zone : Klipfontein, Graaff Reinet : Medium sized skull without lower jaw : Broom, R., 1940, *Ann. Transv. Mus.*, xx, p. 179, fig. 21.

R.C. 40 : *Dicynodon grahami* Broom (sp. nov.) : Dicynodontidae : Paul McCabe : 1938 : *Cistecephalus*-zone : St. Olives, Graaff Reinet : Medium sized skull with part of lower jaw : Broom, R., 1940, *Ann. Transv. Mus.*, xx, p. 180, fig. 22.

R.C. 41 : *Dicynodon richardi* Broom (sp. nov.) : Dicynodontidae : S. H. Rubidge : 1938 : *Cistecephalus*-zone : Wimbledon, Graaff-Reinet : Anomodont skull : Broom, R., 1940, *Ann. Transv. Mus.*, xx, p. 178, fig. 19.

R.C. 42 : *Dicynodon whitsoni* Broom (sp. nov.) : Dicynodontidae : S. H. Rubidge : 1938 : *Cistecephalus*-zone: : Wellwood : Small anomodont skull : Broom, R. (not published).

R.C. 43 : *Dicynodon swierstrai* Broom (sp. nov.) : Dicynodontidae : S. H. Rubidge and party : 1938 : *Cistecephalus*-zone : Klipfontein, Graaff Reinet : Anomodont skull : Broom, R., 1940, *Ann. Transv. Mus.*, xx, p. 183, fig. 25A.

R.C. 44 : *Dicynodon sidneyi* Broom (sp. nov.) : Dicynodontidae : J. W. Kitching : 1938 : *Cistecephalus*-zone : Klipfontein, Graaff-Reinet : Skull with lower jaw and cervical vertebrae : Broom, R., 1940, *Ann. Transv. Mus.*, xx, p. 184, fig. 25B.

R.C. 45 : *Dicynodon parringtoni* Broom (sp. nov.) : Dicynodontidae : D. Esterhuyzen : 1939 : *Cistecephalus*-zone : Bethesda Road : Medium sized anomodont skull with lower jaw : Broom, R. (not published).

R.C. 46 : *Lystrosaurus rubidgei* Broom (sp. nov.) : Lystrosauridae : C. J. Kitching and party : 1939 : Base of *Lystrosaurus*-zone : Bethesda Road : Anterior two-thirds of large *Lystrosaurus* skull : Broom, R., 1940, *Ann. Transv. Mus.*, xx, p. 189, fig. 29.

R.C. 47 : *Nanictosaurus rubidgei* Broom (sp. nov.) : Galesauridae : C. J. Kitching and sons : 1937 : *Cistecephalus*-zone : Wellwood, Graaff Reinet : Very small cynodont with lower jaw : Broom, R., 1940, *Ann. Transv. Mus.*, xx, p. 190, figs. 31, 32A.

R.C. 48 : *Nanictosaurus robustus* Broom (sp. nov.) : Galesauridae : S. H. Rubidge and party : Apr. 1938 : *Cistecephalus*-zone : Hoeksplaas, Murraysburg : Small cynodont skull with lower jaw : Broom, R., 1940, *Ann. Transv. Mus.*, xx, p. 192, figs. 32B, 33.

R.C. 49 : *Nanictidops kitchingi* Broom (gen. et sp. nov.) : Scaloposauria : C. J. Kitching : 1938 : *Cistecephalus*-zone : Patrysfontein, Graaff Reinet : Small weathered skull without lower jaw : Broom, R., 1940, *Ann. Transv. Mus.*, xx, p. 165, figs. 8, 9.

R.C. 50 : *Owenetta rubidgei* Broom (gen. et sp. nov.) : Procolophonidae : S. H. Rubidge : 1938 : *Cistecephalus*-zone : New Bethesda : Small skull with lower jaw : Broom, R., 1939, *Ann. Transv. Mus.*, xix, p. 319, figs. 1, 2.

R.C. 51 : *Alopecorhynchus rubidgei* Brink & Kitching (gen. et sp. nov.) : Gorgonopsidae : C. J. Kitching and party : 1939 : *Cistecephalus*-zone : Patrysfontein, Graaff Reinet : Small skull with lower jaw : Brink, A. S. & J. W. Kitching, 1953, *Palaeont. Afric.*, i, p. 8, figs. 9, 10. (Generic and specific name originally suggested by R. Broom in manuscript.)

R.C. 52 : *Dicynodon maccabei* Broom (sp. nov.) : Dicynodontidae : Dick McCabe : 1938 : *Cistecephalus*-zone : St. Olives, Graaff Reinet : Medium sized skull without lower jaw : Broom, R., 1940, *Ann. Transv. Mus.*, xx, p. 178, fig. 20.

R.C. 53 : *Mygalesuchus peggyae* Broom (gen. et sp. nov.) : Rubidginidae : Peggy Rubidge : 1941 : *Cistecephalus*-zone : Wellwood : Very small skull with lower jaw and partial skeleton : Broom, R., 1942, *Bull. S. Afr. Mus. Ass.*, ii, p. 386.

R.C. 54 : *Myosauroides minnaari* Broom (gen. et sp. nov.) : Endothiodontidae : C. J. Kitching and sons : 1940 : *Cistecephalus*-zone : Kleinfontein, Graaff Reinet : Small anomodont skull with lower jaw and partial skeleton : Broom, R., 1941, *Ann. Transv. Mus.*, xx, p. 209, fig. 13.

R.C. 55 : *Rubidgina angusticeps* Broom (gen. et sp. nov.) : Rubidginidae : C. J. Kitching and party : 1940 : *Cistecephalus*-zone : Wellwood : Small skull with lower jaw : Broom, R., 1942, *Bull. S. Afr. Mus. Ass.*, ii, p. 386.

R.C. 56 : *Mygalesaurus platyceps* Broom (gen. et sp. nov.) : Rubidginidae : S. H. Rubidge and party : — : *Cistecephalus*-zone : Doornberg, Graaff Reinet : Very small skull with lower jaw : Broom, R., 1942, *Bull. S. Afr. Mus. Ass.*, ii, p. 386.

R.C. 57 : *Clelandina rubidgei* Broom (gen. et sp. nov.) : Gorgonopsidae : C. J. Kitching : Jan. 1940 : *Endothiodon*-zone : Sundays River, Adendorp,

Graaff Reinet : Medium sized badly preserved skull : Broom, R., 1948, *Trans. roy. Soc. Edinb.*, lxi, p. 587, figs. 8-10.

R.C. 58 : *Cerdops burgheri* Broom (gen. et sp. nov.) : Akidnognathidae : A. Burger : — : *Cistecephalus*-zone : De Rust, New Bethesda : Small therocephalian skull with lower jaw : Broom, R., 1948, *Trans. roy. Soc. Edinb.*, lxi, p. 585, figs. 6B, 7C.

R.C. 59 : *Elaphrosuchus rubidgei* Broom (gen. et sp. nov.) : Erythrosuchidae : S. H. Rubidge and party : 1937 : *Lystrosaurus*-zone : Barendskraal, Middelburg : Pseudosuchian skull with lower jaw : Broom, R., 1946, *Ann. Transv. Mus.*, xx, p. 343, figs. 1, 2A.

R.C. 60 : *Tigricephalus kingwilli* Broom (gen. et sp. nov.) : Gorgonopsidae : S. H. Rubidge and party : Jan. 1943 : *Cistecephalus*-zone : Middlevlei, Murraysburg : Skull with lower jaw : Broom, R., 1948, *Trans. roy. Soc. Edinb.*, lxi, p. 599, figs. 17B, 18B.

R.C. 61 : *Scymnognathus holmesi* Broom (sp. nov.) : Gorgonopsidae : B. and S. Kitching : 28 Dec. 1942 : *Cistecephalus*-zone : Brooksfield, Murraysburg : Small skull with lower jaw : Broom, R., 1948, *Trans. roy. Soc. Edinb.*, lxi, p. 603, figs. 19B, 20A.

R.C. 62 : *Smilesaurus ferox* Broom (gen. et sp. nov.) : Rubidgeidae : S. Kitching : Sept. 1943 : *Endothiodon*-zone : Graaff Reinet : Large gorgonopsian skull with lower jaw : Broom, R., 1948, *Trans. roy. Soc. Edinb.*, lxi, p. 599, figs. 19A, 20B.

R.C. 63 : *Dicynodon benjamini* Broom (sp. nov.) : Dicynodontidae : B. Kitching : 28 Dec. 1942 : *Cistecephalus*-zone : Brooksfield, Murraysburg : Anomodont skull without lower jaw : Broom, R., 1948, *Trans. roy. Soc. Edinb.*, lxi, p. 606, figs. 23B, 24B.

R.C. 64 : *Dicynodon duvenhagei* Broom (sp. nov.) : Dicynodontidae : A. J. Duvenhage : Oct. 1944 : *Cistecephalus*-zone : Doornkloof, Graaff Reinet : Medium sized anomodont without lower jaw : Broom, R., 1948, *Trans. roy. Soc. Edinb.*, lxi, p. 607, fig. 25.

R.C. 65 : *Pelanomodon wesselsi* Broom (sp. nov.) : Cryptodontidae : Tois Wessels : 27 Dec. 1943 : *Cistecephalus*-zone : Murraysburg Commonage : Very large anomodont skull without lower jaw : Broom, R., 1948, *Trans. roy. Soc. Edinb.*, lxi, p. 612, fig. 30.

R.C. 66 : *Platycyclops richardi* Broom (sp. nov.) : Cryptodontidae : Dick McCabe : Dec. 1937 : *Cistecephalus*-zone : Woodcliffe, Graaff Reinet : Anterior two-thirds of a large, well preserved anomodont skull : Broom, R., 1948, *Trans. roy. Soc. Edinb.*, lxi, p. 613, fig. 31A, B.

R.C. 67 : *Aulacephalodon* (*Aulacocephalodon*) *cadlei* Broom (sp. nov.) : Dicynodontidae : S. H. Rubidge and party : Apr. 1938 : *Cistecephalus*-zone : Hoeksplaas, Murraysburg : Large anomodont skull with squamosals missing : Broom, R., 1948, *Trans. roy. Soc. Edinb.*, lxi, p. 615, fig. 31C, D.

R.C. 68 : *Cistecephalus platyceps* Broom (sp. nov.) : Cistecephalidae : S. H. Rubidge and party : — : *Cistecephalus*-zone : Murraysburg Commonage : skull : Broom, R., 1948, *Trans. roy. Soc. Edinb.*, lxi.

R.C. 69 : *Ictidochampsa platyceps* Broom (gen. et sp. nov.) : Alopecodontidae : C. J. Kitching : — : *Cistecephalus*-zone : New Bethesda Commonage : Weathered therocephalian skull : Broom, R., 1948, *Trans. roy. Soc. Edinb.*, lxi, p. 584, figs. 6A, 7A, B.

R.C. 70 : *Millerettops kitchingi* Broom (gen. et sp. nov.) : Millerettidae : B. and S. Kitching : June 1941 : *Cistecephalus*-zone : New Bethesda Commonage : Well preserved captorhinomorph skull with lower jaw : Broom, R., 1948, *Trans. roy. Soc. Edinb.*, lxi, p. 579, figs. 2, 3.

R.C. 71 : *Millerettoides platyceps* Broom (gen. et sp. nov.) : Millerettidae : B. Kitching : — : *Cistecephalus*-zone : Ganora, New Bethesda : Well preserved small captorhinomorph skull with lower jaw : Broom, R., 1948, *Trans. roy. Soc. Edinb.*, lxi, p. 581, fig. 4.

R.C. 72 : *Galeophrys kitchingi* Broom (gen. et sp. nov.) : Procynosuchidae : Kitching brothers : — : Ganora, New Bethesda : Small cynodont skull with lower jaw : Broom, R., 1948, *Trans. roy. Soc. Edinb.*, lxi, p. 627, fig. 44C, D.

R.C. 73 : *Rhinesuchus rubidgei* Broom (sp. nov.) : Rhinesuchidae : Collector and date uncertain : *Cistecephalus*-zone : Wimbledon, Graaff Reinet : Large amphibian skull : Broom, R., 1948, *Trans. roy. Soc. Edinb.*, lxi, p. 578, fig. 1.

R.C. 74 : *Cyniscops rubidgei* Broom : Gorgonopsidae : C. J. Kitching : — : *Cistecephalus*-zone : New Bethesda Commonage : Almost complete skull : Duplicate (Erroneously indicated as the type specimen in the Bibliographical List of Haughton and Brink; the type is R.C. 7.)

R.C. 75 : *Cyniscops longiceps* Broom (sp. nov.) : Gorgonopsidae : S. H. Rubidge and party : — : *Cistecephalus*-zone : Springfontein, Graaff Reinet : Skull with lower jaw : Broom, R., 1941, *Ann. Transv. Mus.*, xx, p. 197, figs. 1B, 2B.

R.C. 76 : *Digalodon rubidgei* Broom and Robinson (gen. et sp. nov.) : Dicynodontia *incertae sedis* : Kitching brothers : Dec. 1946 : *Cistecephalus*-zone : Ferndale, Graaff Reinet : Small anomodont skull without lower jaw : Broom, R. and J. T. Robinson, 1948, *Proc. zool. Soc.*, p. 402, figs. 7, 8.

R.C. 77 : *Dicynodon galecephalus* Broom and Robinson (sp. nov.) : Dicynodontidae : Kitching brothers : — : *Cistecephalus*-zone : Ferndale, Graaff Reinet : Small anomodont without lower jaw : Broom, R. and J. T. Robinson, 1948, *Proc. zool. Soc.*, p. 404, figs. 9, 10.

R.C. 78 : *Millerosaurus ornatus* Broom (gen. et sp. nov.) : Varanopsidae : Kitching brothers : — : *Cistecephalus*-zone : New Bethesda : Very small pelycosaur skull with lower jaw : Broom, R., 1948, *Trans. roy. Soc. Edinb.*, lxi, p. 582, figs. 5A-C.

R.C. 79 : *Cistecephalus major* Broom (sp. nov.) : Cistecephalidae : J. W. Kitching : — : *Cistecephalus*-zone : Doornplaas, Graaff Reinet : Very large cistecephalid skull with lower jaw : Broom, R., 1948, *Trans. roy. Soc. Edinb.*, lxi, p. 615, figs. 32, 33B.

R.C. 80 : *Cistecephalus platyfrons* Broom (sp. nov.) : Cistecephalidae : Kitching brothers : — : *Cistecephalus*-zone : Ferndale, Graaff Reinet : skull without lower jaw : Broom, R., 1948, *Trans. roy. Soc. Edinb.*, lxi, p. 617, fig. 34.

R.C. 81 : *Smilesaurus maccabei* Broom (sp. nov.) : Rubidgeidae : Neil McCabe : — : *Cistecephalus*-zone : Riverdale, Graaff Reinet : Large gorgonopsian skull with lower jaw : Broom, R., 1948, *Trans. roy. Soc. Edinb.*, lxi, p. 601, fig. 21A, B.

R.C. 82 : *Pardocephalus wallacei* Broom (gen. et sp. nov.) : Gorgonopsidae : B. Kitching : July 1944 : *Cistecephalus*-zone : Dalham, Graaff Reinet : Skull with lower jaw; top of skull weathered away : Broom, R., 1948, *Trans. roy. Soc. Edinb.*, lxi, p. 603, fig. 21C.

R.C. 83 : *Dicynodon howardi* Broom (sp. nov.) : Dicynodontidae : Kitching brothers : — : *Cistecephalus*-zone : Riversdale, Graaff Reinet : Medium sized skull without lower jaw : Broom, R., 1948, *Trans. roy. Soc. Edinb.*, lxi, p. 604, fig. 22A.

R.C. 84 : *Dicynodon glaucops* Broom (sp. nov.) : Dicynodontidae : B. Kitching : — : *Cistecephalus*-zone : Doornplaas, Graaff Reinet : Medium sized skull without lower jaw : Broom, R., 1948, *Trans. roy. Soc. Edinb.*, lxi, p. 604, fig. 22B.

R.C. 85 : *Dicynodon aetorhamphus* Broom (sp. nov.) : Dicynodontidae : S. H. Rubidge and party : 28 Dec. 1944 : *Cistecephalus*-zone : Hoeksplaas, Murraysburg : Medium sized skull without lower jaw : Broom, R., 1948, *Trans. roy. Soc. Edinb.*, lxi, p. 605, figs. 23A, 24A.

R.C. 86 : *Dicynodon brachyrhynchus* Broom (sp. nov.) : Dicynodontidae : Kitching brothers : — : *Cistecephalus*-zone : Ferndale, Graaff Reinet : Medium sized skull without lower jaw : Broom, R., 1948, *Trans. roy. Soc. Edinb.*, lxi, p. 609, figs. 27B, 28B.

R.C. 87 : *Galecranium liorhynchus* Broom (gen. et sp. nov.) : Procynosuchidae : Kitching brothers : — : *Cistecephalus*-zone : Ganora, New Bethesda : Small cynodont skull : Broom, R., 1948, *Trans. roy. Soc. Edinb.*, lxi, p. 628, fig. 44A, B.

R.C. 88 : *Platycyclops crassus* Broom (sp. nov.) : Cryptodontidae : S. H. Rubidge : — : *Cistecephalus*-zone : Ferndale, Graaff Reinet : Very large anomodont skull with portion of lower jaw : Broom, R., 1948, *Trans. roy. Soc. Edinb.*, lxi, p. 614, fig. 29A.

R.C. 89 : *Tetracynodon tenuis* Broom & Robinson (gen. et sp. nov.) : Scaloposauridae : L. Kitching : — : *Cistecephalus*-zone : New Bethesda Commonage : Small skull with lower jaw : Broom, R. & J. T.

Robinson, 1948, Broom Commemorative Volume, *Roy. Soc. S. Afr.*, p. 41, figs. 6C, 7B.

R.C. 90 : *Youngopsis rubidgei* Broom & Robinson (gen. et sp. nov.) : Younginidae : J. W. Kitching : 1939 : *Cistecephalus*-zone : Doornkloof, Graaff Reinet : Small eosuchian skull : Broom, R. & J. T. Robinson, 1948, *Proc. zool. Soc.*, 118, p. 396, fig. 2A, C.

R.C. 91 : *Youngoides minor* Broom & Robinson (sp. nov.) : Younginidae : Kitching brothers : 1940 : *Cistecephalus*-zone : New Bethesda Commonage : Small eosuchian skull with lower jaw : Broom, R. & J. T. Robinson, 1948, *Proc. zool. Soc.*, 118, p. 397, fig. 2B, D.

R.C. 92 : *Leavachia duvenhagei* Broom (gen. et sp. nov.) : Procynosuchidae : S. H. Rubidge : — : *Cistecephalus*-zone : Doornkloof, Graaff Reinet : Well preserved skull and much of skeleton : Broom, R., 1948, *Trans. roy. Soc. Edinb.*, lxi, p. 618, figs. 35-43.

R.C. 93 : *Cistecephalus rubidgei* Broom (sp. nov.) : Cistecephalidae : Kitching brothers : — : *Cistecephalus*-zone : Murraysburg Commonage : Skull without lower jaw : Broom, R., 1948, *Trans. roy. Soc. Edinb.*, lxi, p. 617, fig. 33B.

R.C. 94 : *Clelandina major* Broom (sp. nov.) : Gorgonopsidae : J. W. Kitching : — : *Endothiodon*-zone : Spandau Kop, Graaff Reinet : Skull without lower jaw : Broom, R., 1948, *Trans. roy. Soc. Edinb.*, lxi, p. 590, fig. 11.

R.C. 95 : *Dicynodon scheepersi* Broom (sp. nov.) : Dicynodontidae : S. Kitching : — : *Endothiodon*-zone : Third Drift, Adendorp, Graaff Reinet : Large anomodont with lower jaw : Broom, R., 1948, *Trans. roy. Soc. Edinb.*, lxi, p. 611, fig. 29B.

R.C. 96 : *Dicynodon leontocephalus* Broom (sp. nov.) : Dicynodontidae : S. H. Rubidge and party : 1939 : *Cistecephalus*-zone (perhaps *Lystrosaurus*-zone) : Springfield, Middelburg : Large anomodont skull without lower jaw : Broom, R., 1950, *Ann. Transv. Mus.*, xxi, p. 246, fig. 1.

R.C. 97 : *Dicynodon clarencei* Broom (sp. nov.) : Dicynodontidae : S. H. Rubidge and party : 1945 : *Cistecephalus*-zone : 20 miles south of Hanover : Small anomodont skull with lower jaw : Broom, R., 1950, *Ann. Transv. Mus.*, xxi, p. 247, fig. 2.

R.C. 98 : *Pelanomodon halli* Broom (sp. nov.) : Cryptodontidae : S. H. Rubidge and party : — : *Cistecephalus*-zone : The Willows, Middelburg : Medium sized skull without lower jaw : Broom, R., 1950, *Ann. Transv. Mus.*, xxi, p. 248, fig. 3.

R.C. 99 : *Moschorhinus esterhuyseni* : Identified by J. W. Kitching : Whaitsiidae : Kitching brothers : 1941 : *Cistecephalus*-zone : Brandkraal, Middelburg : Skull without lower jaw : Brink, A. S., 1954, *Trans. roy. Soc. S. Afr.*, xxxiv, p. 56.

R.C. 100 : *Dicynodon rubidgei* Broom (sp. nov.) : Dicynodontidae : R. Rubidge : — : *Cistecephalus*-zone : Wellwood : Complete but weathered skull : Broom, R., 1932, Mammal-like Reptiles, p. 189, fig. 62F. (This specimen was sent by R. Rubidge to the British Museum of Natural History where it was given the number 47081.)

R.C. 101 : *Broomicephalus laticeps* Brink & Kitching (gen. et sp. nov.) : Gorgonopsidae : Charles Rubidge : *Cistecephalus*-zone : Zoetvlei, Richmond : Skull with lower jaw : Brink, A. S. & J. W. Kitching, 1953, *Palaeont. Afric.*, i, p. 3, figs. 1, 2.

R.C. 102 : *Dracocephalus scheepersi* Brink & Kitching (gen. et sp. nov.) : Gorgonopsidae : S. C. Kitching : — : *Cistecephalus*-zone : Zuurplaas, Graaff Reinet : Skull with lower jaw : Brink, A. S. & J. W. Kitching, 1953, *Palaeont. Afric.*, i, p. 5, figs. 3, 4.

R.C. 103 : *Dinogorgon oudebergensis* Brink & Kitching (sp. nov.) : Rubidgeidae : J. W. Kitching : — : *Cistecephalus*-zone : Oudeberg, Graaff Reinet : Large gorgonopsian skull with lower jaw : Brink, A. S. & J. W. Kitching, 1953, *Palaeont. Afric.*, i, p. 6, figs. 5, 6.

R.C. 104 : *Ictidosuchops* (*Ictidosuchoides*) *intermedius* : Ictidosuchidae : F. Els : — : *Cistecephalus*-zone : New Bethesda : Greater part of skeleton with portion of skull impression.

R.C. 105 : *Ictidosuchops intermedius* : Ictidosuchidae : J. W. Kitching : 1938 : *Cistecephalus*-zone : Stylkrans, New Bethesda : Skull with lower jaw.

R.C. 106 : *Ictidosuchops intermedius* : Ictidosuchidae : B. J. Kitching : July 1939 : *Cistecephalus*-zone : St. Olives, Graaff Reinet : Complete skull with lower jaw : Broom, R., 1940, *Ann. Transv. Mus.*, xx, p. 161, figs. 4, 5.

R.C. 107 : *Notictosaurus luckhoffi* Broom (gen. et sp. nov.) : Galesauridae : R. Luckhoff : — : *Lystrosaurus*-zone : Bethesda Road : Small cynodont skull with lower jaw : Broom, R., 1936, *Ann. Transv. Mus.*, xviii, p. 382, figs. 28-30 (Luckhoff Collection L.1).

R.C. 108 : *Notosollasia luckhoffi* Broom (sp. nov.) : Whaitsiidae : R. Luckhoff : — : *Cistecephalus*-zone : Bethesda Road : Imperfect snout : Broom, R., 1936, *Ann. Transv. Mus.*, xviii, p. 363, fig. 11. (Luckhoff Collection L.2.)

R.C. 109 : *Nanoparia luckhoffi* Broom (gen. et sp. nov.) : Pareiasauridae : R. Luckhoff : — : *Cistecephalus*-zone : Oudeberg, Graaff Reinet : Small skull without lower jaw : Broom, R., 1936, *Ann. Transv. Mus.*, xviii, p. 349, fig. 1. (Luckhoff Collection L.3.)

R.C. 110 : *Gorgonorhinus luckhoffi* Broom (gen. et sp. nov.) : Gorgonopsidae : R. Luckhoff : — : *Cistecephalus*-zone : Zuurplaas, Graaff Reinet : Anterior portion of skull : Broom, R., 1937, *Ann. Transv. Mus.*, xix, p. 141, fig. 3.

R.C. 111 : *Gorgonorhinus minor* Broom (sp. nov.) Gorgonopsidae : R. Luckhoff : — : *Cistecephalus*-zone : Zuurplaas, Graaff Reinet : Skull with

anterior part of lower jaw missing : Broom, R., 1948, *Transv. roy. Soc. Edinb.*, lxi, p. 597, figs. 17A, 18A. (Luckhoff Collection L.4.)

R.C. 112 : *Protacmon ruebsameni* Broom (sp. nov.) Diademodontidae : R. Ruebsamen : — : *Cynognathus*-zone : Lady Frere : Skull badly fragmented in preparation : Broom, R., 1950, *S. Afr. J. Sci.*, xlvii, p. 86, fig. 1. (Ruebsamen Coll.).

R.C. 113 : *Sysphinctostoma gracilis* Broom (sp. nov.) Galesauridae : R. Ruebsamen : — : *Cynognathus*-zone : Lady Frere : Skull with partial skeleton : Broom, R., 1950, *S. Afr. J. Sci.*, xlvii, p. 88, figs. 2A, 3. (Ruebsamen Coll.).

R.C. 114 : *Sesamodontoides pauli* Broom (gen. et sp. nov.) : Bauriidae : R. Ruebsamen : — : *Cynognathus*-zone : Lady Frere : Skull and parts of lower jaw : Broom, R., 1950, *S. Afr. J. Sci.*, xlvii, p. 88, fig. 2B.

R.C. 115 : *Prorubidgea maccabei* (paratype) : Gorgonopsidae : Kitching brothers : — : *Cistecephalus*-zone : Ferndale, Graaff Reinet : Skull with lower jaw : See R.C. 34.

R.C. 116 : *Promoschorhynchus platyrhinus* (paratype) : Whaitsiidae : Hans Wessels : — : *Cistecephalus*-zone : Wellwood : Small skull with lower jaw : Brink, A. S., 1954, *Trans. roy. Soc. S. Afr.*, xxxiv, p. 43.

R.C. 117 : *Dicynodon calverleyi* (paratype) : Dicynodontidae : — : *Cistecephalus*-zone : Graaff Reinet district : Medium sized skull without lower jaw

R.C. 118 : *Dicynodon* sp. : S. J. Kitching : — : *Cistecephalus*-zone : New Bethesda : Small skull with lower jaw.

R.C. 119 : *Aelurognathus minor* : Gorgonopsidae : C. J. Kitching : — : *Cistecephalus*-zone : Bethesda Road : Small skull with lower jaw.

R.C. 120 : *Aelurognathus* sp. : S. H. Rubidge : *Endothiodon*-zone : South of Aberdeen : Weathered and crushed skull.

R.C. 121 : *Rhinesuchus* sp. : Rhinesuchidae : S. C. Kitching : *Cistecephalus*-zone : Klipplaat, Richmond : Very large, well preserved amphibian skull with lower jaw.

R.C. 122 : *Dicynodon* sp. : Dicynodontidae : Kitching brothers : Feb. 1944 : *Endothiodon* / *Cistecephalus*-zone : Third Drift, Graaff Reinet : Two small anomodont skulls and a lower jaw in one block.

R.C. 123 : *Dicynodon* sp. : Dicynodontidae : S. H. Rubidge and party : 1938 : *Cistecephalus*-zone : Wimbledon, Graaff Reinet : Two small anomodonts skulls without lower jaws, associated in one block—traditionally referred to as "Romeo and Juliet".

R.C. 124 : *Dicynodon* sp. : Dicynodontidae : S. H. Rubidge and party : 2 Feb. 1945 : *Endothiodon* / *Cistecephalus*-zone : Matjieskloof, Aberdeen : Three small anomodont skulls associated in one block—traditionally referred to as "The Triplets".

R.C. 125 : *Owenetta rubidgei* (paratype) : Procolophonidae : S. H. Rubidge and party : 15 Dec. 1950 : *Lystrosaurus*-zone : Melsetter, Middel-

burg : Small skull showing palate very clearly. (See R.C. 50.)

R.C. 126 : *Owenetta rubidgei* (Identified by J. W. Kitching) : Collector and locality unknown : Small skull with lower jaw.

R.C. 127 : *Owenetta rubidgei* (Identified by J. W. Kitching) : Kitching brothers : Sept. 1945 : *Cistecephalus*-zone : Graaff Reinet Commonage : Well preserved skull with lower jaw.

R.C. 128 : *Owenetta rubidgei* (Identified by J. W. Kitching) : S. H. Rubidge and party : 1952 : *Cistecephalus*-zone : Oudeberg, Graaff Reinet : Small crushed skull with lower jaw.

R.C. 129 : *Pristerodon buffaloensis* (Identified by J. W. Kitching) : Endothiodontidae : — : *Endothiodon*-zone : — : Small skull with crushed lower jaw.

R.C. 130 : *Galecranium liorhynchus* : Procynosuchidae : C. J. Kitching : 1937 : *Cistecephalus*-zone : Karreelaagte, New Bethesda : Almost complete skull with lower jaw : See Brink, A. S. & J. W. Kitching, 1953, *S. Afr. J. Sci.*, xlix, p. 314.

R.C. 131 : *Emydops* sp. (identified by M. J. Toerien) : Endothiodontidae : S. H. Rubidge : 1940 : *Cistecephalus*-zone : Goliatskraal, Graaff Reinet : Badly crushed small skull but with fair palate.

R.C. 132 : *Procynosuchus rubidgei* : Procynosuchidae : C. J. Kitching : 1941 : *Cistecephalus*-zone : Zeekoegat, Graaff Reinet : Small, almost complete cynodont skull : See Brink, A. S. & J. W. Kitching, 1953, *S. Afr. J. Sci.*, xlix, p. 314.

R.C. 133 : *Nanictosaurus rubidgei* : Galesauridae : S. H. Rubidge : — : *Cistecephalus*-zone : Wellwood : Small cynodont skull weathered on the left : See Brink, A. S. & J. W. Kitching, 1953, *S. Afr. J. Sci.*, xlix, p. 316.

R.C. 134 : *Dicynodon* cf. *sollasi* : Dicynodontidae : S. H. Rubidge : 1951 : *Cistecephalus*-zone : Oudeberg, Graaff-Reinet : Small anomodont skull with lower jaw (Identified by M. J. Toerien).

R.C. 135 : *Hofmeyeria* cf. *atavus* : Pristerognathidae : B. J. Kitching : 1944 : *Cistecephalus*-zone : Graaff Reinet Commonage : Small crushed therocephalian skull with lower jaw (identified by J. W. Kitching).

R.C. 136 : *Emydops* cf. *microdon* : Endothiodontidae : S. H. Rubidge : 27 Dec. 1947 : *Cistecephalus*-zone : Wellwood : Small anomodont skull with lower jaw and part of skeleton (identified by M. J. Toerien).

R.C. 137 : *Dinanomodon* cf. *rubidgei* : Dicynodontidae : Hans Wessels : 1962 : *Cistecephalus*-zone : Blaauwater, Graaff Reinet : Anterior two-thirds of juvenile skull (identified by J. W. Kitching).

R.C. 138 : *Pareiasaurus* sp. : Pareiasauridae : S. H. Rubidge and party : 30 Dec. 1940 : *Cistecephalus*-zone : Tierkloof, Graaff Reinet : Well preserved skull.

R.C. 139 : (Very small lacertid skull and skeletal impression from the Cradock district, collected by Coetzer in 1937.)

R.C. 140 : (Anomodont foot from Bloemhoff, Cradock, collected by Willie Probart in 1943.)

R.C. 141 : (Medium sized anomodont foot and other bones from Bloemhoff, Cradock, collected by Willie Probart in 1943.)

R.C. 142 : (Anomodont foot from Bloemhoff, Cradock.)

R.C. 143 : *Ictidosuchops intermedius* (paratype) : Ictidosuchidae : Kitching brothers : 1940 : *Cistecephalus*-zone : Garnora, Graaff Reinet : Anterior two-thirds of skull and well preserved manus : Broom, R., 1941 (*Ictidosuchoides*), *Ann. Transv. Mus.*, xx, p. 194, fig. 3.

R.C. 144 : (Small *Dicynodon* sp. from Glen Harry, Graaff Reinet.)

R.C. 145 : (Very small lacertid skull with greater part of skeleton from Wellwood, collected by S. H. Rubidge and party in 1938.)

R.C. 146 : (Therocephalian lower jaw showing interesting tooth replacement, collected by S. H. Rubidge on Wellwood in 1939.)

R.C. 147 : *Lycaenops ornatus* : Gorgonopsidae : S. H. Rubidge and party : *Endothiodon*-zone : Matjiesfontein, Aberdeen : Skull with part of right mandible in place : Brink, A. S. & J. W. Kitching, 1953, *Palaeont. Afric.*, i, p. 21.

R.C. 148 : *Cyniscops longiceps* : Gorgonopsidae : S. H. Rubidge and party : — : *Endothiodon*-zone : Matjiesfontein, Aberdeen : Almost complete skull with lower jaw : Brink, A. S. & J. W. Kitching, 1953, *Palaeont. Afric.*, i, p. 17, fig. 20.

R.C. 149 : *Smilesaurus* sp. : Rubidgeidae : Hans Wessels : 29 Dec. 1940 : *Cistecephalus*-zone : Middelvlei, Murraysburg : Gorgonopsian skull without lower jaw : Identified by J. W. Kitching.

R.C. 150 : *Pelanomodon rubidgei* (paratype) : Cryptodontidae : C. J. Kitching : 1939 : *Cistecephalus*-zone : Osfontein, Graaff Reinet : Large anomodont skull without lower jaw : See R.C. 10 : Toerien, M. J., 1953, *Palaeont. Afric.*, i, p. 103, fig. 68. (No. 1584 on specimen is Broom's Transvaal Museum Number.)

FOSSIL AND SUBFOSSIL PRIMATES FROM THE LIMESTONE DEPOSITS AT TAUNG, BOLT'S FARM AND WITKRANS, SOUTH AFRICA

By Leonard Freedman

Department of Anatomy, University of the Witwatersrand, Johannesburg, South Africa*

ABSTRACT

(1) New fossil and subfossil cercopithecoid specimens are described from the limestone deposits at Taung, Bolt's Farm and Witkrans, South Africa.

(2) The following first reports are made:
   (*a*) *Parapapio whitei* from Bolt's Farm.
   (*b*) *Parapapio whitei* from Taung.
   (*c*) *Papio ursinus* from Witkrans.
   (*d*) *Cercopithecoides williamsi* from Bolt's Farm.

(3) The following first descriptions are given:
   (*a*) *Parapapio whitei* male cranium.
   (*b*) *Parapapio whitei* female cranium.
   (*c*) *Parapapio antiquus* male cranium.

(4) The morphological and size differences in the male crania of the *Parapapio* spp. are described.

(5) The affinities of the genus *Cercopithecoides* to the Colobinae are discussed.

INTRODUCTION

A very considerable number of Primate specimens was excavated by the University of California African Expedition from the various deposits at Bolt's farm, Taung and Witkrans, South Africa. These specimens are all now housed in the Museum of Paleontology at the University of California, Berkeley, where they were examined by Dr. H. B. S. Cooke in 1957-1958 and then sent to the writer for description. The remaining fauna and the geology of the sites are discussed in an unpublished paper by Cooke. The most important of the new primate specimens are described and classified below. The measurements used are from Freedman (1957); the photographs are oriented on the occlusal plane.

The new specimens all belong in the superfamily Cercopithecoidea and a number represent the first report of certain species from these sites. The material includes specimens which show anatomical regions not previously described and the material in general increases our knowledge of the range of variation within the various species. The species found in the new material are: *Parapapio antiquus*, *Parapapio broomi*, *Parapapio whitei*, *Papio ursinus*, *Papio wellsi*, *Papio robinsoni*, and *Cercopithecoides williamsi*.

**Now:* Department of Anatomy, University of Sydney, Sydney, N.S.W., Australia.

Besides the material described below, there are a large number of post-cranial bones, juvenile specimens and skull fragments which are clearly cercopithecoid. Due to the incompleteness of our knowledge of the fossil forms of this superfamily, the specimens cannot at present be classified further with any degree of certainty. It was therefore felt that it was better to omit description of this material for the present.

PARAPAPIO Jones, 1937

The new material includes specimens of the species *Parapapio broomi* and *Parapapio whitei* from Bolt's Farm. The latter species has not previously been reported from this site and only a single maxillary fragment with teeth (B.F. 21) of *P. broomi* (Freedman, 1957) was previously recorded from this site.

From Taung, the new material includes specimens of *Parapapio antiquus* and *Parapapio whitei*. *P. whitei* has not previously been reorded from this site.

No specimens of the genus *Parapapio* were found in the new material from Witkrans.

Parapapio broomi Jones, 1937

Referred material. Four new specimens from Bolt's Farm, all from pit 23.

(1) Specimen 56786 is a badly damaged cranium with most of the base and muzzle missing. In the small remaining left posterior part of the maxilla, only M^2 and M^3 (the latter still in its crypt) are present. The specimen was probably from a female.

(2) Specimen 56792 is a small anterior portion of the muzzle of a female with P^3—M^2 on the left and P^3, M^1 and M^2 on the right.

(3) Specimen 56796 is the symphyseal region and right corpus of a female mandible. I_1—P_3 are present on the left and I_1—M_3 on the right, almost all in a good state of preservation.

(4) Specimen 56787 is the badly damaged left corpus and ramus of a mandible of unknown sex. Only M_3 is present and undamaged.

Description. The identification of specimen 56786 is not easy as most of the muzzle is missing and the specimen is from an immature individual. However, from the small portions of the nasal bones and maxillae present, it does seem as if the muzzle shape was similar to that seen in *P. broomi* females. There is a slight concavity in the profile contour, but that shape is sometimes found in females of this species—particularly when immature.

The muzzle dorsum in the same specimen, 56786, is separated from the sides of the muzzle by a very weak maxillary ridge. The maxillary fossae were either very shallow or absent. The slope of the orbits and the parts of the maxillae lying below the infero-lateral part of the orbits is shallow and not almost vertical, as in *Papio robinsoni* and most of the *Papio* spp. The supra-orbital tori are weak and separated from the calvaria roof by a very shallow

ophryonic groove. The calvaria shape is similar to that previously described for *P. broomi* (Freedman, 1957).

Specimen 56792 is only a small fragment and shows no morphological features of interest. The upper teeth of both this specimen and 56786 are of the *Papio-Parapapio* type; on size (Table 3), some dimensions (e.g. P^3) are slightly larger than those previously found in this species.

The female mandible, 56796, has virtually no mandibular fossa; the symphyseal region is too damaged to show detailed structure. Mandible 56787 is broken and distorted but there is some suggestion that the ramus was displaced slightly lateral to the corpus. On size and morphology, the lower teeth fit those previously described for *P. broomi*.

Measurements. See Tables 2—4.

Remarks. The new material confirms the presence of *P. broomi* at Bolt's Farm, where only a single specimen was previously known.

Parapapio whitei Broom, 1940

Referred material. Two specimens from Bolt's Farm and three from Taung.

(1) Specimen 56785, from pit 23 at Bolt's Farm, is an almost complete male cranium. The zygomatic arches are missing and so is part of the calotte, but there is an endocranial cast present where the bone is missing in the latter region. P^4—M^3 are present bilaterally and, except for both P^4 teeth and the right M^1, they are in a fair state of preservation.

(2) Specimen 56794 is a single broken male left *C*, also from pit 23 at Bolt's Farm.

(3) Specimen 56614 is a very badly crushed right half of the muzzle of a male from pit 5a at Taung. The right *C* to P^4 are present, but the *C* has lost its distal third. Small parts of the three right molars are also present.

(4) Specimen 56652 is a part of a female cranium from pit 5 at Taung. Most of the muzzle is present but, of the calvaria, only the left anterior portion remains. The left M^1—M^3 are present, but very badly damaged.

(5) Specimen 56613, from pit 5 at Taung, is the badly crushed anterior part of the maxilla and palate of an immature female. The right P^3—M^1 and the left P^4—M^2 are present and well preserved; the right M^3 can be seen in its crypt.

Description. A single male muzzle was recently referred to *Parapapio whitei* from Makapan (Freedman, 1961b), but no other good cranial material is known of the male of this species. The new material described below includes a very fine cranium (56785) and a crushed muzzle (56614).

Specimen 56785 is the cranium of a large robust male. In norma lateralis, the profile shape (Fig. 1) dips fairly steeply between the orbits and then becomes more horizontal over the muzzle dorsum. The area in which the angle changes is slightly damaged, thus accentuating the concavity. However, the profile shape is clearly of the *Parapapio* type. The muzzle dorsum is large and slightly

TABLE 1
Cranial Measurements (in mm.)

SPECIES SEX & NUMBER	GENERAL			CALVARIA								
				Height		Breadth			Length		Foramen Magnum	
	Greatest Length	Basal Length	Bizygomatic Breadth	Basion-Bregma	Basion-Glabella	Min. interfrontal	Greatest temporal	Mastoid	Inion-Glabella	Inion-Basion	Breadth	Length
P. whitei *Male* 56785	167	117	(111)		81	54	(92)		110	54		
P. antiquus *Male* 56604 *Female* 56694 56608	(144)		95			57 52	74		95			
P. wellsi *Female* 56606	142	101	(92)	55	71	52	72	75	98	42	15·6	14·0
P. robinsoni *Male* 56765 *Female* 56767 56797	(153) (158)	(106)	(96) (94)	64	77	52 52	 74	78	100 100	52	17·2	19·0
C. williamsi *Female* 56784 56778		(90)	(96)		77	52	72					

TABLE 1 (*Continued*)

SPECIES SEX & NUMBER	MUZZLE													
	Height		Breadth			Length			Orbit				Nasal Aperture	
	Post. to M^3	Ant. to P^3	Ant. to M^3	Ant. to P^3	Dors. to M^2	Muzzle	Palate	Nasal	Inter-orbital	Ext. orbital	Height	Breadth	Breadth	Length
P. whitei														
Male														
56785	60	27	53	43	46	88	71		13·7	85·6	26·7	(28·3)	19·1	29·3
P. antiquus														
Male														
56604		21				84								
Female														
56694		15	46	35		68			9·0	(69·5)	21·5	24·2	18·5	
56608			50	35										
P. wellsi														
Female														
56606		26	49	35	40	68	59	(34)	10·8	75·3	22·6	25·6	16·9	(24·5)
P. robinsoni														
Male														
56765			(53)	48			(89)							
Female														
56767		26	(48)	(38)		68	67		7·4		(22·3)	23·3		
56797		20	49	39	41	76		35	(11·0)	(80·5)	25·1	27·5	(21·7)	31·0
C. williamsi														
Female														
56784		22	42	38		54	51	24	19·1	79·4			14·1	27·0
56778		24	43	35									17·9	28·0

TABLE 2
Mandibular Measurements (in mm.)

SPECIES SEX & NUMBER	Height			Breadth					Length		
	Post. to M_3	Ant. to P_4	Mental sp. to most anterior pt.	Post. to M_3	Ant. to M_3	Ant. to P_4	Through mental sp.	At base of canines	Gonion to mental spine	Ramus at condyle neck	Condyle to most anterior pt.
P. broomi *Female* 56796		24	30				24	20			
P. robinsoni *Male* 56766	30										
56768		37	41		(44)	37	22	28			
Female 56770	26	22	27	49	40	24	18	16	68		
? sex 56769	25										
56772	31										
56773	31										
C. williamsi *Female* 56784	24	21	26			29	27	21		32	(95)

TABLE 3
Measurements of the upper teeth (in mm.)

SPECIES SEX & NUMBER	C				P^3		P^4		M^1			M^2			M^3			ROWS	
	h	b	l_1	l_2	b	l(h)	b	l	bm	bd	l	bm	bd	l	bm	bd	l	P_4-M^3	C-M^3
P. broomi																			
Female																			
56786												11·7	10·9	11·2	10·5	9·3	10·9		
56792					8·1	8·0		6·4			(10·4)			(11·5)					
P. whitei																			
Male																			
56785									9·9		9·9	11·7	10·9	11·7	10·8	9·0	11·7	37·7	
56794		9·0	8·4	9·0															
56614					8·4	7·3	9·1	7·8											
Female																			
56652												12·5	11·0	11·7					
56613							8·3	6·9	10·2	9·0	11·1	11·4	10·2	(13·0)		(9·4)			
P. antiquus																			
Male																			
56604	(22)										(9·8)							(38·5)	(54·0)
Female																			
56694								6·7		8·7	(8·9)	11·3	9·6	10·9	10·9	7·7	9·8	35·8	
56608					7·3	7·4	8·2	6·8	9·1	7·7	9·2	10·5	9·1	11·0	10·4	7·2	9·6	35·9	
P. wellsi																			
Female																			
56606										9·4								(38·5)	
P. robinsoni																			
Male																			
56765						10·6	10·2	8·7	10·9	9·6	(10·3)	12·4	11·6	15·3	13·4	10·5	16·0		
56766					7·8	9·6	8·7	7·8	9·8	(9·1)	(11·4)	11·5	10·2	13·6	11·7	9·2	14·6	(45·5)	
Female																			
56767									(10·0)	9·5	(10·3)	11·4	10·5	11·8	11·4	9·9	13·0		
56797								7·2			(10·6)			(12·8)					
P. ursinus																			
Male																			
56701					8·7	8·3	9·2	9·0	11·0	11·1	12·5	13·0	12·2	15·8					
56701a	(47)	(10·8)	(11·5)	(13·6)															
V4743FEP																			
43/122 x		12·6	11·6	12·7															
56697e	(47)	(10·8)	(10·1)	(11·9)															
56697f	(49)	(10·9)	(10·8)	(13·3)															
Female																			
56700										9·0			10·5	11·8	11·5		13·5		
? Sex																			
56699a															(12·0)		13·2		
56697a																10·2	13·5		
56698a															12·8	10·5	14·9		
56696b															12·3	10·0	13·9		
56702c															13·0	10·3	14·1		
C. williamsi																			
Female																			
56784																8·2	10·7		45·8
56778					6·8	6·4	8·7	6·0	9·2	8·9	8·5	10·9	10·3	9·3					
Taung																			
Female																			
56610					7·3	5·6	7·6	6·7	9·5	8·8	10·0	11·6	10·0	12·2					

TABLE 4
Measurements of the lower teeth (in mm.)

SPECIES SEX & NUMBER	$\overline{C}$			P_3		P_4		M_1			M_2			M_3				ROWS	
	h	b	l	b	l(h)	b	l	bm	bd	l	bm	bd	l	bm	bd	bh	l	P_4-M_3	C-M_3
P. broomi																			
Female																			
56796**	(10·9)	(5·1)	(6·9)	(5·7)		6·9	6·6	7·7	7·9	9·1	9·5	9·3	11·0	9·9	9·1	6·0	13·5	40·1	(52·6)
? Sex																			
56787														9·3	7·5	5·9	14·2		
P. robinsoni																			
Male																			
56766				5·6	21·0	7·4	8·5	8·3	8·7	10·4	10·2	9·6	12·9	11·0	10·3	8·2	16·8	49·1	
56768				6·8	19·1	7·5	9·2	8·9	9·0	9·8	10·9	10·7	13·2	10·9					
Female								7·4	8·5		9·7	9·4	12·4	10·7	9·2	6·7	16·1		
56770																			
56771				5·2		7·3	8·3	8·5	9·0	10·5	10·3	10·0	13·0	11·2	10·3	6·5	17·0		
? Sex																			
56769						6·7	8·3	8·0	9·0	9·3	10·0	9·9	12·0	10·0	8·9	6·8	15·0	44·5	
56772*..														11·0	9·8	6·7	16·8		
56773*..											10·5	10·4	13·4	10·9	10·0	7·2	17·0		
56774									8·9		10·0	10·3	13·0						
56706											9·8	9·5	11·6	10·0	9·7	7·6	16·0		
P. ursinus																			
Male																			
56773				6·7	20·4	(7·6)	8·9	(9·0)	9·5	10·5	10·9	10·9	12·8	11·7	9·8	7·3	17·7		
56699b										(10·4)									
56702a					25·9														
Female																			
56703						(7·5)							(12·1)						(45·7)
? Sex																			
56697b														11·0	9·6		18·5		
56697c														13·0	11·1	7·6	19·8		
56698b														12·4	11·2	7·8	18·8		
56696a														10·1	10·2	6·9	16·9		
56697d							(9·6)												
C. williamsi																			
Female																			
56784				4·9		5·5	6·9							8·8	(9·4)	6·4	13·7	37·9	
Taung																			
Male																			
56660					17·2		8·0			(10·7)			(11·8)	9·1	8·5		12·4	(42·5)	
56618						7·2	8·2												
56693						8·1	7·9	8·5	9·3	10·5	(10·5)	(10·7)	12·7	(11·2)	10·4		14·7	45·5	
Female																			
56691	11·0	7·9	4·6									10·2		(10·5)	10·3		15·6		
56623				5·4			7·8												
56626				5·0	8·3		7·3	7·7	7·9	9·4									
? Sex																			
56655						(7·0)		7·5	7·8	(9·5)			(11·3)	9·4	8·8			-	

	I_1			I_2			ROWS	
	h	b	l	h	b	l	I (*a*)	I (*b*)
**56796	6·1	6·4	5·0	5·8	6·5	4·6	17·0	15·8

* ? one individual

concave on each side from nasal bone to maxillary ridge. The maxillary ridges are not well developed in this specimen. The sides of the muzzle are almost vertical and only slightly excavated by maxillary fossae. The maxilla is very robust below the lateral half of the orbit and the roots of the zygomatic arches are very strong. Specimen 56614 is very badly crushed, but, as far as can be seen, it appears to have had a muzzle similar to that described above.

In specimen 56785, the anterior portions of the temporal lines are robust and curve inwards rapidly. On the small posterior part of the calvaria present there is a slight sagittal crest which might have extended forwards for as much as one third of the distance between inion and glabella. From the mastoid region, a well-developed shelf-like occipital crest extends around to the inion.

A most unusual feature is present on either side of the new male calvaria (56785), just above the zygomatic process of the temporal bone. Usually in this region the sidewalls of the calvaria curve down smoothly to deviate laterally into the medial root of the zygomatic process, forming a broad ledge at the inferior margin of the squamous temporal. In specimen 56785 this region displays a large outward bulging of bone which reduces the medial zygomatic root to a very narrow ledge. The feature is present bilaterally but on the left side the posterior portion of the region has been lost. The outer table of bone is missing here and it can be seen that the underlying space is occupied by air cells, similar to those seen in the mastoid region postero-inferior to it. (A similar external appearance, the mons temporo-sphenoidalis, which was described by Dart (1924) in Bushmen, is not formed by pneumatization, but is an outward curve of the bones of the calvaria sidewall to accommodate the expanded temporal lobe of the brain.)

Viewed from below (Fig. 2), the great depth of the palate bounded by almost vertical alveolar processes can be seen. The foramen magnum is very small.

The female specimen, 56652, is considerably damaged and distorted. The left side of the muzzle is rough and uneven, but the right side is completely smooth. The orbits appear very large, particularly supero-inferiorly, the profile shape rather *Papio*-like in the deepness of the concavity, the nasal aperture large and the muzzle extremely high (Fig. 3). How much of all this is due to distortion is difficult to assess.

There is no bony prominence in the region above the zygomatic process of the temporal of this female specimen. The zygomatic arch is short and not very robust. The temporal lines are reasonably well developed anteriorly but, after a sharp initial inward curve, they appear to run directly posteriorly and finally to curve slightly laterally. In size, this specimen is considerably smaller and less robust than the male of this species as described above.

The new male and female upper teeth (Table 3) fit their equivalents as described previously (Freedman, 1957 and 1961b) in both size and morphology.

Measurements. See Tables 1 and 3.

Remarks. The description of the male cranium of this species is a significant

addition to our knowledge of the fossil Cercopithecoidea and, particularly, to that of the *Parapapio* species. The taxonomy of this genus is still not wholly satisfactory, but the description of the crania of the male *P. whitei* and the male *Parapapio antiquus* (see below) in this paper show that, although on dental size and morphology (except for P_3 and the canines) the sexes within each species cannot be separated, there are considerable differences in size and morphology in the crania of the two sexes of *Parapapio* species. Further, the great difference in size and morphology between the crania of the males of the species *P. antiquus* and *P. whitei* (which can now also be compared with the known males of *P. broomi*) indicate that, although there is overlap in size between the *Parapapio* species on almost all dental dimensions, as more crania are recovered, so more differences in morphology appear which more clearly separate the various species.

Of the female cranium of *P. whitei*, only one piece of any size has hitherto been recovered and that is only a left maxilla with teeth (STS. 239). When compared with females of the species known from Taung, the new female, 56652, appears to fit best in *P. whitei*. However, an accurate description of the female calvaria of this species will only be possible when a less distorted specimen is found.

Parapapio antiquus (Haughton), 1925

Referred material. Three new specimens from Taung.

(1) Specimen 56604, from pit 5a, is an almost complete well preserved male cranium. Its base and the left part of the palate are still embedded in matrix. On the right, C—M^3 are present, but the occlusal surfaces of these teeth are still embedded in the block.

(2) Specimen 56694 is from pit 5b and consists of a damaged female cranium lacking the base and posterior part of the calvaria. P^4—M^3 are present on the right and P^3—M^3 on the left, but only the left molars are undamaged.

(2) Specimen 56608, from pit 5a, is the damaged palate of a female. The left P^3—M^3 are well preserved and not very greatly worn. A number of other teeth, including the right and left I^1 and right P^4, M^2 and M^3 are present, but, except for the M^2, they are all badly damaged.

Description. Specimen 56604 (Fig. 4) is the first good male cranium with teeth of this species to be recovered. Morphologically, the specimen closely resembles the fairly complete female cranium (Tvl. 639) previously described (Freedman, 1957) and also the female specimen (56694) to be described below. On size, the muzzle of this new male specimen is longer than that of the females and similar to that of the male (C.T. 5364) previously referred to this species by Freedman (1957). (Some doubt about this latter specimen belonging in *P. antiquus* was expressed by Freedman (1961a)).

The muzzle of 56604 has a large flattened dorsum in which the maxillae only slope down gently on either side of the nasals. The sides of the muzzle are



FIG. 1—Lateral view of the male cranium of *Parapapio whitei* (56785)

almost vertical and the maxillary fossae are large, but not deeply excavated. The supra-orbital tori are weak and the calvaria roof rises for some distance posterior to them. The zygomatic arch is moderately robust and the anterior parts of the temporal lines prominent. The calvaria is considerably eroded, but it appears as if a slight occipital crest was present, at least laterally.

Specimen 56694, the female calvaria, shows the typical profile shape of a *Parapapio*. The muzzle dorsum is fairly flat and the sides of the muzzle are almost vertical with large but shallow maxillary fossae. The general shape is thus similar to that of the previously described female of this species (Tvl. 639). The supra-orbital tori of the new specimen are, however, very weak and the calvaria roof rises steeply for a short distance behind them.

Only the lateral surfaces of the upper teeth can be seen in the male 56604. The *C* is large and might not have been fully erupted. P^3 shows an extension of the enamel on to the mesio-buccal root. The distal portion of M^3 shows some

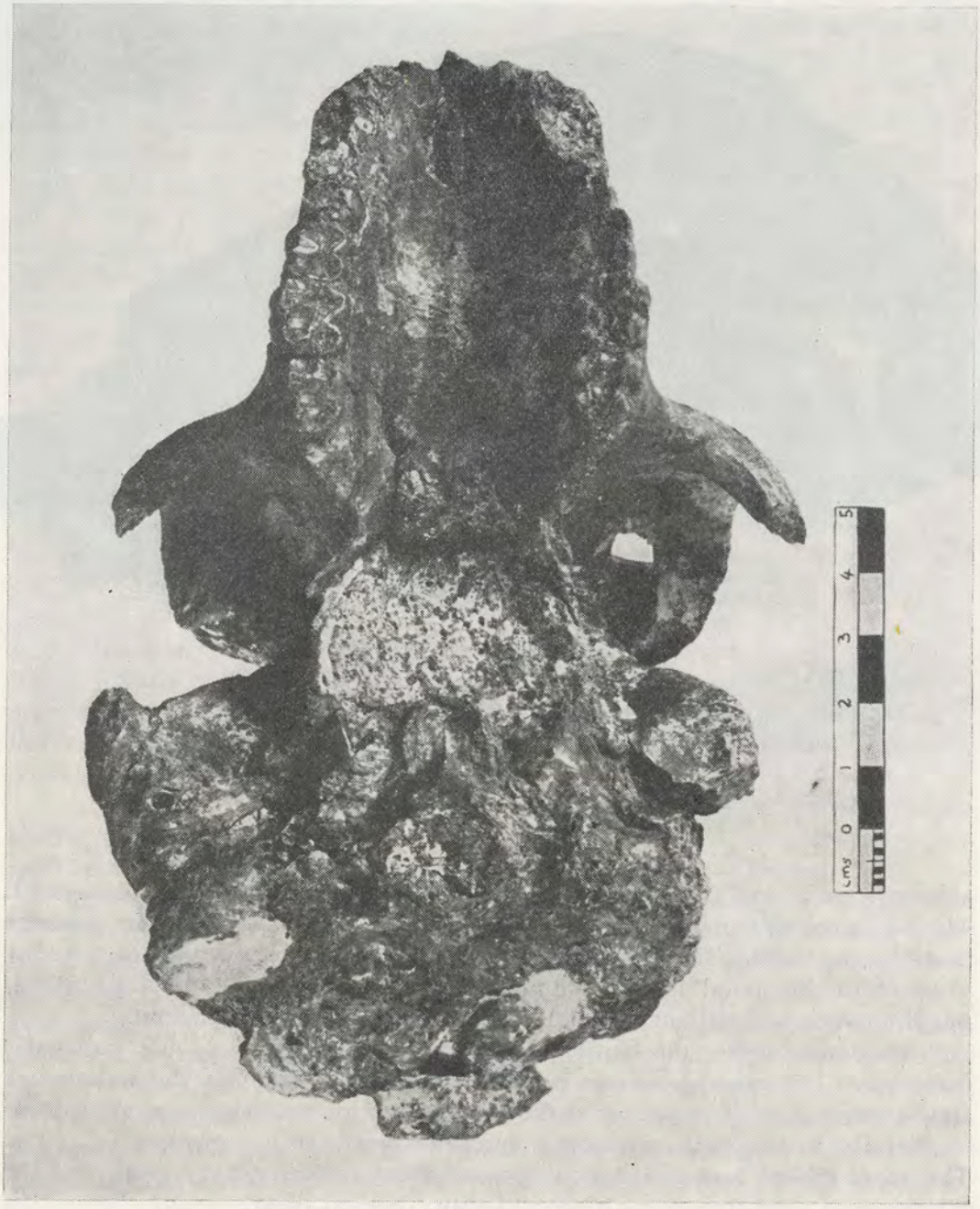


FIG. 2—Basal view of the male cranium of *P. whitei* (56785)



FIG. 3—Lateral view of the female cranium of *P. whitei* (56652)

reduction, but exactly how much cannot be seen as it is still partially embedded in matrix.

The upper teeth in the females 56694 and 56608 (Fig. 5) fit the sizes and morphology of these teeth as previously described in this species (Freedman, 1957 and 1961a). Of particular interest is the great reduction of M^3, especially distally, which these specimens share with those specimens previously described with this tooth present (Tvl. 639, T. 17, T. 20 and T. 25).

Measurements. See Tables 1 and 3.

Remarks. The new material described above is valuable because of two points which it illustrates. The first is the characteristic reduction of M^3 in at least the females of this species and the second is the sexual dimorphism in the size and morphology of the cranium. This latter point is also illustrated by the new material of *Parapapio whitei* and has been discussed above under that species.

PAPIO Erxleben, 1777

The new material includes a number of specimens belonging in the genus *Papio*.

From Taung there are two good *Papio* crania which are referred below to *Papio wellsi*. In addition, in a large block of breccia from that same site, of which only a cast was available to me, there are at least two more crania which can be assigned to this same species.

A number of new specimens of *Papio robinsoni* are described below from Bolt's Farm. Previously, only a single female mandible of that species (B.F. 20) was known from Bolt's Farm (Freedman, 1957).

The new material from Witkrans Cave described below is very fragmentary, but almost certainly all belongs in the species *Papio ursinus*. Previously, Peabody (1954) had listed "*Papio* (and related baboon genera)" from that site.

Papio wellsi Freedman, 1961

Referred material. From Taung, two new skulls (1 and 2 below) are hereby referred to *P. wellsi* and two other skulls (3 below) must almost certainly also be included in this species.

(1) Specimen 56606 from pit 5a is a female cranium lacking only the left zygomatic arch. The specimen is in an excellent state of preservation except for the teeth which are either broken or absent.

(2) Specimen 56605, also from pit 5a, is another well preserved female cranium. The base is still embedded in breccia but, as far as can be seen, no teeth are present.

(3) In a block, 56831, from site 5b, there are at least two good crania, probably female and of this species.

Description. Specimen 56606 is a slightly larger cranium than those of this species previously described (S.A.M. 11728 and T .13—Freedman, 1961a), particularly



FIG. 4—Left: Supero-lateral view of the male cranium of *Parapapio antiquus* (56604). Right: Lateral view of the female cranium of *Papio wellsi* (56605)



FIG. 5—Basal view of female palate of *P. antiquus* (56608)

in the breadths of the muzzle and calvaria. In profile view (Fig. 6), the drop in the inter-orbital region is steep, the drop being further accentuated by the fairly robust supra-orbital tori (Fig. 7). The maxillary fossae are only slightly excavated in the new specimen and the nasal aperture is rather small (Fig. 8). The portion of the maxilla below the orbit is large and gives rise to a robust zygomatic process. There is a large well-marked notch on the inferior part of the maxilla, just before it gives rise to its zygomatic process. The palate (Fig. 9) is horseshoe-shaped and deep and heavy bars of bone limit the posterior palatine foramina posteriorly. The specimen is generally very well preserved and many details of structure—including even the turbinals—can be seen.

Specimen 56605 (Fig. 4) has its base still embedded in a block of matrix,



FIG. 6—Lateral view of the female cranium of *Papio wellsi* (56606)

but its morphology is very similar to that of the new female specimen described above. However, the supra-orbital tori are slightly less robust and the maxillary fossae are more deeply excavated. From the cast of the large block, 56831, the two specimens in that block, which appear to be females of this species, appear to fit well the above and previous description of *P. wellsi* females (Fig. 10).

Measurements. See Tables 1 and 3.

Remarks. The new material agrees well with the previous description of this species (Freedman, 1961a) and adds knowledge of a number of features and of the variability within the species. The new descriptions of the maxilla and zygomatic arch are of particular interest. Unfortunately no new useful dental material is available for study. Because of the similar sizes of the cercopithecoid species found at Taung, a number of new mandibles cannot be assigned with any degree of certainty and are dealt with in a separate section below.

Papio robinsoni Freedman, 1957

Referred material. From Bolt's Farm six new specimens are referred to this species (1—6 below) and seven (7, 8 and 9 below) are referred doubtfully. Except specimens 56797 and 56795, which come from pit 23, all the material comes from pit 6.

(1) Specimen 56795 is a damaged male muzzle, with *C*—M^3 present on the left and the *C* and parts of P^3—M^3 on the right.

(2) Specimen 56766 consists of a bilaterally crushed male muzzle. P^3—M^3 are present on the right and P^3—M^1 on the left. Almost all of these teeth are well preserved and not very worn. An associated right mandibular corpus, almost certainly from the same individual, has P_3—M_3 present, very well preserved and only slightly worn.

(3) Specimen 56767 is a fairly well preserved and almost complete female cranium, lacking only a small left lateral part of the muzzle and calvaria. M^1—M^3 are present on the right and are fairly well preserved.

(4) Specimen 56797 is another almost complete female cranium in which the calvaria is crushed and the teeth are all badly broken.

(5) Specimen 56768 consists of the symphyseal region and most of both corpora of a male mandible. Left P_3—M_2 and right I_2 and P_3—M_3 are present and fairly well preserved.

(6) Specimen 56795 is a small anterior portion of a male mandible with left I_1 and I_2, and the *C* still erupting.

(7) Specimen 56770 is a badly damaged female mandible lacking completely the superior parts of both rami. M_1—M_3 are present on the left and M_2 and M_3 on the right.

(8) Specimen 56771 is the complete lower dentition of a female.

(9) Five specimens (56769, 56772, 56773, 56774 and 56706) each consist of a small posterior part of a mandible with teeth. The sexes of these specimens are not known.



FIG. 7—Dorsal view of the female cranium of *P. wellsi* (56606)

Description. The new material of the male cranium is restricted to two damaged muzzles, 56765 and 56766. The first of these specimens appears to be considerably more robust than the second. The main features of 56765 are a fairly steeply sloping anterior end to the muzzle and only slightly excavated maxillary fossae. Specimen 56766 is characterised by extremely large, deeply excavated maxillary fossae. Unfortunately, the interesting muzzle dorsum region, in which the two maxillae meet over the nasals in the male of this species, has been lost from both specimens.



FIG. 8—Anterior view of the female cranium of *P. wellsi* (56606)

The new female cranial material includes two fairly complete specimens, 56797 and 56767. In general, both specimens fit the description of the female of this species given previously (Freedman, 1957). Of the two specimens, 56797 has a considerably larger muzzle with rather less excavated maxillary fossae and a larger flatter muzzle dorsum. The temporal lines are well developed in 56767. In neither specimen do the maxillae meet over the nasals in the midline.

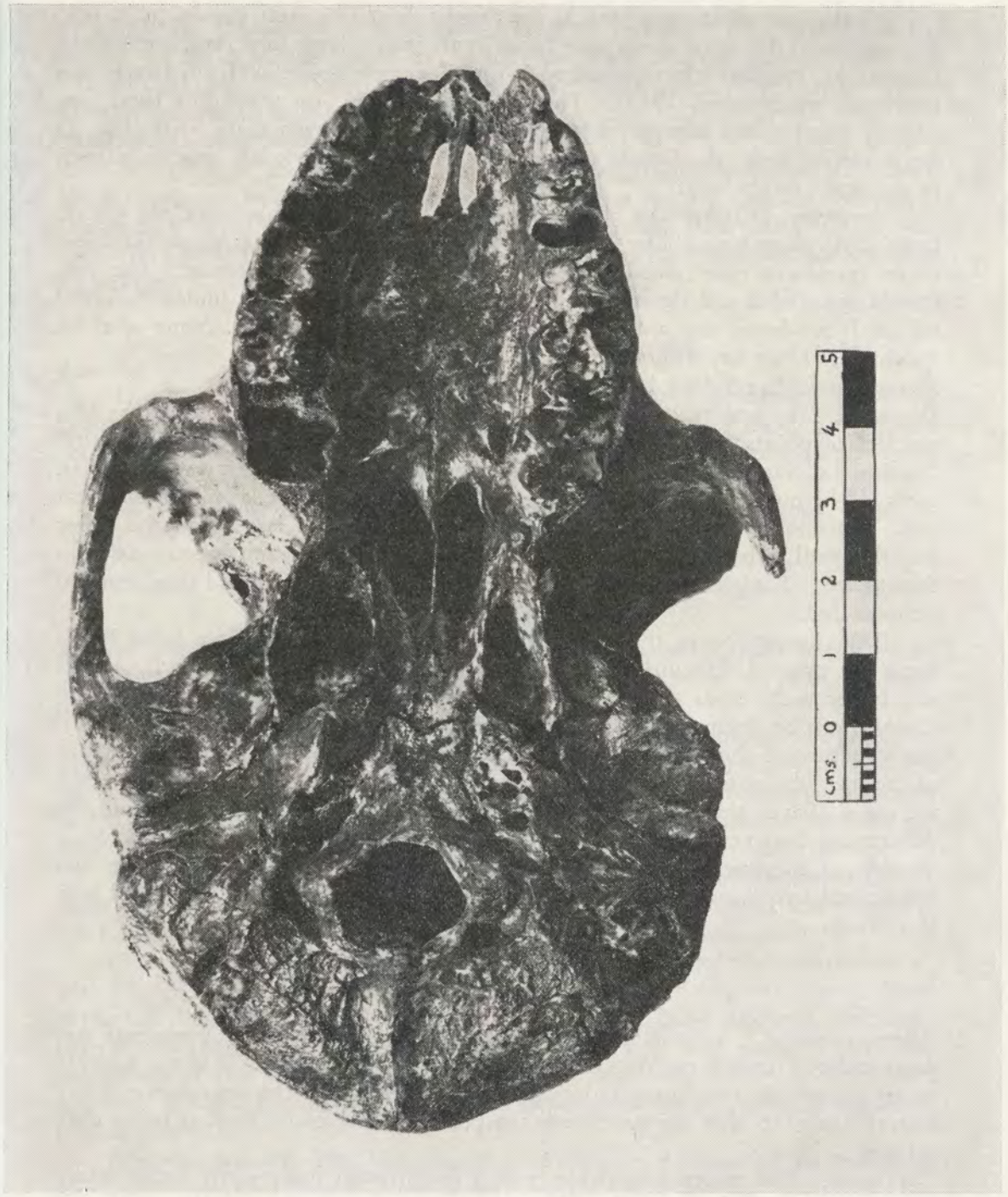


FIG. 9—Basal view of the female cranium of *P. wellsi* (56606)

Of the new male upper teeth, the large robust *C* is well shown in 56765. The molars of this same specimen (Table 2) are rather large in certain dimensions (M^2 and M^3 lengths) when compared to the specimens described from Swartkrans previously (Freedman, 1957). The molars of 56766, on the other hand, are slightly small when compared to those of the Swartkrans male material. As far as can be seen, the female upper molars fit those previously described both in size and morphology.

Specimen 56768 is the robust anterior portion of a male mandible with a large fairly deep mandibular fossa; 56795 is an even smaller anterior fragment of an immature male mandible and shows no features of interest. The two female mandibles and those of unknown sex (described above under Referred material) on dental size and morphology could fit this species. None of these specimens shows any diagnostic details of mandibular structure.

Measurements. See Tables 1—4.

Discussion. The two new male muzzles and the two new female crania vary in a number of points of both size and morphology, but these probably fall within the limits of variability which were indicated by the previously known material. It should be noted, however, that the two female specimens come from different pits. The one new male upper dentition appears slightly large, and the other slightly small, when compared to that of the male *P. robinsoni* specimens from Swartkrans. A slight extension of the range for the species would thus seem to be indicated.

The description in this paper of good *Parapapio whitei* crania from Bolt's Farm has created difficulties in the taxonomy of certain mandibular fragments and lower teeth from this site. Fairly complete mandibles of *P. robinsoni* and *P. whitei* can be distinguished by a study of the size of the canines (mainly male), the structure of the anterior surface of the mandible and the presence and size of the mandibular fossa. Small non-diagnostic regions of the mandible and teeth are too similar in the two species to be separated. Until more is known about the differences between the mandibles and lower teeth of these two species, a number of specimens will have to remain uncertain taxonomically. The two female and five mandibular fragments of unknown sex described above fall into this category.

Papio ursinus (Kerr), 1792

Referred material. A number of small maxillary and mandibular fragments and some isolated teeth from Witkrans are referred to this species. It is not possible to say for certain how many individuals are represented. The appearance of the material suggests that the specimens are probably best considered as being only subfossil.

Description. The material available is very fragmentary and mostly rather badly damaged. A male left maxillary fragment with some teeth (56701), parts of a male mandible with teeth (56773) and a left mandibular corpus with teeth

(56703) of a female are the only specimens whih include parts of the cranium or mandible. These are all only small fragments and show little morphological detail. Of the dentition, there are, in addition, eight isolated incisors, four male *C* teeth and over two dozen isolated premolars and molars. The best preserved of these specimens have been measured.

Measurements. See Tables 3 and 4.

Remarks. On size, morphology and probable dating, there is nothing to exclude these fragments from being assigned to the species *Papio ursinus*. However, it should be pointed out that the dimensions of these teeth (like those of *P. ursinus*) differ very little from the middle Pleistocene species *Papio robinsoni* known from Swartkrans, Cooper's, Kromdraai, Bolt's Farm, etc.

CERCOPITHECOIDES Mollett, 1947

The new material from Bolt's Farm includes three specimens which are referred to *Cercopithecoides williamsi*, the single species now recognised in the genus *Cercopithecoides* (Freedman, 1961b). This is the first record of this genus from Bolt's Farm.

No specimens of this genus were found in the material from Taung or Witkrans.

Cercopithecoides williamsi Mollett, 1947

Referred material. Three new female specimens recovered from Bolt's Farm. Specimens 56784 and 56782 come from pit 23 and specimen 56778 comes from pit 6.

(1) Specimen 56784 is the complete cranium and mandible of an old female. The cranium lacks only the right zygomatic arch and the posterior part of the calvaria; the mandible lacks the left gonial region, the right corpus posterior to M_2 and the right ramus. Of the teeth, only the right I^1 and the right M_3 are missing, but the teeth which are present are all very worn and badly damaged.

(2) Specimen 56782 is another female cranium and mandible, but it is very badly bilaterally crushed. Only general features of the cranium and mandible can be discerned; the teeth are very badly damaged and fragmented.

(3) Specimen 56778 is the anterior portion of the muzzle of a third female, with P^3—M^2 bilaterally present and in a fairly good state of preservation. Parts of the left I^2 and the right M^3 are also present, but in a badly damaged condition.

Description. The three new female specimens agree well with material of female individuals of this species previously described from the Taung, Sterkfontein, Makapan and Swartkrans limestone cave deposits in South Africa (Freedman, 1957 and 1961b).

In norma lateralis (Fig. 11), specimen 56784 is very similar to the only good previously described female skull of this species (STS. 394A). However, the supra-orbital tori are more robust and the initial angle of the nasals below the



FIG. 10—Block of breccia from Taung containing a large number of skull and post-cranial cercopithecoid specimens (56831)

tori is rather steeper. Posterior to the tori, the ophryonic groove is even deepe in the new specimen than in the Sterkfontein specimen and the rise of the calvaria roof behind the groove is steeper. In the new specimen, the temporal lines, particularly anteriorly, are very well-marked and may have met anterior to the inion; the zygomatic arch of this specimen is robust. As far as can be seen, female 56782, the badly crushed specimen, conforms to the description of the female skull as given here and previously. The specimen is interesting in that it shows a very long post-glenoid process (about 12 mm.). This process is also long in STS. 394A, but shorter in 56784.

Viewed from the front (Fig. 12), the new female cranium, 56784, shows its very wide inter-orbital measurement and a marked downward curve of the supra-orbital tori medially towards the glabella. The nasal bones in this specimen are most peculiar in that they are flat and lie on a lower plane than the long nasal processes of the maxilla, which project forwards as ridges on either side of them. The canine eminence in all three new specimens is well marked. On the left canine eminence of 56784 there is a fairly large opening with raised edges which may have been caused by the root of the *C* emerging or by an apical abscess.

The palate of 56784 (Fig. 13) shows similar features to those described in the male M. 2999 (Freedman, 1961b), namely, the long slit-like posterior palatine foramina, bars of bone bounding the palate posteriorly and the raised posterior part of the inter-palatine suture.

Of the upper female dentition, the incisors are again seen to be very small and the *C* large, in both 56784, where these teeth are present, and in 56778, where the sockets of the teeth give a good indication of the tooth size. The pre-molars and molars of 56784 are very badly damaged, but those of 56778 are fairly well preserved and fit the previously described pattern for the species. In the latter specimen (56778), large cuspules are present buccally and lingually between the main cusps on M^2 and buccally only on M^1.

The new female mandible, 56784, conforms to the description of the mandible of this species as previously given (Freedman, 1957). The symphyseal region is flattened and fairly steep and a single foramen symphyseosum is present. On the antero-inferior part of the corpus there is a single mental foramen (Fig. 11). The ramus, in the fashion described previously for this genus, is antero-posteriorly long, and displaced buccal to M_3, forming a broad ledge next to this tooth (Fig. 14). The coronoid process is very large and much higher than the condyle, which shows virtually no neck. The crushed mandible of 56782 is similar to the one just described.

The lower teeth of 56784 (Fig. 14) are very worn and badly damaged, but follow the patterns and sizes of the equivalent teeth as previously described.

Measurements. See Tables 1—4.

Remarks. The existence of *C. williamsi* at Bolt's Farm is proved by this new material. There is no obvious difference between the material from the two pits. The new material, although not very extensive, confirms and extends the



FIG. 11—Lateral view of the female cranium and mandible of *Cercopithecoides williamsi* (56784)

description of a number of features previously described from single specimens of this species. Too few dental dimensions are available for a statistical comparison with specimens of the species from other sites, but even the few known show that the Bolt's Farm material is probably most closely linked to those from Swartkrans. From what is known of the relative dating of the South



FIG. 12—Anterior view of the female cranium of *C. williamsi* (56784)

African limestone cave deposits, this would fit in with the previously proposed chronocline in the *C. williamsi* material (Freedman, 1961b).

With regard to the affinities of the genus, which are at present still obscure, a few relevant remarks can now be made. The bilophodont molars seem clearly to indicate that the genus should be placed in the Cercopithecidae. The prominent tempora lines and the very large coronoid process both suggest a par-

ticularly large temporalis muscle. The zygomatic arch is robust, suggesting that masseter was also a relatively large muscle. The small molars with high cusps and rather deep infoldings of enamel between the cusps, plus the relatively large masticatory muscles described above, might well be indicative of a chopping—possibly leaf-eating—function. The general skull shape, with short muzzle and relatively large female canines, is of the type associated with the monkey-like Cercopithecidae. It therefore seems that *C. williamsi* was probably a leaf-eating cercopithecoid with monkey-like characters in the skull. As this pattern of features is that seen in the modern Colobinae, it is proposed that the genus Cercopithecoides, of which *C. williamsi* is the only known species, be included in the Colobinae, as suggested previously by Robinson (1952).

Discussion

The following are the cercopithecoid species now known to occur at the sites discussed in this paper:—

1. Witkrans: *Papio ursinus*.
2. Bolt's Farm: *Parapapio broomi* (pit 23), *Parapapio whitei* (pit 23), *Papio robinsoni* (pits 6 and 23) and *Cercopithecoides williamsi* (pits 6 and 23).
3. Taung: *Parapapio jonesi*, *Parapapio whitei* (pits 5 and 5a), *Parapapio antiquus* (pits 5a and 5b), *Papio wellsi* (pits 5a and 5b), *Papio izodi* and *Cercopithecoides williamsi*.

Except for *Parapapio jonesi*, *Papio izodi* and *Cercopithecoides williamsi* from Taung, specimens of all of these species were found in the new material described in this paper.

A number of specimens from Taung which have not been described above require comment. As discussed in a previous paper (Freedman, 1961a), the cercopithecoid species known from Taung (with the exception of *C. williamsi*) are of rather similar dental size and morphology. As a result, unless diagnostic regions are present, it is very difficult to assign certain specimens. Of a number of specimens which fall into this category, two new cranial specimens might be mentioned. Specimen 56610, an immature crushed female muzzle from pit 5a, shows a superficial resemblance to *Parapapio antiquus*. However, the crown of an unerupted M^3 can be seen which appears to be large when compared with those of the described equivalents of that species and the specimen is thus best left in abeyance. The measurements of the upper teeth of this specimen are included in Table 3 under Taung. Also, specimen 56653, a very fragmentary muzzle and mandible with teeth of a female from pit 5, probably belongs in *Parapapio whitei*. No measurements are possible on the specimen and, because of the similarity in size of the Taung species, it too is best left in abeyance.

The new material from Taung does not include good associated crania and mandibles and hence, as was found in the study quoted above, the mandibles recovered from this site cannot be classified with any degree of certainty. For



FIG. 13—Basal view of the female cranium of *C. williamsi* (56784)

the sake of completeness, the best of the new mandibles recovered from Taung are listed and briefly described below and their measurements included at the end of Table 4.

Mandibles from Taung.

(1) Specimen 56660 from pit 5b, is the well preserved mandible of an

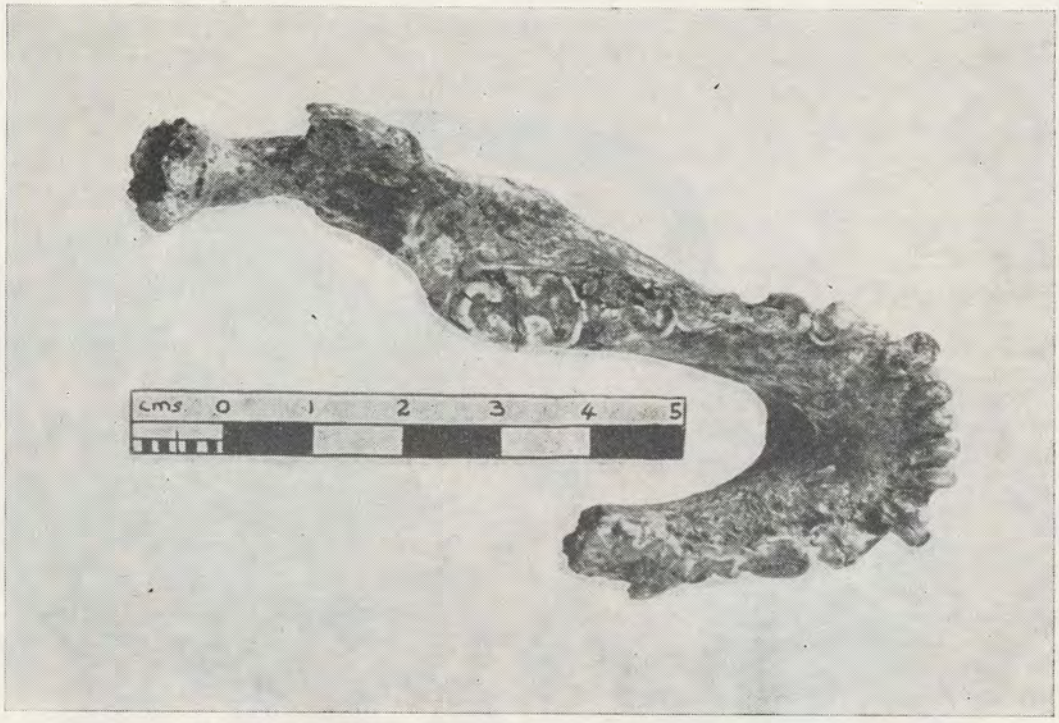


FIG. 14—Occlusal view of the female mandible of *C. williamsi* (56784)

almost mature male (Fig. 15). Only the left ramus is completely missing. Of the teeth, the right *C*—M_3 and the left M_1—M_3 are present and most are fairly well preserved.

(2) Specimen 56618, from pit 5, is the symphyseal region and left corpus of a male. On the right the damaged *C* is present; on the left the *C*—P_4 are present and some fragments of the molars.

(3) Specimen 56693, from pit 5b, consists of the almost complete left corpus with P_3—M_3, and part of the right corpus with M_1, M_2 and the anterior half of M_3. The left teeth are very worn, but only slightly damaged; the right teeth are badly damaged. The specimen comes from a male individual.

(4) Specimen 56691, from pit 5b, is a badly damaged, but almost complete mandible of a female, lacking only the rami. The left *C* and right M_3 are the only relatively undamaged teeth.

(5) Specimen 56623, from pit 5, is a female symphyseal region and the anterior parts of the right and left corpora. The left I_1—P_4 and the right I_1—M_2 are present, but posterior to P_3 on the right and P_4 on the left all are badly damaged.

(6) Specimen 56626, from pit 5, is part of the right corpus of a female mandible with P_3—M_1.

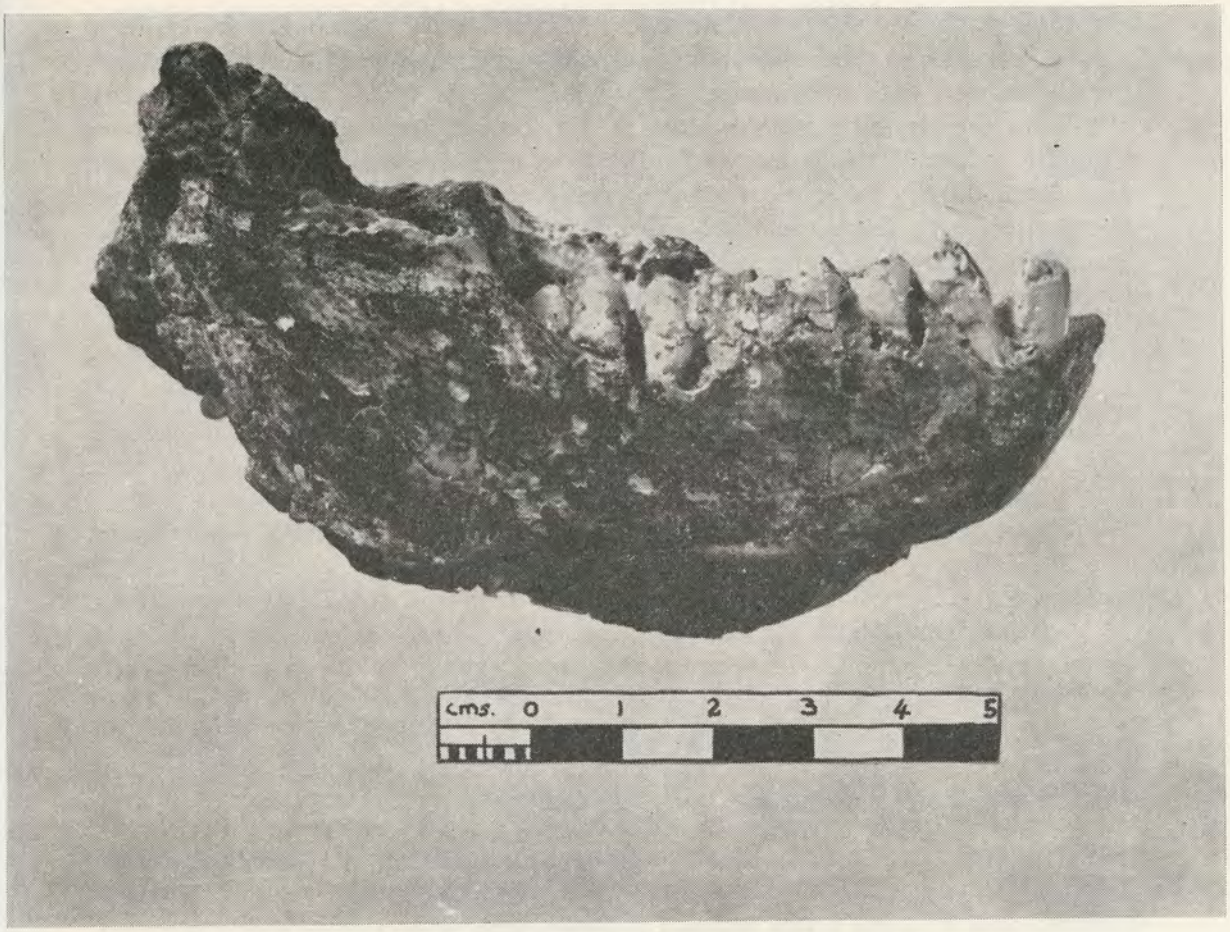


FIG. 15—Lateral view of a male mandible from Taung (56660)

(7) Specimen 56655, from pit 5, is part of the left corpus of a mandible of a specimen of unknown sex. P_4—M_3 are present, mostly badly damaged.

(8) Specimen 56831, from pit 5b, is a large block (Fig. 10) with a number of cercopithecoid specimens partially embedded in matrix. Among these there are four good mandibles. The best specimen is an almost complete male mandible with most of the teeth still present and the next best is the left half of a mandible with P_4—M_3. There is also a small posterior portion of a mandible and a juvenile mandible.

ACKNOWLEDGMENTS

My thanks are due to Professor R. A. Stirton and the University of California for allowing me to borrow and describe the above material. The University of the Witwatersrand kindly made me a grant to transport the material from

and back to the Museum of Paleontology, University of California. Dr H. B. S. Cooke, formerly of the Department of Geology, University of the Witwatersrand, greatly assisted with information about the localities of the various specimens. Whilst in the United States of America, Dr Cooke prepared most of the above material and made preliminary identifications. The Wenner-Gren Foundation, New York, kindly made me a grant to study *Colobus* monkeys in East Africa for comparison with *Cercopithecoides*. The photograph used for Fig. 10 was kindly loaned to me by Dr Cooke. Miss A. Scot Skirving, Department of Anatomy, University of Sydney, kindly typed the final draft of this paper.

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NOTES ON SOME CHALICOTHERE REMAINS FROM MAKAPANSGAT

By G. L. Webb

Abstract

This paper deals with the South African chalicothere remains from Makapansgat, Potgietersrus, with mention of those from Serengeti described by Dietrich. From Makapansgat there are 12 post-cranial remains comprising 2 terminal phalanges, 1 intermediate phalanx, 1 co-ossified phalanx, 1 carpal or tarsal bone, 2 metacarpals, 2 tibiae, 2 innominates and 1 scapula: and 74 cranial remains. This latter figure is made up of 45 isolated teeth, of which 36 are upper teeth and 9 are lower teeth, 7 maxillary fragments and 22 mandibular fragments.

The South African form, classified as *Metaschizotherium transvaalensis* is compared with the American forms *Moropus elatus* and *Moropus petersoni* and is found to resemble more closely in size *M. elatus*.

The reasons for retaining the classification of *M. transvaalensis* are given and discussed.

Finally the relationship of the Makapansgat specimens to the osteodontokeratic culture is discussed.

Introduction

The chalicotheres are unique in possessing a combination of grazing teeth and short feet with phalanges terminating in claws and not in hooves.

African chalicotherine remains are scarce; a phalangeal bone in the Kaiso Beds of Uganda was the first indication that this type of animal had lived in Africa. This bone was described in very general terms by Andrews (1923) without generic identification. No further paper appeard on this subject until Dietrich (1942) described some chalicotherine remains from South Serengeti, Tanganyika. They consisted chiefly of a metacarpal, a phalanx and a tooth which Dietrich identified as belonging to Von Koenigswald's genus *Metaschizotherium*. In spite of the fact that this genus belongs to the Upper Miocene fauna of Europe, Dietrich referred his Pleistocene specimens to the same genus since they retained the low-crowned molar form of the European type.

In 1949 three isolated teeth and a terminal phalanx, recovered from the Limeworks Quarry of the Makapansgat Valley in the Potgietersrus District, Transvaal, were described by George (1950) who placed them in the same genus *Metaschizotherium* but as a new species *M. transvaalensis*.

The metacarpal and phalanx from Serengeti belong to the second digit of the left manus but unfortunately both are fragmentary and no comparative measurements were given by Dietrich. The tooth on which Dietrich based his classification was a right upper second molar which had been heavily worn. The tooth is almost complete and the following table gives the comparative measurements of the genotype *M. fraasi* from Steinheim, *M. hennigi* from Serengeti and *M. transvaalensis* from Makapansgat. The measurements of *M. transvaalensis* and *M. hennigi* are almost identical except for the breadth/length index

where *M. transvaalensis* agrees more closely with *M. fraasi*. Without any knowledge of the range of variation of this index in any of the species it is uncertain what weight is to be attached to these varying proportions.

	M. fraasi	*M. hennigi*	*M. transvaalensis*
Anterior-posterior diameter ..	46mm.	55mm.	53mm.
Transverse diameter	36mm.	40mm.	42mm.
Height at paracone	30mm.	33mm.	33mm.
Height at protocone	—	12mm.	12mm.
Breadth/length index	78·26	72·72	79·24

There is an unfortunate error in Hopwood and Hollyfield 'An Annotated Bibliography of the Fossil Mammals of Africa'. They state on p. 151 that *M. transvaalensis* (George, 1950) comes from Tanganyika, it should of course read Transvaal, South Africa.

Thus very little is known about the African chalicotheres. Their remains, although present in Pleistocene deposits, are exceptionally rare so it is extremely important to place them on record when found, however fragmentary they may happen to be.

Chalicothere remains from Makapansgat

The collection of chalicotherine remains in the Bernard Price Institute for Palaeontological Research is still small but has increased substantially as compared with the four fragments available in 1949 when the first remains were recovered. Of the more than 50,000 fragments recovered from Makapansgat Limeworks breccia the vast majority belong to the Artiodactyla. Only 86 belong to the Chalicotheroidea, i.e. a ratio of approximately 1 in 568. Of these 86 fragments 74 or 84·0% are cranial, the remaining 12 are post-cranial and comprise two terminal phalanges, 1 intermediate phalanx, 1 co-ossified phalanx, 1 carpal or tarsal bone, 2 metacarpals, 2 tibiae, 2 innominates and 1 scapula.

Of the 76 cranial remains 45 or nearly 60% are isolated teeth (36 upper and 9 lower), the remaining fragments being 7 maxillary, and 22 mandibular fragments.

All these specimens, the majority isolated from the basal grey breccia, have been cleaned, numbered and catalogued and are in the collection at the Bernard Price Institute for Palaeontological Research.

The chalicothere remains all come from the basal grey breccia at Makapansgat with the exception of three specimens that came from the immediately overlying part of the pink breccia. No specimens have been recovered from the higher or "cercopithecoides" portion of the Phase 1 breccia.

General description of the chalicothere skeleton

As the skeleton altered considerably during the evolution of the group the following brief description is only general but will serve as an introduction to the discussion of the remains.

Early skulls were long and relatively low but later forms show a marked shortening of the preorbital region. The preorbital and post-orbital portions are approximately subequal in length. In later forms, e.g. *Macrotherium*, the maxilla drops vertically and the nasals are retracted and seldom project beyond the second premolar. A very definite feature is the orbit being completely open behind; in early forms the orbit was above the second molar whereas later it lay just above the last molar.

The brain case is small and restricted giving rise to high sharp sagittal and lamboidal crests for the attachment of the masticatory muscles.

The post glenoid process is heavy.

The basioccipital and basisphenoid usually have a sharp median keel becoming confluent with the vomer in the nasal passage.

The palate is usually wide in the region of the cheek teeth but the premaxillaries become very narrow and short.

The basicranial foramina are characteristic for all chalicotheres. The optic foramen is situated slightly behind the postorbital boundary and a long furrow runs back from this to the foramen lacerum anterius which is found directly above the foramen rotundum. An alisphenoid canal is present and the foramen ovale opens just behind this canal but in front of the bulla. Behind the ovale is the foramen lacerum medius and at the back of the bulla found close together are the foramen lacerum posterius and the condylar foramen. A large stylomastoid foramen is present.

The mandible is usually long with a slender horizontal ramus. The ascending ramus is wide but the lower angle projects below the border of the horizontal ramus. The coronoid process usually extends avove the condyle.

There is considerable diversity in the number of teeth in both the upper and lower jaws. There are usually three brachyodont upper molars, quadrate in shape with well developed mesostyles. The three lower molars are double crescents with typical separated metastylids. Incisors and canines are present in the earlier forms but have been lost in the later forms particularly from the upper jaw. The first deciduous molars and premolars are lost in both upper and lower jaws. The dental formula is most probably ?, 0, 3, 3/3—0, 1—0, 3, 3.

The post-cranial skeleton is perissodactyl-like with a few distinct features that are typical of the chalicotheres.

The neck and pelvis are elongated.

The forelimbs are longer than the hind limbs. Early forms had tetradactyl fore feet, the later ones tridactyl. The hind feet are tridactyl. The chalicothere metapodials have a characteristic 'ball and ridge' articulation with the phalanges.

165M. Left Scapula fragment.

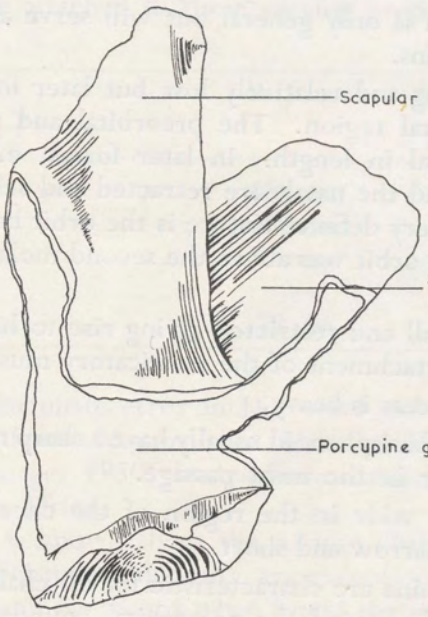
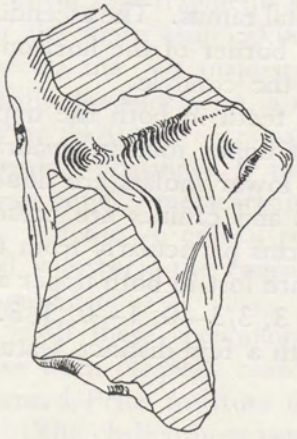


FIGURE 16

14112M. Proximal end of left Metacarpal II.



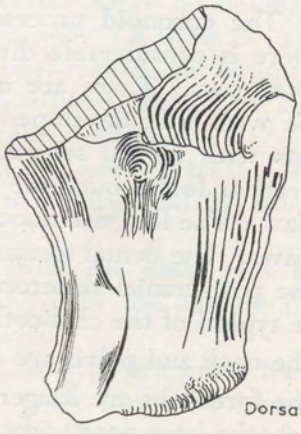


FIGURE 17

In all but the most primitive form *Eomoropus* the terminal phalanges are laterally compressed, pointed and deeply bifid.

Caudal vertebrae have been found in the various deposits and therefore they are regarded as having been tailed creatures.

The Makapansgat remains show that *Metaschizotherium transvaalensis* was a fairly massive creature. The drawings that have been made to illustrate them were made with the aid of a dioptograph, for the use of which I am obligated to the kindness of Professor P. V. Tobias and the staff of the Department of Anatomy in the Medical School of the University of the Witwatersrand.

Post-cranial remains from Makapansgat

Of the 12 post-cranial fragments none is complete. This is not due only to the damage they sustained before fossilisation but also to damage during the mining. This latter damage has been represented in the drawings by cross-hatching.

Their fragmentary condition would have rendered them undecipherable without having access (through the generosity of the Director of the Natal Museum in Pietermaritzburg, who kindly loaned me a copy) to 'The Osteology of the Chalicotheroidea' (Holland and Peterson, 1914) that enabled us to identify the fragments.

A. *The forelimb*

165M. Left scapula. (Figure 16, $\times \frac{1}{2}$.) This specimen is part of the distal end of a left scapula. The area between the glenoid cavity and the scapular blade and spine has been extensively gnawed by a porcupine. Only the medial and central parts of the articular surface of the glenoid cavity are present. The bone has also sustained damage of the articular surface and the blade through mining, but in addition it is obvious that the scapular spine had been broken by some accident other than porcupine gnawing before fossilisation. As the bone is so incomplete it is impossible to give any further valuable information or measurements concerning it.

14112M. Left metacarpal II. (Figure 17, $\times \frac{1}{2}$.) This specimen, damaged mainly during mining, is the proximal end only of a left metacarpal II; part of the head and shaft are missing. The lower end of the shaft shows signs of use as though by pounding before fossilisation. The specimen is markedly expanded in the proximal region and is therefore a metacarpal II and not metacarpal III or IV, both of which lack this characteristic.

13636M. Right metacarpal IV. (Figure 18, $\times \frac{1}{2}$.) The distal portion of a right metacarpal IV had a small part of the shaft broken across during mining. The larger protuberance on the dorsal surface is on the radial side and serves to distinguish it from metacarpal III where it is on the ulnar side. Metacarpal IV is also the only one in which the antero-posterior diameter of the distal end is greater

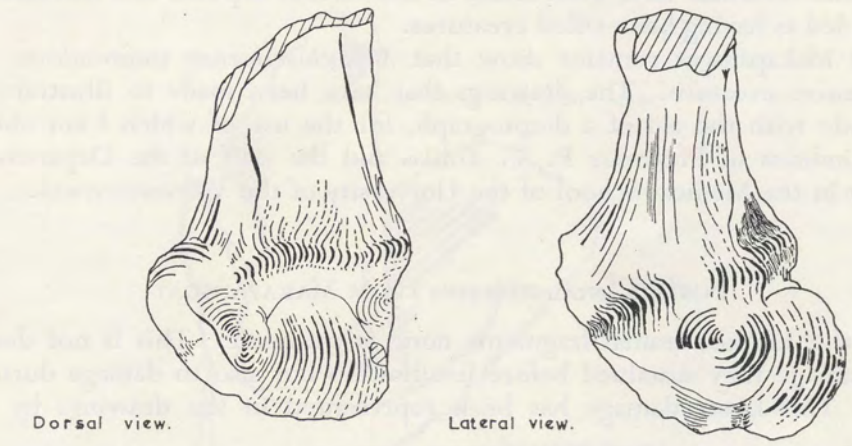


FIGURE 18

than the transverse diameter. The shaft becomes more circular in cross section proximally.

14111M. Intermediate phalanx. (Figure 19, $\times \frac{1}{2}$.) This fragment of an intermediate phalanx of the right manus has been recognised from the grooved nature of its anterior articulatory surface; otherwise the specimen has been extensively damaged during mining.

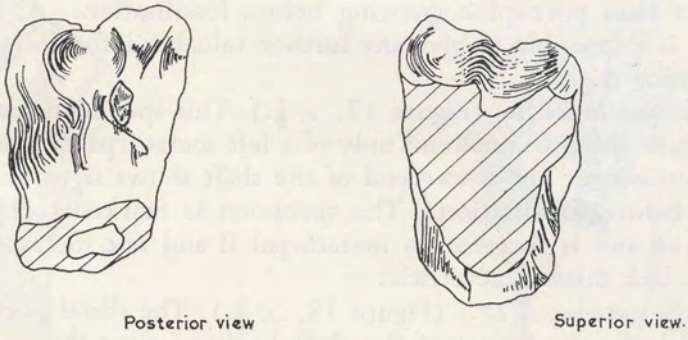


FIGURE 19

B. *The hindlimb*

5362M. Right innominate. (Figure 20, $\times \frac{1}{2}$.) This small fragment of a right pelvic innominate includes part of the acetabulum and ilium. The specimen was so badly damaged during mining that no comparative measurements that seemed useful could be taken.

12486M. Right innominate. (Figure 21, $\times \frac{1}{2}$.) This specimen comprises most of the acetabular region of a right pelvic innominate bone. Within the acetabulum there is a deep concave depression for the attachment of the ligamentum teres such as is characteristic of chalicotheres, no other animal having quite so marked a depression. The ilium, ischium and pubis are all missing—mainly as a result of mining—giving the specimen a triangular shape.

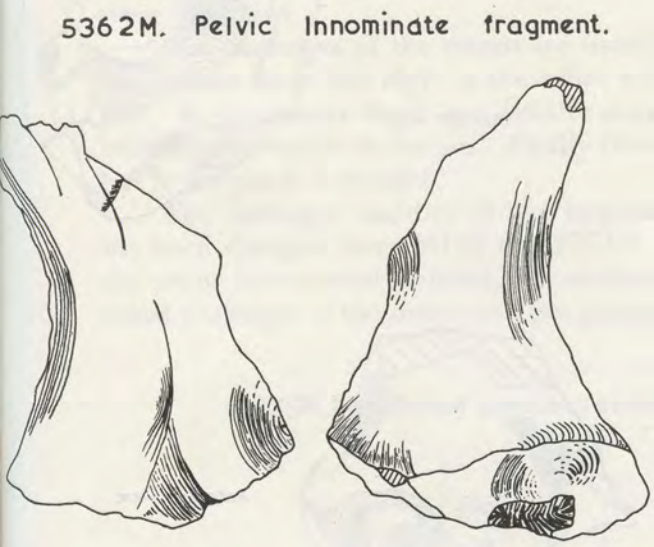


FIGURE 20

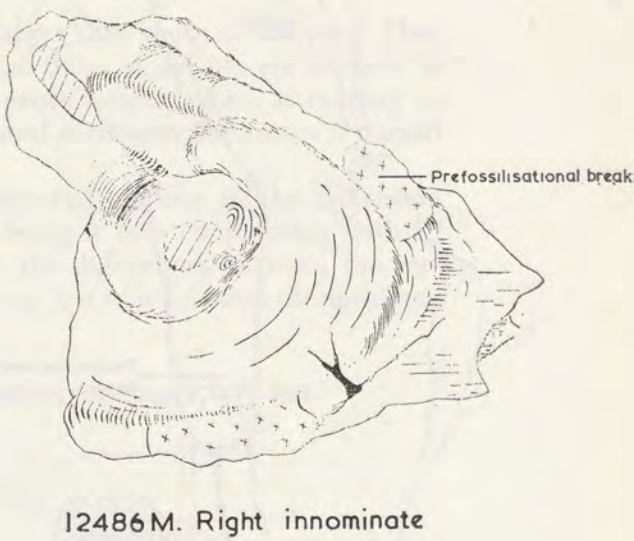


FIGURE 21

Despite the fact that most of the fractured surface is recent and due to mining there is sufficient trace of old fracturing and wear to show that the bone had acquired its present form before fossilisation, except for its ischial portion which has been broken away recently. It is also obvious that the margin of the acetabular cavity has been so broken and worn by use that its original shape has been considerably modified. The cavity itself is also irregular and roughened. The prefossilisational marks near the depression may have been caused during the extraction of the femoral head from the cavity. Towards the edge of the cavity some fine chisel marks are apparent, due to the preparation of the specimen and these must not be confused with the prefossilisation ones. This bone could have served as a receptacle in which food was pounded or crushed.

2043M. Right tibia, proximal end. (Figure 22, $\times \frac{1}{2}$.) Although recognisable as a proximal part of a tibia this specimen was badly broken during mining and no useful comparative measurements can be recorded. The ridges for the attachment of the muscles on the posterior surface are clearly visible. The subtriangular outline of the shaft is a characteristic feature of the chalicothere tibia. On the lateral surface there is a portion of the surface bone which has been lost before fossilisation.

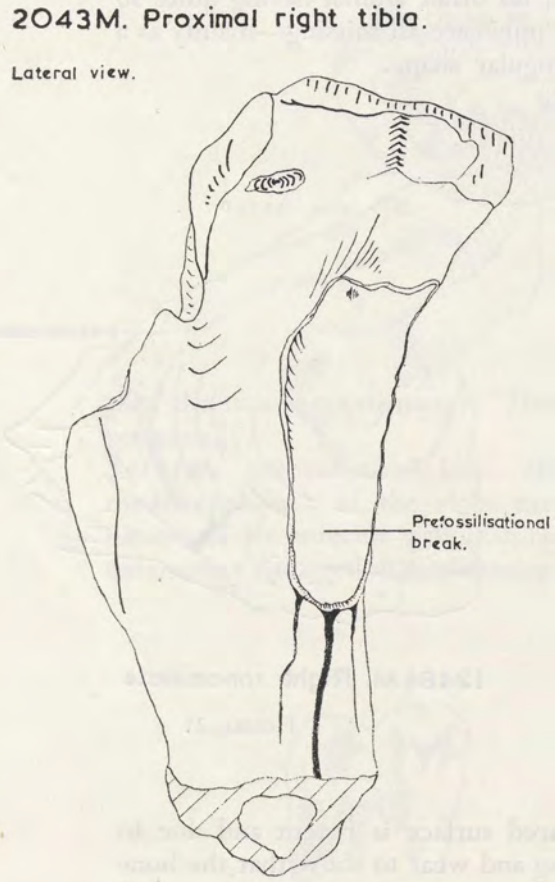


FIGURE 22

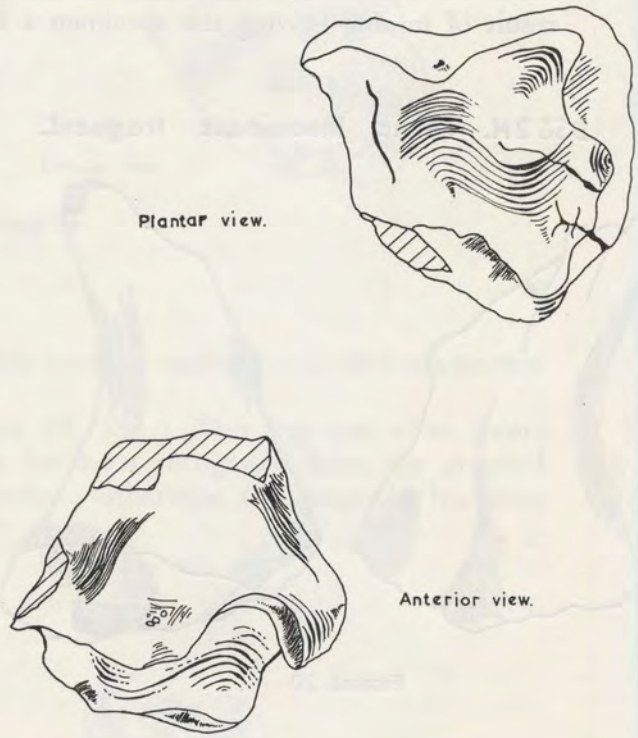


FIGURE 23

5974M. Right tibia, distal end. (Figure 23, $\times \frac{1}{2}$.) This damaged fragment of a right tibia is characterised by the broad lip-like posterior malleolus. It has no connection with the specimen described above and must have come from a second creature.

13635M. Left co-ossified phalanx. (Figure 24, $\times \frac{1}{2}$.) This specimen is a left duplex bone of the pes, most probably from digit II. A duplex bone arises from

the fusion of the proximal and intermediate phalanges. There is very little of the proximal articulatory surface present owing to the battered condition before fossilisation of the region surrounding and involving it. The distal surface externally on the dorsal side seems also to have been pounded away.

13633M. Phalanx. This specimen is also very fragmentary and it is difficult to determine whether it belonged to the manus or to the pes. Probably it is part of a duplex bone.

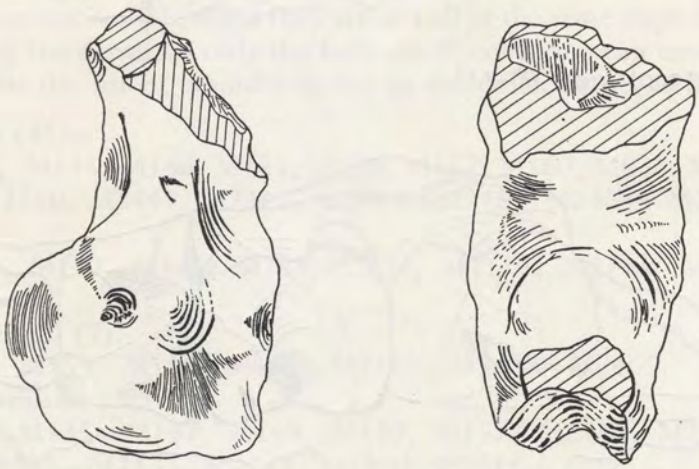
C. *Terminal phalanges*

It is difficult to determine whether a terminal phalanx comes from the manus or the pes unless a complete hand or foot is recovered. However, with the help of Holland and Peterson's text and diagrams two terminal phalanges were identified.

The phalanges of the manus are usually larger than those of the pes. They vary in size from one digit to the other whereas those of the pes are uniform in size. In the manus there is a definite dorsal protuberance which is missing or only slightly visible in the pes. Finally the ventral surface in the manus is curved but in the pes it is straight.

The catalogue number of the original terminal phalanx in the collection has been changed from M159 to 12773M to bring it into conjunction with all the other post-cranial remains. According to the differences between the terminal phalanges of the manus and pes given above it is now felt that the specimen

13635M. Coössified proximal & intermediate phalanges, left pes.

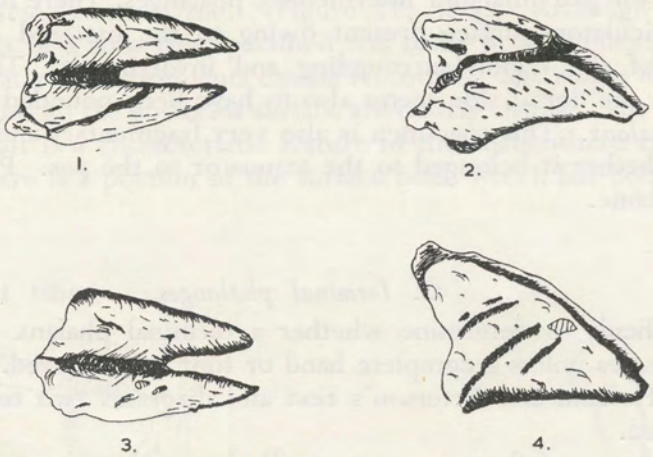


Tibial view

Dorsal view.

FIGURE 24

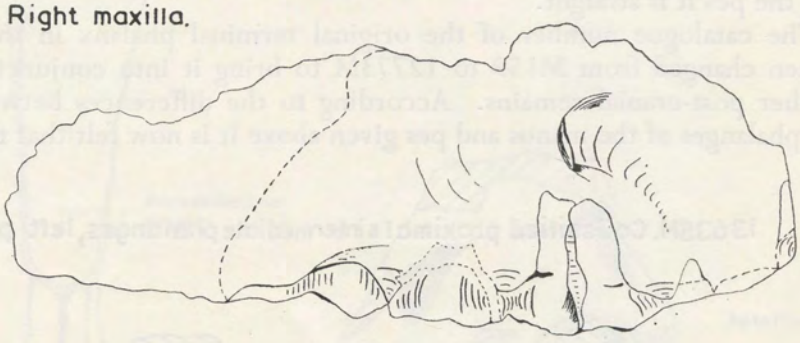
12773M and 13814M Ungual phalanges.



M12773. 1. Anterior view, 2. Lateral view.
M13814. 3. Anterior view, 4. Lateral view.

FIGURE 25

M153 Right maxilla.



Lateral view. P^4- M^3



Occlusal view. P^4- M^3.

FIGURE 26

12773M belongs to digit II or III of the pes rather than to digit III or IV of the manus as originally described.

12773M. Terminal phalanx. (Figure 25, $\times \frac{1}{2}$.) This is one of the original specimens recovered and has been described by George in 1950 in *S. Afr. J. Sci.* but for the reasons given above is now taken to come from digit II or III of the pes.

13814M. Terminal phalanx. (Figure 25, $\times \frac{1}{2}$.) This specimen is also from the pes and most likely also came from digit II or IIII.

Both of these terminal phalanges were broken off before fossilisation just anteriorly to their articulatory surfaces. The tips of the claws in 13814M have been broken recently. These two specimens had apparently been used before fossilisation both having been broken near their articulatory surfaces and the claws in 12773M being worn down.

The measurements below show the similarity in size of both the specimens and emphasizes the reasons for identifying them as being part of the pes.

	12773M.	*13814M.*
Greatest length of broken specimen	57mm.	55mm.
Greatest transverse diameter at plantar surface ..	34mm.	32mm.
Length of cleft along dorsal surface	57mm.	51mm.
Length of cleft along plantar surface	30mm.	22mm.
Greatest height	35mm.	38mm.

Cranial remains from Makapansgat

It was stated earlier that 84% of the chalicothere remains are cranial and consist predominantly of isolated teeth. There are 45 isolated teeth, 7 fragments of maxilla and 22 mandibular fragments. It has thus been possible to obtain an almost complete set of the upper and lower dentitions although some of the specimens are not complete and they are not all at the same stage of development. In describing the dentition only the best specimens have been used and described in detail, but the list of cranial remains in the collection is as follows:

Isolated teeth (45).

Uppers, M145, M146, M151, M155, M157, M160, M638, M2144, M2145, M2147—M2150, M2441, M2442, M2444—M2451, M2453—M2462, M2468—M2470.

Lowers, M140, M141, M148, M154, M1116, M2143, M2463, M2464, M2467.

Maxillary remains (7).

M144, M153, M156, M158, M2142, M2438, M2465.

Mandibular remains (22).

M131, M135—M137, M149, M150, M152, M2141, M2151, M2427—M2433, M2435—M2437, M2439, M2440, M2466.

A. *Superior dentition.* The presence or absence of incisors or canines cannot as yet be determined as no premaxillary remains or isolated upper incisors or canines

have been recovered. Unfortunately too there are no premolars in the collection but the three molars are represented although in a rather fragmentary form.

The most prominent feature of the upper permanent molars is the W-shaped ectoloph. In addition there are two unequally large internal conical cusps. On

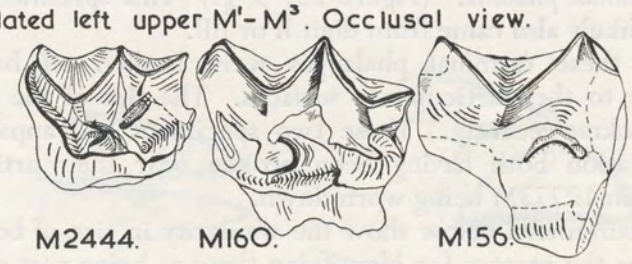
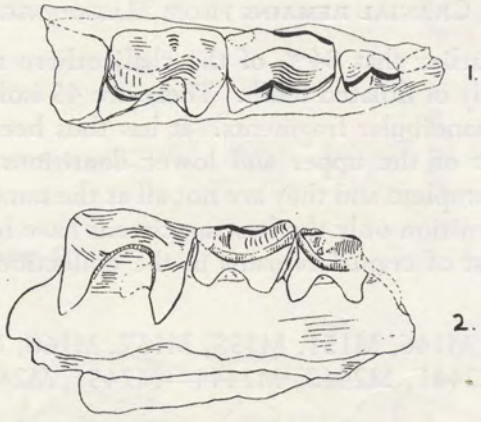


FIGURE 27

the internal face of the teeth there is a prominent but smoothly rounded cingulum. There is little or no difference in the configuration of the crowns of the three molars except that the features become more marked in each successive molar (see Fig. 27). In transverse diameter all three molars are fairly similar but there



M 131. Right mandible P_3 - M_1.

1. Occlusal view 2. Lateral view.

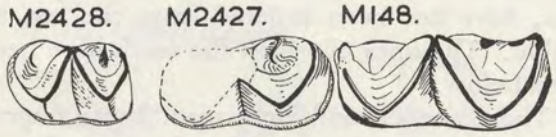
FIGURE 28

is a large increase in antero-posterior diameter between M^1 and M^2 but only a slight, if any, increase between M^2 and M^3.

Unfortunately the superior dentition is the lesser well represented, there

being no premolars and mostly fragmentary molars, those present being three right and one left M^1, two right and three left M^2, one right and one left M^3.

M153 is a maxillary fragment of an aged specimen bearing P^4—M^3, highly worn by natural abrasion but the teeth were also greatly damaged by mining. All the other specimens are isolated teeth except M156, which is a maxillary fragment with part of M^2 and a fragmentary M^3.



Lower left P_4, M_2, M_3. Superior view

FIGURE 29

B. *Inferior dentition*. In the remains from Makapansgat Limeworks there is an isolated lower incisor but whether there were 1, 2 or 3 incisors and one or more canines can only be known when an anterior portion of the lower jaw has been recovered.

Generally in chalicotheres P_1 is absent and P_2 a simple tooth of small size. We have not found any examples of a P_2 at Makapansgat but P_3 has developed the typical molariform pattern although it is still a fairly small tooth (see Fig. 28).

P_4 shows a marked increase in size, especially in the antero-posterior direc-

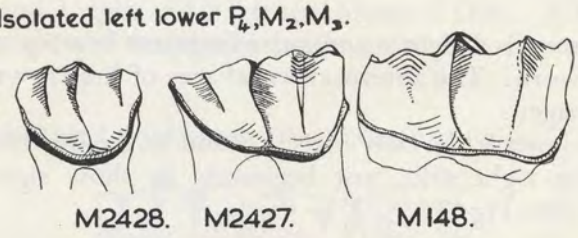


FIGURE 30

tion, and also has the characteristic W-shaped outline externally. The postero-internal area of the tooth is also particularly well developed. In both P_3 and P_4 on the external surface there is a cingulum while internally the tooth is almost smooth.

In the molar series the only two specimens of M_1 are both fragmentary as a result of mining and exhibit little structural detail. The crown pattern of M_1 is similar to that of P_4 but more definitely developed while the cingulum is less prominent. There is an increase in both antero-posterior and transverse

diameters between M_1 and M_2; thus M_2 although a much larger tooth still has the same general characteristics as the preceding tooth with the exception of the cingulum which in M_2 is well developed postero-externally. M_3 is a still longer tooth but lacks the third lobe which is found in the European and Asiatic species. Externally and posteriorly the cingulum is prominent but the tooth is smooth internally.

The majority of the lower teeth from Makapansgat, other than the very fragmentary pieces, have not been isolated from the jaw but include adjacent parts of the mandible. The ones in which the teeth have been used for measurements are described below.

M131 and M135. These are left and right mandibular fragments from the same jaw. Both bear PM_3—M_1, although M135 is far more fragmentary than M131. However, in both jaws the teeth are so extremely worn that the details of their structure are undecipherable. (See Fig. 28, $\times \frac{1}{2}$.)

M140. This is an isolated left P_4 which is well worn. One root has been recently broken.

M2428. This is a left mandibular fragment bearing a slightly worn P_4 which is the best in the collection. (See Figs. 29 & 30, $\times \frac{1}{2}$.)

M150. This is a left mandibular fragment bearing a DM_4 and an erupting M_1, the tooth still being below the superior surface of the jaw.

M2427. This is a left mandibular fragment with an almost complete M_2 (Figs. 29, 30). Unfortunately a portion of the superior surface of the tooth has been broken recently. The cingulum is well developed in this tooth.

M148. This is an isolated left M_3 complete except for the roots. This specimen although worn is the most complete lower tooth in the collection. (See Figures 29 & 30, $\times \frac{1}{2}$.)

M152. This specimen is a right mandibular fragment bearing an almost complete M_3 which is well worn. The antero-external area of the crown has unfortunately been recently damaged.

M1116. This specimen is the only incisor found in the deposit. It is a complete specimen from the right side, just beginning to show signs of wear on the anterior surface. (See Fig. 31, $\times \frac{1}{2}$.)

Measurements of M1116.

Complete length of specimen	65mm.
Length of tooth only	37mm.
Width at anterior surface	22mm.
Transverse (greatest) diameter	17mm.

C. *Deciduous dentition.* The upper deciduous dentition is made up of three molars all of which are represented in the collection as isolated teeth as follows: 2 right and 5 left specimens of DM^2, 7 right and no left specimens of DM^3, and 5 right and 2 left specimens of DM^4.

DM^2 is much longer antero-posteriorly than transversely especially in

comparison with the permanent series. This greater length is due to the presence of a prominent protostyle which unites with the protocone to give a long ectoloph (see Fig. 32, $\times \frac{1}{2}$). Internally the tooth is surrounded by a heavy cingulum becoming lighter externally. DM^3 and DM^4 increase progressively in size and show the typical molariform pattern even better than the permanent teeth. Internally the cingulum is heavy, becoming almost smooth externally.

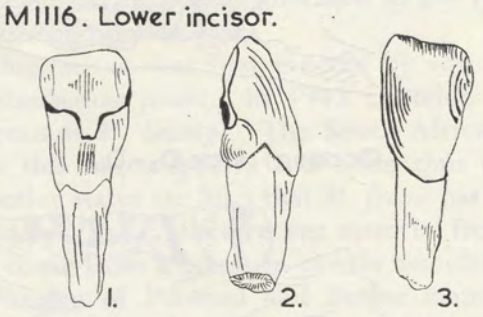


FIGURE 31

It is not known if inferior milk incisors or canines were present; probably they were. The three deciduous molars of the lower dentition are represented in the collection as follows: 3 right specimens of DM_2, 2 right and one left specimens of DM_3, and 2 right and 2 left specimens of DM_4. All these specimens are contained in mandibular fragments and are not isolated. (Compare figures 33 & 34, $\times \frac{1}{2}$.)

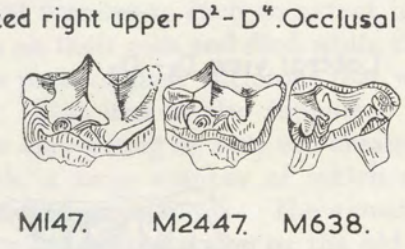


FIGURE 32

In this series DM_2 is a simple tooth with a long narrow crown, DM_3 is almost twice as long as the preceding tooth and is molariform in every respect. DM_4 is only slightly longer than DM_3 but has a greater transverse diameter, otherwise there is practically no difference between them. In all these inferior deciduous molars the cingulum is but slightly developed.

D. *Comparison with the American forms.* Wherever possible comparative measurements between the South African form and the two American species *Moropus elatus* and *Moropus petersoni* have been taken. From these measurements it is clear that the South African form and *M. elatus* compare closely in size whereas

M 2151. Right mandible



Occlusal view. $D_2 - D_4$



Lateral view. $D_2 - D_4$

FIGURE 33

M637. Right mandible.



Lateral view. $D_2 - D_3$



Occlusal view. $D_2 - D_3$.

FIGURE 34

M. petersoni appears to have been much smaller. The measurements were taken on some of the post-cranial remains and on a series of the upper and lower molars. With regard to the measurements of the teeth, the transverse diameters

were more often than not identical but the antero-posterior diameters were slightly higher (1—2 mm.) in the American form.

Discussion

As the collection contains only two complete adult teeth (M148 & M160) all the others being either broken or fragmentary, identification and description have both been difficult. However, it is obvious that only one genus and species is present and that the remains can all be allocated to the type named by George (1950) as *Metaschizotherium transvaalensis*.

The genus *Metaschizotherium* was first erected by von Koenigswald in 1932 with the type *Metaschizotherium fraasi*. In 1942 Dietrich placed the Serengeti specimens into this genus as *M. hennigi*. The South African specimens are very closely comparable to this latter species and were thus classified as *M. transvaalensis*. However, Butler states (*in litt.*) that *M. fraasi* has now been transferred to the genus *Phyllotillon* by Viret. More recent material from Olduvai, collected by Leakey, appears to come from a creature closely associated with *Ancylotherium pentelicum* from the Pontian of Pikermi and Butler maintains that *M. hennigi* and consequently *M. transvaalensis* should both be transferred to this genus. This view is in agreement with the work of Schaub, 1943 and Thenius, 1953. If this suggested transfer were to take place then it is obvious that the genus *Metaschizotherium* would disappear. However, until remains which are more complete are recovered, that will enable direct comparison to be made between the South African form and those from Olduvai and Pikermi, the classification of the Makapansgat specimens will remain as *Metaschizotherium transvaalensis*.

Taking into consideration the maxillary and mandibular remains, only two of the mandibles are known to be a pair and none of the maxilla are thought to accompany the mandibles and therefore the minimum number of chalicotheres represented in the deposit is thought to be 17.

The fact that so many creatures were accessible and yet the cranial remains outnumber the post-cranial remains to such an extent indicates that the animals did not come to the caves on their own and died while they were there but were killed first and only those parts of their skeletons that were going to be utilised were taken to the caves. This idea is also supported by the fact that all the remains come from either very young or very old creatures. This is particularly noticeable from the teeth, a large number of which are deciduous while the remaining ones show heavy signs of wear. The remains show that the chalicotheres were large beasts and so the young or the old would more easily be a prey to the hunter.

Relationship of the chalicothere remains to the osteodontokeratic culture

It has been stated already that the chalicothere remains account for only 86 of the 50,000 and more fragments recovered from about 10 tons of the Phase 1 breccia, i.e. ·072% of the total remains.

Secondly it was noted that 74 or 84% of the fragments were cranial (or more precisely dental, i.e. isolated teeth and fragments of upper and lower jaws containing one or more teeth).

The 12 post-cranial fragments (apart from the damaged left scapula, the damaged upper and lower fragments of a right tibia and the two innominate fragments) came from a right manus and a left pes.

Yet it has been established that at least 17 chalicotheres had been at the disposal of the creatures responsible for the deposition of the bones within the cave.

The deposit at Makapansgat was originally attributed by Professor Dart (1925) to primitive mankind and was subsequently suspected and finally proven by numerous discoveries since 1947 to be australopithecine-bearing in the upper and lower strata of the Phase I and also in the Phase II breccia.

It is unnecessary for me to recapitulate here the reasons he has advanced (Dart 1957) for believing that the bone deposit was made by these earliest representatives of mankind in the Transvaal, but it is desirable to point out to what extent his contentions are supported, or not, by these fragments under the detailed scrutiny which I have been able to give them.

In the first place it is characteristic of primitive human deposits to find the remains of very old and very young animals, those most easily captured.

In the second place it is obvious that, even if the flesh of the 17 chalicotheres was consumed by the australopithecines, they did not transport into the cave any of the very restricted skeletal parts of these creatures other than those of which they hoped to make some use.

In the third place the only reason advanced hitherto for a creature selecting jaws and pieces of jaws is either to sharpen their teeth upon them, as porcupines do, or to use them as ripping tools, saws and scrapers as human beings did.

I have pointed out that porcupine marks are present on the scapula; they are not found on any other of the fragments nor are they found elsewhere on these bones or with any degree of frequency on the other fragments of the deposit.

None of these chalicothere teeth could serve as ripping tools or saws, but as scrapers of flesh they would be virtually everlasting. (Vide plates I & II.)

Judging from the number of mandibles in the deposit these were the parts most sought after, the size of their teeth and accompanying fragment of mandible being very convenient (see figs. 28 & 33) especially in comparison with the maxillae which were very large. The lower teeth, which are much smaller and not as strong as the upper teeth, were apparently useful, if still in the jaw, but not when isolated.

In order to make scraping tools of these large teeth it was necessary to shatter the jaws, breaking them across, after removing the ascending ramus in the case of the lower jaws and breaking off the maxillae or even extracting the individual teeth in the case of the upper jaws. Specimens M2435 and M2428 are

excellent examples of mandibular fragments showing the prefossilisational blows that shattered them.

However useful the mandibular teeth were, even when furnished with a natural handle, there are actually more isolated maxillary teeth present than mandibular fragments; the only justification for this was their presumably greater effectiveness as scrapers owing to their wider and rougher cutting surfaces.

The clue to australopithecine interest in the manus and pes probably lay, as Professor Dart (1957) suggested, in the scratching or digging ability of the clawed terminal digits.

The only other fragments to be accounted for are the damaged scapula which had probably served as an axe, the tibia which was doubtless a club and the two innominates. These provided the most capacious and strongest type of natural mortar that was available for the australopithecines—other than those of rhinoceros—in which to pound any food they desired to crush with the aid of inferior metacarpal extremities such as are often found in an abraded and rounded condition in the breccia. The chalicothere metacarpal bones may have served as such pestles as the ends of many other abraded metacarpals both artiodactyl and perissodactyl appear to have done.

Acknowledgments

My thanks are due to Professor R. A. Dart for all the help and advice which he has so generously given; to Mr J. W. Kitching for his assistance in the identification of the individual bones and teeth and to Mr A. R. Hughes for his kindness in taking the photographs. As already stated I am deeply obligated to the Natal Museum, Pietermaritzburg, for the loan of literature, without which it would not have been possible for us to identify the more fragmentary items amongst the remains. Dr P. M. Butler of Royal Holloway College, University of London, has also assisted me with the most recent information about literature and classification.

In conclusion I welcome this opportunity of expressing my thankfulness to the South African Council for Scientific and Industrial Research, whose provision of a technical assistant to Professor Dart has enabled me to carry out this investigation during my tenure of that post.

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Plate I.

Maxillary remains from Makapansgat to show their broken nature and the chiefly isolated state in which the teeth were found. All the teeth come from the right side except the extreme left specimens in the first and third rows from the top and the third specimen from the left in the third row from the top. Unless otherwise stated all the occlusal surfaces are worn by natural abrasion. In the specimens where only partial or no roots appear these have all been recently broken. All recent breaks are due to the processes of mining and preparation.

Represented in the Plate are five examples of DM^3, five examples of DM^4, three examples of M^1, three examples of M^2, and three maxillary fragments bearing more than one tooth. Despite the fact that there are numerous examples of the same tooth they are not all at the same stages of growth—some being newly erupted while others have occlusal surfaces which are heavily worn. In the paper as complete a set of each dentition as was available has been described but not each individual fragment recovered. (Refer to Text Sections 8A and 8C and Figs. 13, 14, and 19.)

Top Row: 1. Left M^1 (lower left edge damaged recently otherwise complete); 2. Right DM^3 (complete except for roots); 3. Right DM^4 (occlusal surface heavily worn); 4. Right DM^3 (lower left edge shows prefossilisational breaks, lower right edge is recently broken, occlusal surface heavily worn); 5. Right DM^3 (numerous recent breaks on outer surface of tooth, part of broken maxilla still attached); 6. Right DM^4 (complete, newly erupted tooth).

2nd Row: Right M^1 (numerous recent breaks on all surfaces); 2. Right DM^4 (complete except for recent break on outer wall); 3. Right DM^3 (occlusal surface heavily worn, part of maxilla still attached with broken margins worn smooth, compare with Top Row specimen 5 whose margins are rough and unused); 4. Right DM^3 (outer wall recently broken, edges of the attached maxilla are worn smooth by manual use); 5. Right DM^4 (complete except for small recent break on lower right edge); 6. Right DM^4 (left side of tooth recently damaged, portion of maxilla still present).

3rd Row: 1. Left M^2 (anterior half of tooth recently broken off, occlusal surface well worn); 2. Right M^1 (outer surface recently broken, occlusal surface heavily worn); 3. Left maxillary fragment bearing M^2 and M^3 (note prefossilisational exposure of root of M^2 and area around base of M^3, broken maxillary margins are worn smooth by manual use, see Fig. 14); 4. Right M^2 (complete well worn tooth, part of maxilla still present shows signs of manual use); 5. Right M^2 (original and most complete specimen in the collection, see Text Sections 3 and 4 and Fig. 14).

4th Row: 1. Right maxillary fragment bearing P^4—M^3 (worn virtually to the roots by natural abrasion, numerous recent breaks are visible all over the specimen, this is one of the specimens from the pink breccia, see Text Section 5 and Fig. 13); 2. Right maxillary fragment bearing P^4—M^2 (worn virtually to the roots by natural abrasion, this whole specimen was badly broken during mining).



PLATE I

Plate II.

Mandibular remains from Makapansgat to show the fractured state in which pieces of the jaw and teeth were found, noting especially the fact that there are no isolated teeth as there were amongst the maxillary remains. There are eight right and eight left mandibular fragments and one right incisor; the right mandibular fragments are the 3rd and 4th specimens in the top row, 2nd and 4th specimens in the 2nd row and the complete 3rd row. Unless otherwise stated all the occlusal surfaces have been worn by natural abrasion. All recent breaks are due to the processes of mining and preparation.

Represented in the Plate are all the examples which make up a complete lower dentition except for a P_2. There are nine fragments bearing one tooth only and seven bearing more than one tooth as well as the isolated right incisor. In the paper as complete a set of each dentition as was available has been described and in addition some individual descriptions of the specimens which have been used for measurements and comparisons are given. (Refer to Text Sections 8B and 8C and Figs. 15, 16, 17, 18, 20 and 21).

Top Row: 1. Left DM_3 (complete, mandible recently broken posteriorly but anteriorly all breaks are prefossilisational). 2. Left DM_4 (tooth and jaw show extensive recent damage). 3. Lower right incisor (early stages of normal wear evident, the only isolated lower tooth recovered, see Text section 8B and Fig. 18). 4. Right mandibular fragment bearing DM_2 and DM_3 (teeth complete and newly erupted, all breaks prefossilisational, an excellent scraper, see Text section 10 and Fig. 21). 5. Right DM_4 (both tooth and jaw show recent damage).

2nd Row: 1. Left DM_4 with a M_1 just erupting (large number of recent breaks present which obscure the prefossilisational breaks). 2. Right mandibular fragment (teeth recently broken at roots, mandible itself also shows recent breaks). 3. Left mandible bearing P_3—M_1 (two outer teeth fragmentary, occlusal surface of P_4 heavily worn, lower portion of jaw worn away by use and molar roots on externo-lateral surface exposed). 4. Right mandibular fragment bearing P_3—M_1 (occlusal surface of teeth heavily worn, deep crack along lower surface is prefossilisational, below crack jaw is worn away by use). These latter two specimens belong to the same animal and are two of the specimens which come from the pink breccia. (See Text section 8B and Fig. 15.)

3rd Row: 1. Right M_3 (tooth complete except for small recent break on the right, all other breaks prefossilisational and margins all worn smooth by manual use, note exposure of root where mandible was originally broken, an excellent scraper, see Text section 10). 2. Deciduous molar (both tooth and jaw very fragmentary hence no clearer identification). 3. Right mandibular fragment (probable M_1 present worn virtually to roots, empty sockets of probable M_2 visible, no recent breaks, specimen has been well gnawed by porcupine). 4. Right mandibular fragment bearing DM_2—DM_4 (occlusal surface of teeth worn by natural abrasion, mandible recently broken anteriorly. See Fig. 20).

4th Row: 1. Left lower molar (probable M_1 occlusal surface recently broken off, tooth still attached to part of jaw on one side free on the other, no breaks apparent on free surface, margins of mandible all worn smooth by manual use). 2. Left mandibular fragment (M_2 and M_3 recently broken off flush with the mandible, note the deep prefossilisational cracks, reverse side is indented (opposite crack on right side) probably due to blows given during breaking of the jaw, lower portion of left side of jaw has been scooped out). 3. Left P_4 (tooth complete, mandible shows blow mark on extreme lower right edge, other breaks are recent, see Figures 16 and 17). 4. Left M_2 (occlusal surface recently broken, jaw also recently broken both anteriorly and posteriorly, see Figures 16 and 17).



PLATE II

ZUR NOMENKLATUR UND VERBREITUNG DES GENUS *DINOFELIS* ZDANSKY, 1924 (*THERAILURUS* PIVETEAU, 1948)

Von Helmut Hemmer, Mainz

ZUSAMMENFASSUNG

Dinofelis abeli Zdansky 1924 und die Arten des Genus *Therailurus* Piveateau 1948 gehoren zum gleichen Genus (*Dinofelis*). Die in der Gebissspezialisation primitivste Art ist *Dinofelis diastemata* (Astre 1929), die am weitesten fortgeschrittene *Dinofelis piveteaui* (Ewer 1955), parallel dazu *Dinofelis abeli* Zdansky 1924. *D. diastemata—D. barlowi—D. piveteaui* bilden eine zusammenhängende Reihe, während *D. abeli* mehr isoliert steht.

ABSTRACT

Dinofelis abeli Zdansky 1924 and the species of the genus *Therailurus* Piveteau 1948 belong to the same genus (*Dinofelis*). The most primitive species concerning the specialisation of the teeth is *Dinofelis diastemata* (Astre 1929), the most evolved is *Dinofelis piveteaui* (Ewer 1955) and by parallel evolution *Dinofelis abeli* Zdansky 1924. *D. diastemata—D. barlowi—D. piveteaui* form a connected succession whilst *D. abeli* takes a more isolated place.

Anlässlich einer Bearbeitung fossiler Pantherinae wurde die Überprüfung verschiedener Felidengenera auf ihre systematische Zugehörigkeit erforderlich, die von Kretzoi (1929) ohne Angaben von Gründen zu dieser Unterfamilie gestellt wurden. So rechnete er unter anderem das Genus *Dinofelis* Zdansky dazu, das in Form der Art *Dinofelis abeli* an Hand eines verdrückten, aber ziemlich kompletten Craniums aus dem Pliozän Nordchinas beschrieben war (Zdansky 1924, p. 137 ff. und Taf. 31, Fig. 1-4). Jener Schädel scheint bislang auch der einzige bedeutsame Fund seiner Art geblieben zu sein. Gleicherweisen scheint *Dinofelis* in der Literatur seit der Originalbeschreibung keine weitere Beachtung gefunden zu haben; etwaige spätere Vergleiche mit anderen Felidengenera, die an Hand der Abbildungen Zdanskys durchaus möglich sind, sind dem Autor nicht bekannt.

Zdansky beschreibt für *Dinofelis* im Gebiss einige Merkmale, die von den modernen Feliden in Richtung Machairodontinae abweichen und stellt grosse Ahnlichkeiten zu den nordamerikanischen Nimravinae fest. Ahnliche Zwischenstellung wird andererseits dem Genus *Therailurus* Piveteau, 1948 aus dem Pliozän Westeuropas und dem Pleistozän Südafrikas zugewiesen (Piveteau 1948 und 1961, Ewer 1955), so dass ein Vergleich beider Formen nahe lag. Folgende Zusammenstellung spezieller bzw. typischer Merkmale von *Dinofelis* und *Therailurus* soll diesen Vergleich übersichtlich darlegen:

Merkmal	*Dinofelis abeli* (Zdansky 1924)	*Therailurus diastemata* (Piveteau 1948)	*Therailurus piveteaui* (Ewer 1955)	*Therailurus barlowi* (Ewer 1955, Toerien 1955)
1. Schädelprofil	Frontalia und Occiput in einer Linie etwa auf gleicher Höhe, Occiput eher sogar etwas höher	Frontalia und Occiput in einer Linie auf gleicher Höhe	Frontalia und Occiput in einer Linie auf gleicher Höhe	Frontalia und Occiput in einer Linie auf gleicher Höhe
2. Crista sagittalis und lambdoidea	Kräftig entwickelt	Kräftig entwickelt	Kräftig entwickelt	—
3. Proc. postorbitalis des Frontale	Sehr kurz	Ziemlich kurz	Kurz und stumpf	Kurz und stumpf
4. Proc. postorbitalis des Jugale	Nach innen eingebogen	Nach innen eingebogen	Kurz und stumpf, nach innen eingebogen	Kurz und stumpf (Einbiegung?)
5. Höhe des Jochbogens	Von vorne nach hinten gleichmässig abnehmend	Von vorne nach hinten gleichmässig abnehmend	—	—
6. Kanten des Jochbogens	Oberkante schwach gekrümmt, Unterkante bis zur Cav. glenoid. fast gerade	Oberkante gekrümmt, Unterkante sehr wenig gekrümmt	—	—
7. Nasale	Breit; lange Sutur mit Maxillare	Breit; lange Sutur mit Maxillare	Breit; (lange?) Sutur mit Maxillare	—
8. Lage des Proc. mastoid.	Etwas näher an Proc. paroccipitalis als an Proc. postglenoidalis	Näher an Proc. paroccipitalis als an Proc. postglenoidalis	Beträchtlich näher an Proc. post-glenoidalis als an Proc. paroccipitalis	—
9. Rel. Grösse des Proc. mast.	Gross	Gross	Gross	—
10. Form des aboralen Gaumenrandes	Einfach (spitz-) bogig nach vorn eingezogen	Einfach bogig nach vorn eingezogen	einfach (spitz-) bogig nach vorn einge ogen	—
11. Stellung der Incisivenreihe	Bogig	Nur sehr flachbogig	Bogig	—
12. Rel. Grösse der Incisiven, bes. I^3	Rel. sehr gross	Nicht auffallend gross	Rel. sehr gross	Rel. sehr gross

Merkmal	*Dinofelis abeli*	*T. diastem.*	*T. piveteaui*	*T. barlowi*
13. C maxillaris	Sehr lang; fast gerade; etwas abgeflacht; glatt; ungezähnelte Vorder- und Hinterkanten; Innenseite etwas flacher als Aussenseite	Lang; abgeflacht; ziemlich glatt; ungezähnelte Vorder- und Hinterkanten	Lang, deutlich abgeflacht; fast gerade; nicht ganz glatte, aber ungezähnelte Vorder- und Hinterkanten; Innenseite etwas flacher als Aussenseite	Lang, etwas abgeflacht, fast gerade; glatt; nicht ganz glatte, aber ungezähnelte Vorder- und Hinterkanten; Innenseite etwas flacher als Aussenseite
14. Diastema zwischen C max. und P^3	Ziemlich kurz	Nicht besonders kurz	Kurz	Kurz
15. P^3	Grosser Hauptzacken, deutlich abgesetzte Vorder- und Hinterzacken, Talon sehr kräftig	Grosser Hauptzacken, kleine Vorder- und Hinterzacken, Talon kräftig	Zacken schmal und schlank; grosser Hauptzacken, kleine deutlich abgesetzte Vorder- u. Hinterzacken, Talon sehr kräftig	Grosser Hauptzacken, kleine abgesetzte Vorder- und Hinterzacken, Talon deutlich abgesetzt
16. P^4	Länge der drei Hauptzacken (Parastyl, Protocon, Metacon) von vorn nach hinten jeweils deutlich zunehmend; am Zahnvorderrand kleiner Ectoparastyl; Deuterocon sehr gering ausgebildet, stark reduziert	Deuterocon normal entwickelt, kaum reduziert; Ectoparastyl fehlend	Sehr schlank; Länge der drei Hauptzacken (bei Ewer Parastyl, Paracon, Metacon) von vorn nach hinte jeweils deutlich zunehmend; am Vorderrand kleiner Ectoparastyl (Ectostyl bei Ewer) Deuterocon nur als geringe Anschwellung an der Zahninnenseite, stark reduziert	Länge der drei Hauptzacken von vorn nach hinten zunehmend, aber deutlich nur von Parastyl zu Protocon; Ectoparastyl; undeutlich bis klein Deuterocon normal entwickelt, kaum reduziert
17. M^1	Ausserst klein, einwurzelig	Relativ gross, oval	Klein, einwurzelig	Relativ gross, oval
18. Lage des Unterrandes des Proc. angularis zum Mandibelunterrand davor	Stark nach unten abgewinkelt	Etwas nach unten abgewinkelt	Deutlich nach unten abgewinkelt	Deutlich nach unten abgewinkelt
19. Rel. Grösse des Proc. coronoideus	Niedrig, in Grösreduziert	Nicht besonders reduziert	Niedrig, in Grösse reduziert	Niedrig, in Grösse reduziert
20. C mandibularis	Viel kleiner als C max., glatt	Kleiner als C max. glatt	Viel kleiner als C max., glatt	Abgeflacht; kleiner als C max., glatt

Merkmal	*Dinofelis abeli*	*T. diastem.*	*T. piveteaui*	*T. barlowi*
21. Diastema des unterkiefers	Sehr lang; Oberrand der Mandibel im Diastema nach vorn stark ansteigend	Sehr lang; Oberrand der Mandibel im Diastema nach vorn stark ansteigend	—	Lang; Mandibelrand im Diastema nicht besonders ansteigend
22. P_3	Rel. zu P_4 sehr klein, nur Hauptzacke (Protoconid) gut entwickelt, hoch; Nebenzacken sehr klein	Rel. zu P_4 nicht auffällig klein; nur Hauptzacke gut entwickelt, Nebenzacken klein	—	Rel. zu P_4 sehr klein, nur Hauptzacke gut entwickelt, hoch; Nebenzacken sehr klein
23. P_4	Grosser, spitzer, schlanker Protoconid; Paraconid schlank, stärker als Hypoconid; deutlicher Talonid	Grosser Protoconid Paraconid?; deutlicher Talonid	Grosser Protoconid, Paraconid nur wenig grösser als Hypoconid; deutlicher Talonid	Grosser, spitzer, schlanker Protoconid; Paraconid schlank, etwas stärker als Hypoconid; deutlicher Talonid
24. M_1	Hinterrand des Protoconids glatt, keine Spur eines Metaconids oder Talonids; Paracond deutlich kürzer als Protoconid	Ohne deutlichen Metaconid oder Talonid	Keine Spur eines Metaconids oder Talonids	Ohne Metaconid oder Talonid bis zu deutlich abgesetztem grossen Talonid variierend, Paraconid kürzer als Protoconid

Dieser Vergleich zeigt durch Übereinstimmung sämtlicher spezieller Merkmale von *Dinofelis abeli* mit jeweils mindestens einem der *Therailurus*-Arten deutlich die Zusammengehörigkeit in einem einzigen Genus, das prioritätshalber den Namen *Dinofelis* Zdansky, 1924 tragen muss. *Therailurus* Piveteau, 1948 fällt in die Synonymie von *Dinofelis*.

Dieses Genus erweist sich damit als über ganz Eurasien und Afrika verbreitet, wenn auch noch keine Funde aus den dazwischenliegenden Landschaften vorzuliegen scheinen. Allerdings stammt das bisherige Fundmaterial für jeden Kontinent aus einem anderen Zeitabschnitt. Am ältesten dürfte *D. abeli* sein, die wohl aus der Hipparionfauna stammt, also unterpliozänen (pontischen) Alters ist (Zdansky 1924). In das obere Pliozän (Asti) dürfte die französische *D. diastemata* zu datieren sein (Astre 1929, Piveteau 1948). Die südafrikanischen Funde gehören dem älteren Pleistozän an, und zwar, infolge zeitlicher Trennung der Fundorte Sterkfontein, Makapansgat, Taung einerseits und Kromdraai, Swartkrans andererseits (vergl. Oakley 1962), *D. barlowi* dem Altestpleistozän (Villafranchien), *D. piveteaui* dem Altpleistozän.

Ewer (1955) beschreibt unter der Bezeichnung *Therailuru* sp. ein Mandibelfragment aus Swartkrans. Dessen M_1 könnte nach der Beschreibung sowohl *D. barlowi* wie *piveteaui* zugeordnet werden; der P_4 ist etwas grösser als der von *D. barlowi*, gleicht ihm aber sonst laut Ewer ausserordentlich eng. Nach den Abnützungsspuren am M_1 und P_4 nimmt Ewer einen verlängerten P^4 an; am M_1 tritt eine ganz *D. piveteaui* entsprechende typische Abnutzungsspur als schmale Rinne vor der Furche Paraconid/Protoconid auf, die durch einen kleinen Kamm am vorderen Teil der Innenseite des Metacons des P^4 verursacht ist, wie es von Ewer am *piveteaui*-P^4 festgestellt werden konnte. Morphologisch zeigen sich demnach engste Beziehungen zu der Form *piveteaui*, von der sich das Fragment vorwiegend nur durch seine grösseren Ausmasse unterscheidet. Diese gestatten jedoch keineswegs spezifische Trennung, da sie im Rahmen der Geschlechtsvariationsbreite bei Feliden liegen. Auch der niedrige C mand. spricht für hohe Spezialisierung des Trägers, so, wie wir sie bei *D. piveteaui* vor uns haben. *Therailurus* sp. Ewer kann deshalb ohne weitere Bedenken der zeitgleichen *Dinofelis piveteaui* zugerechnet werden.

Für das Genus *Dinofelis* ist dann folgende Artaufstellung vorzunehmen:

1. *Dinofelis abeli* Zdansky, 1924

SYNONYME: *Dinofelis Abeli* Zdansky 1924, p. 137 ff., Taf. 31, Fig. 1-4
Machairodus horribilis Schlosser 1903 (partim, Zdansky 1924).

HOLOTYPUS: Im hinteren Abschnitt nicht ganz vollständiges Cranium; Paläontologisches Museum Upsala.

TYPUSFUNDORT: Lok. B, Honan, Nordchina.

VERBREITUNG: Nur aus China bekannt.

ZEITSTELLUNG: Unterpliozän (Pontien) (?).

DIAGNOSE: Grösste *Dinofelis*-Art; Schädel langgestreckt, Jochbogen relativ lang; Proc. mastoideus etwas näher am Proc. par-occipitalis als am Proc. postglenoidalis; Incisiven relativ sehr gross; Proc. coronoideus des Unterkiefers relativ niedrig; Diastema des Unterkiefers sehr lang, Mandibeloberrand dort stark nach vorne ansteigend; am P^4 Deuterocon stark reduziert, rudimentär.

MASSE:

1. Nach Abbildung gemessen:

Condylobasallänge	282
Basallänge	270
Unterkieferlänge	195

2. Nach Zdansky 1924:

I^1	8·2 × 5·7	I_1	6·9 × 4·4
I^2	9·6 × 6·9	I_2	7·7 × 6·1
I^3	11·8 × 11·0	I_3	9·5 × 8·0
C max.	26·7 × 17·5	C mand.	19·5 × 14·5
P^3	23·0 × 10·7	P_3	15·0 × 8·0

P^4	36·3 × 14·0	P_4	25·3 × 11·4
M^1	1·9 × 1·7		27.0 × 12·4
	3·0 × 1·2	M_1	27·5 × 12·5
	(Masse der Wurzel)		35.0 × 16.0

Diastema C max.—P^3: 11·0

2. *Dinofelis diastemata* (Astre) 1929

SYNONYME: *Felis diastemata* Astre 1929, p. 199, ff., fig. 1-3
Therailurus diastemata Piveteau 1948.

HOLOTYPUS: Bruchstück eines rechten Mandibelastes mit unvollständigem C mand., P_3, P_4 und Alveole des M_1 und I_3.

TYPUSFUNDORT: Briqueterie Chefdebien bei Perpignan/Frankreich.

VERBREITUNG: Nur aus Frankreich bekannt.

ZEITSTELLUNG: Oberpliozän (Asti).

DIAGNOSE: Schädel ziemlich langgestreckt, Jochbogen relativ lang; Proc. mastoideus näher an Proc. paroccipitalis als an Proc. postglenoidalis; Incisiven nicht besonder gross; Proc. coronoideus des Unterkiefers nicht besonders niedrig; Diastema des Unterkiefers sehr lang, Mandibeloberrand dort stark nach vorn ansteigend; am P^4 grosser Deuterocon.

MASSE: 1. Nach Abbildungen von Piveteau und Astre gemessen:

Gesamtschädellänge	261		
Condylobasallänge	240		
Basallänge	223		
Jochbogenbreite	170		
P^3-Länge	21	P_3-Länge	16
P^4- ,,	29	P_4- ,,	23
		M_1- ,,	23

2. Nach Astre 1929 und Piveteau 1948:

C mand.	15 × 10·5	Kronenhöhe	22
P_4	23		
M_1	24		

Diastema C-P: 27 (am Typus).

3. *Dinofelis piveteaui* (Ewer) 1955

SYNONYME: *Therailurus piveteaui* Ewer 1955, p. 588 ff., Fig. 1-6
Therailurus sp. Ewer 1955, pp. 603-604.

HOLOTYPUS: Besonders im oberen Teil unvollständiges Calvarium; Transvaal Museum No. Ka. 61.

TYPUSFUNDORT: Kromdraai, Südafrika.

VERBREITUNG: Nur aus Südafrika bekannt.

ZEITSTELLUNG: Altpleistozän.

DIAGNOSE: Schädel breit; Jochbogen relativ kurz; Proc. mastoideus beträchtlich näher an Proc. post-glenoid. als an Proc. paroccip. Incisiven relativ gross; Proc. coronoideus des Unterkiefers relativ niedrig; Zähne sehr schlank und flach; am P^4 Deuterocon stark reduziert, rudimentär; M^1 sehr klein, einwurzelig.

MASSE: Nach Ewer 1955:

Condylobasallänge		223	
Basallänge		198	
Jochbogenbreite		186	
I^1	8·5 × 6·4	P^3	19·8 × 10·0
	8·7 × 6·4		19·9 × 9·9
I^2	9·6 × 7·9	P^4	41·0 × 13·0
	9·5 × 7·5		41·2 × 13·2
I^3	11·1 × 10·3	M^1 (alv.)	4·7 × 4·5
	10·8 × 10·6		
C max.	20·5 × 12·1	. . . Kronenhöhe etwa 40-42	
	20·4 × 12·1		
Diastema C max.-P^3:		6·7	
		7·2	
C mand.	17·0 × 12·0	Kronehöhe: 9	
P_4	23·7 × 11·4		
	25·3 × 11·7		
M_1	27·7 × 16·9		
	30·3 × 14·6		

4. *Dinofelis barlowi* (Broom) 1937

SYNONYME: *Meganthereon barlowi* Broom 1937, p. 757 ff.
Machairodus transvaalensis Broom 1939 (partim, P^4/ex Ewer 1955).
Therailurus barlowi (Broom): Ewer 1955, p. 599 ff., fig. 7.
Machaerodus darti Toerien 1955, p. 43 ff, fig. 11-12. (vergl. Ewer 1956).

HOLOTYPUS: Zerbrochener Schädelteil und grosser Teil des rechten Maxillare mit Zahnteilen; isolierter, dazugehöriger linker oberer Canin. Transvaal Museum, Pretoria. No. 1541 und 1542.

TYPUSFUNDORT: Sterkfontein, Südafrika.

VERBREITUNG: Nur aus Südafrika bekannt.

ZEITSTELLUNG: Altestpleistozän (Villafranchien).

DIAGNOSE: Diastema des Unterkiefers relativ lang, Mandibeloberrand dort aber nicht auffällig ansteigend; Zähne rel. gedrungen;

am P^4 Deuterocon normal entwickelt, nicht reduziert; M^1 relativ gross und oval.

MASSE:

1. Nach Ewer (1955)

Gesamtlänge etwa 250 (nach Broom 1937)

C max.	etwa 24·0 × 15·0	24·4 × 14·3	Kronenhöhe 60
P^3	21·5 × 11·3	etwa 20 × 00	(Broom 1937)
P^4	36·2 × 16·5	etwa 38 × 16	37·4 × 16·8
M^1	11·1 × 6·8		

Diastema C max.-P^3 9

P_3	16·1 × 8·7
P_4	24·7 × 11·4
M_1	etwa 26·0 × 14·0

2. Nach Toerien (1955)

Unterkieferlnäge 754

C max.	24·0 × 15·0
C mand.	16·5 × 10·0
P_3	12·2 × 7·1
P_4	21·4 × 10·0
M_1	25·9 × 11·6

Diastema C mand.-P_3 21

Abschliessend bleibt zu klären, ob zwischen den vier zeitverschiedenen *Dinofelis*-Arten irgendein direkter phylogenetischer Zusammenhang möglich erscheint. Ewer (1955) legt den Evolutionstrend, der zu einer machairodontinen Spezialisierung des Genus *Dinofelis* führte, im Vergleich von *D. diastemata* und *D. piveteaui* ausführlich dar. Für die Beurteilung der Primitivität einerseits, der Spezialisation andererseits gibt Ewer drei Indices, nämlich die relative Incisivengrösse (spezialisiert: Indexwert hoch), die Abflachung des oberen Eckzahnes (spezialisiert: Indexwert niedrig) und die relative Jochbogenlänge (spezialisiert: Indexwert niedrig). Als nicht zahlenmässig festzuhaltende Charaktere gelten die relative Grösse und Lage des Proc. mastoideus, die Reduktion des Deuterocon am P^4 und die Reduktion des Proc. coronoideus des Unterkiefers.

Dabei scheint aber die Abflachung des oberen Eckzahnes bei *Dinofelis* unter Zugrundelegung der Anschauung Ewers, dass der niedrige Indexwert die höhere Spezialisation anzeigt, ziemlich unabhängig von der allgemeinen Spezialisationsstufe zu variieren, da der Index gerade bei *D. diastemata* den niedrigsten Wert besitzt (0·54), der nach sämtlichen anderen Eigentümlichkeiten (vergl. dazu auch die oben gegebene Merkmalsvergleichstabelle der Arten) am wenigsten spezialisierten Art der Gattung, wie auch Ewer im Vergleich mit *D. piveteaui* zeigt. In gleiche Richtung weist die geringe Abflachung bei *D. abeli* (Indexwert 0·65), die sonst im Gebiss fast ebenso hoch spezialisiert ist wie *D. piveteaui*

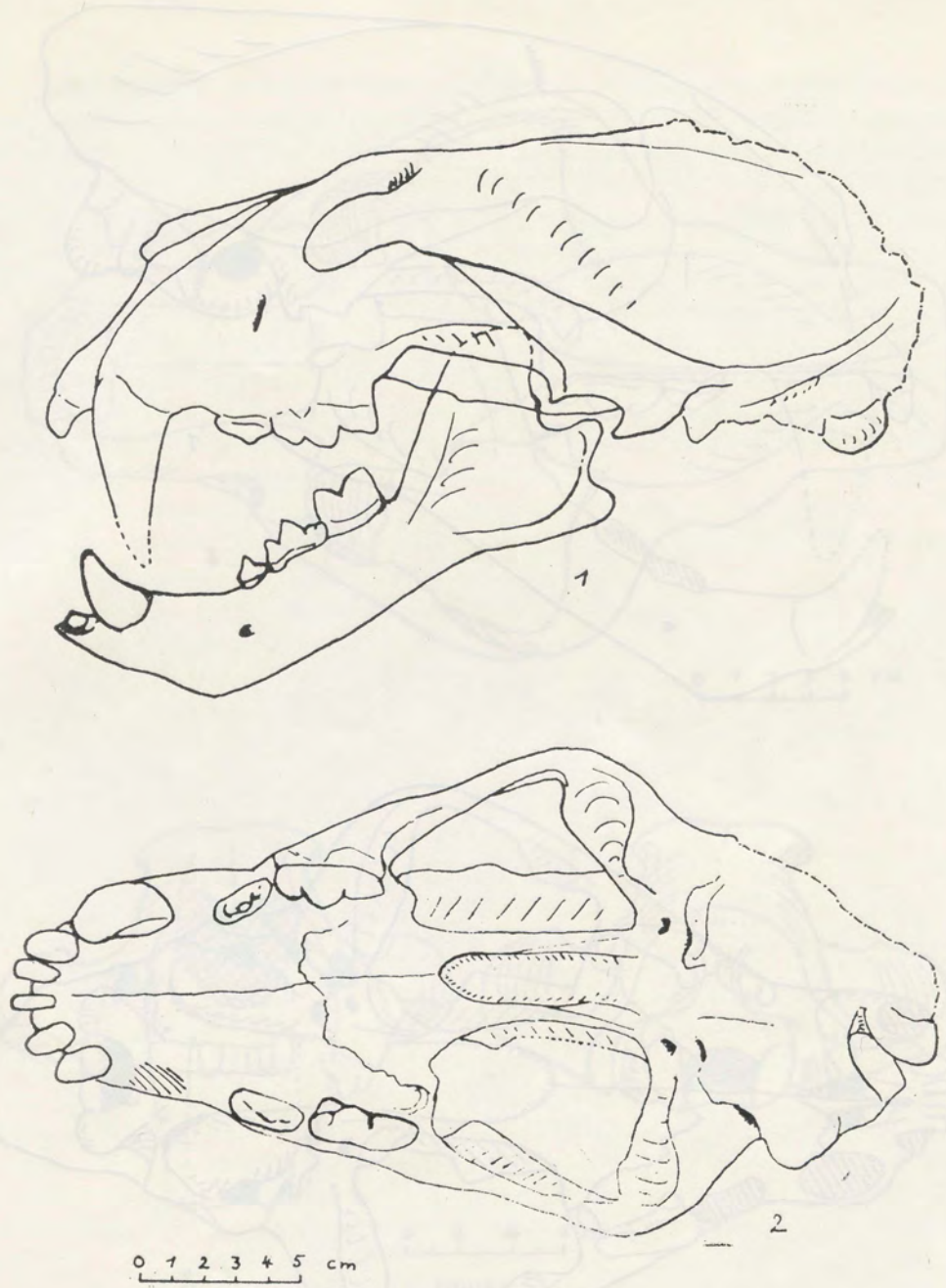


FIGURE 35

Abb. 35: Dinofelis abeli Zdansky 1924
Fig. 1: Norma lateralis
Fig. 2: Norma basilaris
Nach Photos von Zdansky (1924)

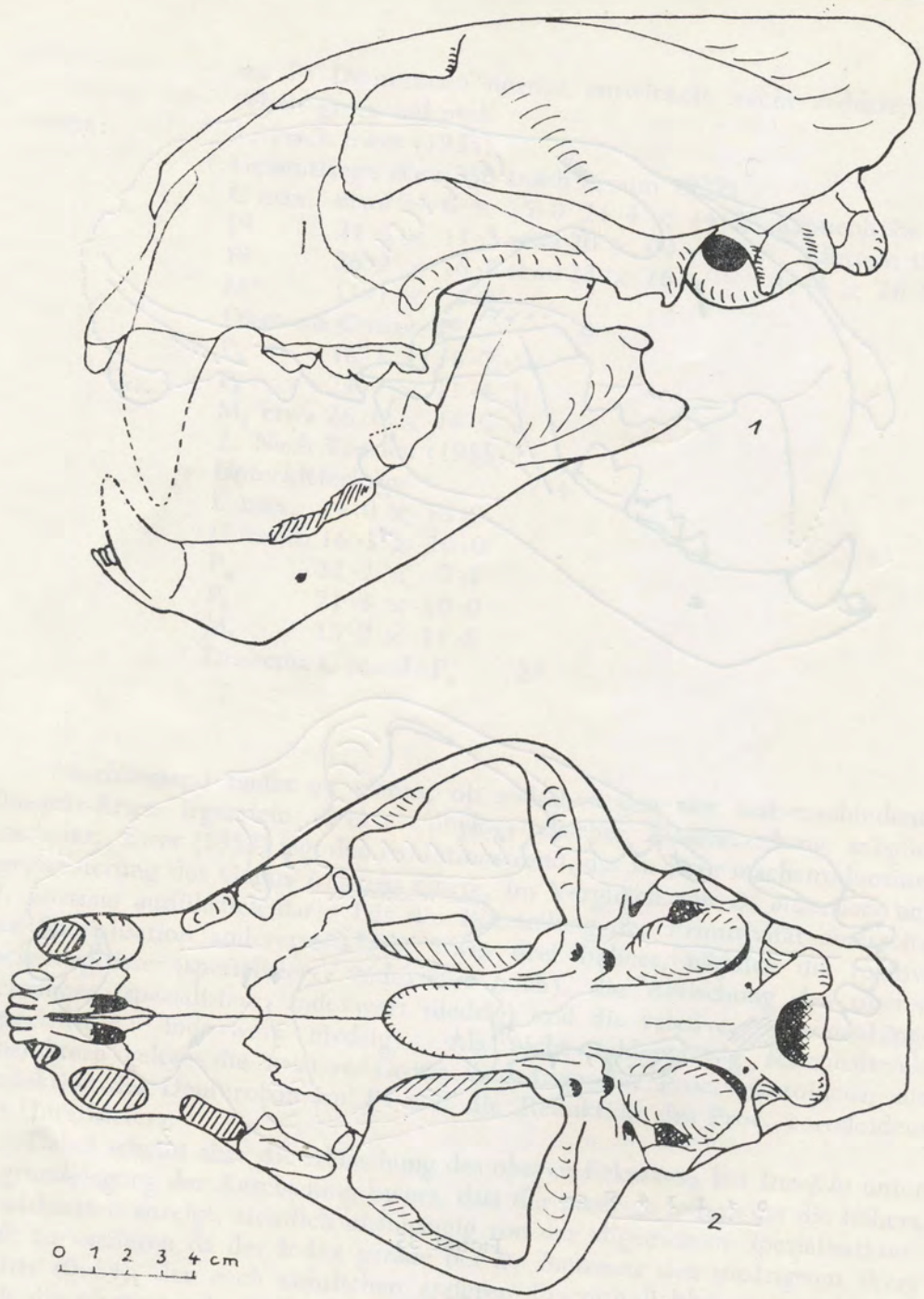


FIGURE 36

Abb. 36: Dinofelis diastemata (Astre 1929)
Fig. 1: Norma lateralis
Fig. 2: N. basilaris

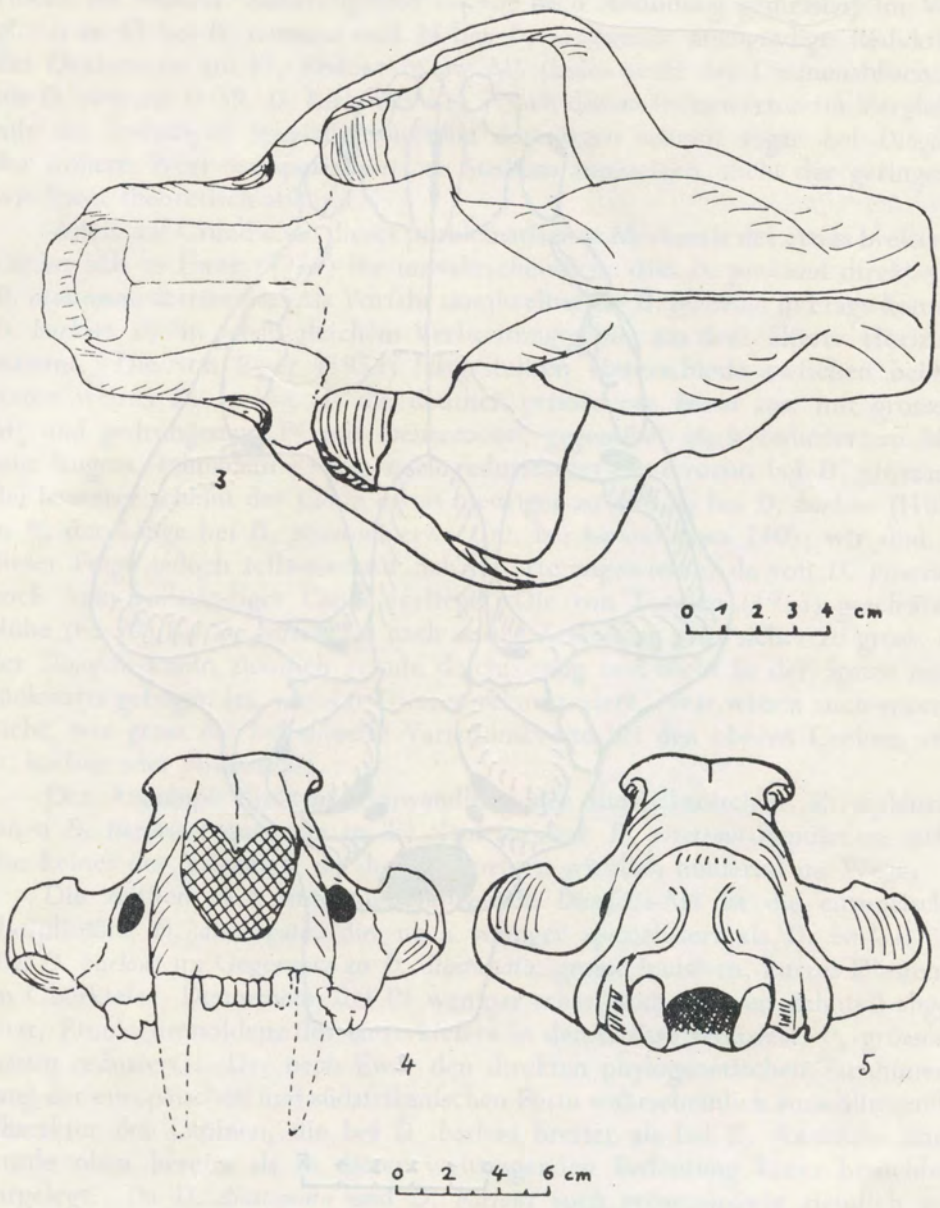


FIGURE 37

Abb. 37:

Fig. 3: N. dorsalis
Fig. 4: N. frontalis
Fig. 5: N. occipitalis
Nach Photos von Piveteau (1948)

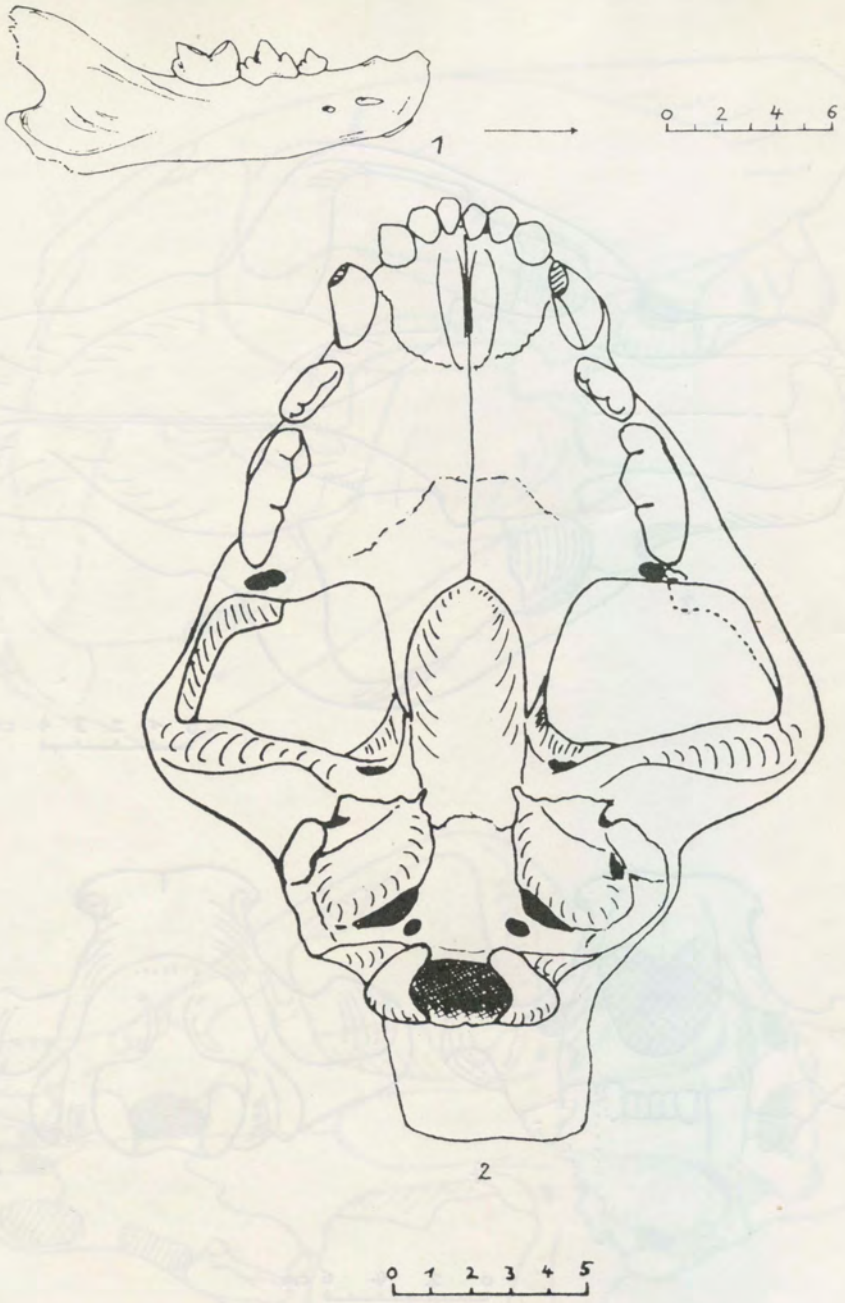


FIGURE 38

Abb. 38: Fig. 1:
Dinofelis barlowi (Broom 1937)
Unterkiefer, nach Toerien (1955)
Fig. 2:
Dinofelis piveteaui (Ewer 1955)
Schädel in Norma basilaris
Nach Photo von Ewer (1955)

(Index für relative Incisivengrösse = 45, nach Abbildung gemessen) im Vergleich zu 47 bei *D. piveteaui* und 34 bei *D. diastemata;* hochgradige Reduktion des Deuterocon am P^4, Reduktion des M^1 (Indexwerte der Caninenabflachung für *D. piveteaui* 0·59, *D. barlowi* 0·61). Nach diesen Indexwerten im Vergleich mit der jeweiligen Spezialisationshöhe der Arten scheint sogar bei *Dinofelis* der höhere Wert das spezialisiertere Stadium anzuzeigen, nicht der geringere, wie Ewer theoretisch ableitet.

Allein auf Grund eben dieses problematischen Merkmals des etwas breiteren Canins hält es Ewer (1955) für unwahrscheinlich, dass *D. piveteaui* direkt von *D. diastemata* abstammt. Als Vorfahr unmittelbar für *D. piveteaui* in Frage kommt *D. barlowi*, die in genau gleichem Verbreitungsgebiet aus dem älteren Horizont stammt. Die von Ewer (1955) festgestellten Unterschiede zwischen beiden Arten weisen *D. barlowi* als die deutlich primitivere Form aus, mit grossem M^1 und gedrungenem P^4 mit Deuterocon, gegenüber stark reduziertem M^1, sehr langem, schmalem P^4 mit stark reduziertem Deuterocon bei *D. piveteaui*. Bei letzterer scheint der Canin etwas niedriger zu sein als bei *D. barlowi* (Höhe in % der Länge bei *D. piveteaui* etwa 200, bei *barlowi* etwa 240); wir sind in dieser Frage jedoch teilweise auf Schätzwerte angewiesen, da von *D. piveteaui* noch kein vollständiger Canin vorliegt. Die von Toerien (1955) geschätzte Höhe (65-70) für *D. barlowi* ist nach seiner Zeichnung ganz sicher zu gross, da der *Dinofelis*-Canin ziemlich gerade dolchförmig und nicht in der Spitze nach rückwarts gebogen ist, wie ihn Toerien rekonstruiert. Wir wissen auch vorerst nicht, wie gross die individuelle Variationsbreite bei den oberen Caninen von *D. barlowi* oder *piveteaui* ist.

Der Annahme direkter Umwandlung der südafrikanischen ältestpleistozänen *D. barlowi*-Population in die altpleistozäne *D. piveteaui*-Population steht also keines der Merkmale der beiden Formen wirklich hindernd im Wege.

Die zeitlich nach unten anschliessende *Dinofelis*-Art ist die europäische oberpliozäne *D. diastemata*, die noch weniger spezialisiert als *D. barlowi* ist (bei *D. barlowi* im Gegensatz zu *D. diastemata*, grosse Incisiven, kurzes Diastema im Oberkiefer, Deuterocon des P^4 weniger scharf vom anderen Zahnteil abgesetzt, Proc. coronoideus des Unterkiefers in der Grösse reduziert, P_3 grössenmässig reduziert). Der nach Ewer den direkten phylogenetischen Zusammenhang der europäischen und südafrikanischen Form wahrscheinlich ausschliessende Charakter der Caninen, die bei *D. barlowi* breiter als bei *D. diastemata* sind, wurde oben bereits als in dieser weittragenden Bedeutung kaum brauchbar dargelegt. Da *D. diastemata* und *D. barlowi* auch grössenmässig ziemlich gut übereinstimmen (mit Ausnahme des Trends zur Verlängerung des P^4, der bei *D. piveteaui* sein Maximum erreicht), ist die Entstehung der Art *D. barlowi* aus einer oberpliozänen *D. diastemata*-Population durchaus wahrscheinlich.

Abseits davon steht die grössere unterpliozäne *D. abeli* aus Ostasien, die in Parallelentwicklung zu den südafrikanischen Formen ein Stadium höherer Gebissspezialisierung erreicht hat und daher keineswegs in die Linie zu *D. diastemata*, die unspezialisierter geblieben ist, gehören kann. Beide Arten, die

gegenüber den südafrikanischen einige auffällige Schädelmerkmale gemeinsam haben (langgestreckter Schädel, rel. Lage der Proc. mastoideus und paroccipitalis zueinander, sehr langes Diastema des Unterkiefers mit stark ansteigendem Mandibeloberrand), sind vielmehr auf eine gemeinsame, wohl eurasiatische Wurzelgruppe des Miozäns zurückzuführen, wobei sich die östliche Gruppe sehr rasch im Gebiss spezialisierte, während die westliche die primitiveren Charaktere bewahrte.

Ein Vergleich des Genus *Dinofelis* mit dem oligozänen europäisch-nordamerikanischen Genus *Nimravus* nach Beschreibung und Abbildungen von Toohey (1958) zeigt grössere Variation in den Schädelmerkmalen bei *Nimravus* und sehr viel primitiveres Gebiss, unterstreicht aber dennoch die Meinung Zdanskys (1924), der bereits grosse Ahnlichkeiten zwischen beiden Genera feststellt. *Dinofelis* geht wohl auf eine *Nimravus*-Gruppe zurück; Zwischenglieder aus dem Miozän fehlen leider noch.

Vergleich einiger Schädelmerkmale von *Dinofelis* und *Nimravus:*

Merkmal	*Dinofelis*	*Nimravus brachyops* (Toohey 1958)
1. Schädelprofil	Frontalia und Occiput etwa in einer Linie auf gleicher Höhe	Occiput niedriger als Frontalia gelegen
2. Crista sagittalis u.-lambdoidea	Kräftig entwickelt	Variierend, meist stark entwickelt
3. Proc. postorb. des Frontale	Kurz und stumpf	Kurz und stumpf
4. Proc. postorb. des Jugale	Ziemlich kurz, nach innen eingebogen	Sehr kurz, nach innen eingebogen
5. Höhe des Jochbogens	Von vorn nach hinten gleichmässig abnehmend	Variierend; nicht gleichmässig nach hinten abnehmend
6. Kanten des Jochbogens	Oberkante gekrümmt, Unterkante sehr wenig gekrümmt	Ober- u. Unterkante meist etwa parallel, Unterkante manchmal nur sehr wenig gekrümmt
7. Nasale	Breit; lange Sutur mit Maxillare	Breit; lange Sutur mit Maxillare
8. Proc. mastoid.	Gross	Nicht besonders gross
9. Form des aboralen Gaumenrandes	Einfach (spitz-) bogig nach vorn eingezogen	Variierend, von einfach bogig nach vorn eingezogen bis zu doppelt geschwungenem Bogen mit medianem Vorsprung.

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A NEW GIANT HYRACOID FROM THE LIMEWORKS QUARRY, MAKAPANSGAT, POTGIETERSRUS

By J. W. Kitching

ABSTRACT

In this paper a new genus and species of giant hyrax from the Limeworks Quarry, Makapansgat, Potgietersrus, is described. This new hyrax is 1½ times larger than the largest specimen thus far extracted from any Pleistocene deposit in Africa. The name *Gigantohyrax maguirei* gen. et sp. nov., is proposed.

INTRODUCTION

During July, 1960, Mr B. Maguire, in charge of the excavations at the Limeworks Quarry, brought to the Institute a block of Upper Phase 1 or *Cercopithecoides*-breccia, in which was embedded approximately two-thirds of a very large *Hyrax* skull, as well as the mandible of a young cercopithecid. Only the right tooth row and a cross section through the brain case of the *Hyrax* were visible, the back of the skull having been destroyed during blasting operations.

More recently a second specimen was discovered in a block of breccia which has been in the collection of the Institute since 1958. This block is also from the Upper Phase 1 or *Cercopithecoides*-breccia and also contained an almost complete skull and lower jaw of a cercopithecid.

When the hyracoids were fully prepared from the matrix they turned out to be the largest of their kind ever to be extracted from any Pleistocene deposit anywhere in Africa.

Before the discovery of these two giant specimens it was generally accepted that only two species of *Procavia*, *P. transvaalensis* and *P. antiqua*, occurred in the dolomite caves of South Africa.

Gigantohyrax maguirei gen. et sp. nov.

Figures 39 and 40

The type (M8230) of this new genus is based on the well preserved anterior two-thirds of the skull discovered by Mr Maguire in 1960. The palate, both tooth rows and the incisors are in an excellent state of preservation.

The paratype (M8234) is an almost complete and reasonably well preserved skull, with the snout portion and dentition damaged.

The largest hyracoid hitherto known from the dolomitic cave deposits of South Africa is *Procavia transvaalensis* from the caves near Krugersdorp, a species which also occurs at the Limeworks Cave deposits at Makapansgat.

Churcher (1956) has shown that *Procavia transvaalensis* is 1½ times larger than the largest living *Procavia capensis*. *Gigantohyrax maguirei* in turn is 1½ times

larger than *Procavia transvaalensis*. Table 1 gives a comparison of basal length and jugal breadth between *Procavia capensis*, *P. transvaalensis* and *Gigantohyrax maguirei*, as well as the percentage ratio. Measurements are given in millimeters.

TABLE 1

Species	*Basal length*	*Jugal breadth*	*Percentage Basal length: Jugal breadth*
Procavia capensis	81·5	48·0	169·7
P. transvaalensis	125·2	73·6	170·1
Gigantohyrax maguirei (Type)	—	125·8	—
Gigantohyrax maguirei (Paratype) ..	200·00	124·0	161·2

In *Gigantohyrax maguirei* most of the cranial bones are fused. There is no trace of an interparietal (M8234). In both *Procavia transvaalensis* and *P. capensis* the interparietal is distinguishable from the parietal and supraoccipital; sutures are clearly visible. If an interparietal is present in *Gigantohyrax*, it has become compressed beyond recognition within the well developed, fairly broad, sagittal crest formed by the prominent temporal ridges. The latter also form very outstanding borders between the frontal and parietal bones, a feature which is inconspicuous in *P. transvaalensis* and mostly absent in *P. capensis*.

The parietal and supraoccipital bones in *Gigantohyrax* also seem to be in the process of fusing, as it is difficult to trace any sutures between them; sutures are only faintly visible in places. This fusion may be the result of the strong development of the occipital crests. In *P. capensis* these sutures are always clearly visible.

The frontal bones in *Gigantohyrax* are slightly raised close to the midline, or alternatively depressed in the direction of the orbits, and in this respect it agrees with *P. transvaalensis*. The marked thickening of the frontals along the supra-orbital borders of the orbits in the new genus is much less conspicuous in *P. transvaalensis*, and absent in *P. capensis*.

The position of the infraorbital foramen in *Gigantohyrax* is above the centre of P^3 and in this respect it agrees with *P. transvaalensis*. In *P. capensis* this foramen is situated above the posterior root of P^3.

The anterior edges of the nasal bones in *Gigantohyrax* are in the same vertical plane as the premaxillae, while in *P. transvaalensis* and *P. capensis* the nasals terminate farther back.

In *Gigantohyrax* the palatine-maxillary suture in the secondary palate is roundly curved, whereas in both *P. transvaalensis* and *P. capensis* it is invariably square.

The postorbital bars in *Gigantohyrax* are short, thick and solidly fused. By contrast the postorbital bars are longer, much more delicate, and invariably there is a gap between the jugal and parietal in both the living and the extinct species of *Procavia*.

In living hyraxes the complete dental formula is $1\frac{1}{2}$: $C\frac{1}{2}$: $P\frac{1}{2}$: $M\frac{1}{2}$, with

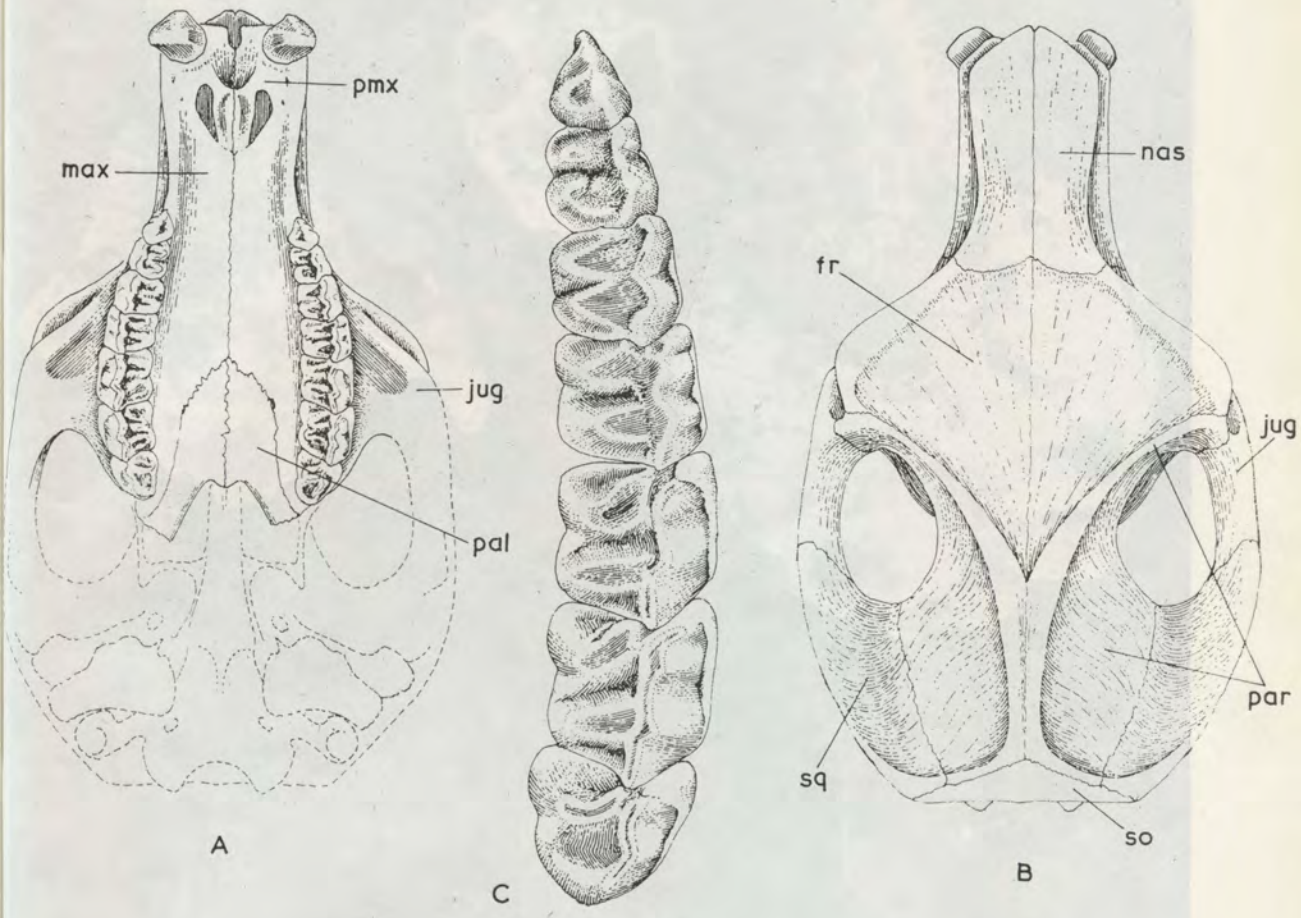


FIGURE 39

A—Ventral view of the type of *Gigantohyrax maguirei* (M8230), with the posterior region outlined according to the paratype and the modern *Procavia capensis*. X $\frac{1}{2}$.
B—Dorsal view of the paratype (M8234), with the snout restored after the type. X $\frac{1}{2}$.
C—Right dental row of the type. X $1\frac{1}{2}$.
Abbreviations: fr—frontal; jug—jugal; max—maxillary; nas—nasal; pal—palatine; par—parietal; so—supraoccipital; sq—squamosal.

the tooth rows converging slightly anteriorly. The two extinct forms agree in these respects, but in the new genus, while the massive hypsodont teeth also agree in crown patterns, there is hardly any wear, in spite of the otherwise fully mature appearance of the skull. For detailed tooth measurements see Table II.

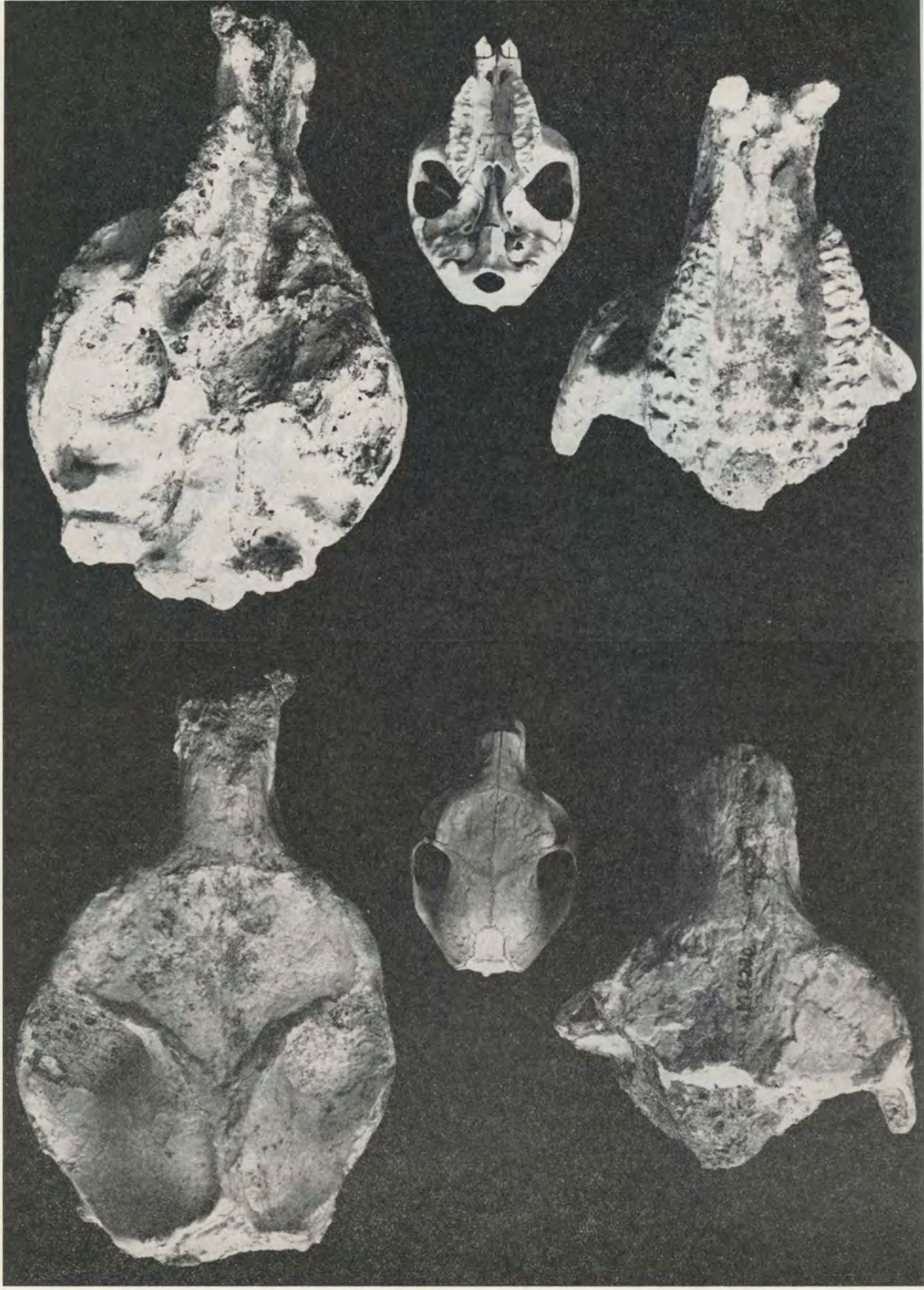


FIGURE 40

TABLE II

Measurements of upper cheek teeth of *Procavia transvaalensis*, "*Procavia obermeyerae*" (synonym of *P. transvaalensis*) and *Gigantopithecus maguirei*.

Dimensions	*P. transvaalensis* (Churcher 1956)	"*P. obermeyerae*" (Churcher 1956)	*G. maguirei* (M8230)
P^{1-4} Length	—	6	38·5
P^{2-4} Length	—	—	30·00
M^{1-3} Length	26·5	28·6	40·00
P^1 Length	—	—	8·5
Breadth	—	—	7·0
P^2 Length	—	—	9·3
Breadth	—	—	9·2
P^3 Length	7·2	7·2	11·9
Breadth	—	7·0	11·7
P^4 Length	—	8·5	12·2
Breadth	8·0	8·6	13·4
M^1 Length	—	9·8	15·5
Breadth	9·2	8·8	14·3
M^2 Length	9·8	9·7	15·7
Breadth	9·9	—	15·4
M^3 Length	10·0	9·3	15·2
Breadth	9·7	—	15·1

The incisors in *Gigantohyrax* are massive and short. Their sockets form marked ridges on the external surfaces of the premaxillae and maxillae, exaggerating as a result the depressions below them in the region of the diastemata.

The new genus also differs from both the *Procavia* species in that the gap between the upper incisors is greater than the width of one incisor.

With the addition of this new genus to our hyracoid records we are faced with the peculiar phenomenon that these three forms, the extinct new genus and the two previously recorded species of *Procavia* (*P. transvaalensis* and *P. antiqua*) in their three greatly different sizes, populated the Makapansgat cave area simultaneously during the period of the deposition of the Upper Phase I breccias.

ACKNOWLEDGMENTS

In addition to my indebtedness to Mr B. Maguire, I wish to record my sincere appreciation of Dr. A. S. Brink's assistance in the preparation of the figures and my thanks to Mr Theo Bekker for the photographic illustration.

Above: Ventral views of the paratype (left) and the type (right) of *Gigantohyrax maguirei*, compared with the modern *Procavia capensis* (centre).

Below: The same skulls in dorsal view. All skulls x $\frac{1}{2}$.

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A NEW GOMPHODONT CYNODONT FROM THE CYNOGNATHUS ZONE OF SOUTH AFRICA

By A. S. Brink

Abstract

This paper describes a somewhat peculiar new gomphodont cynodont from *Cynognathus*-zone beds of the Karroo System of South Africa. It is a fairly good skull, with lower jaw in position, but lacking the anterior portion of the snout. Its peculiarity lies in the fact that while the posterior portion of the dentary is powerfully expanded in true gomphodont style, the zygomatic arch is very weakly developed, unlike the condition in any of its other cynodont contemporaries. It is described as a new genus and species, *Cragievarus kitchingi*, generically after the locality Cragievar and specifically after its collector, Mr J. W. Kitching.

Introduction

In an article on fossil pockets and bone beds in the *Cynognathus*-zone, Mr J. W. Kitching (1963) refers to a locality below and west of the Wonderboomspruit railway bridge on the farm Cragievar some five miles south of Burghersdorp, Cape Province. In March 1962 he recovered from this fossil pocket 26 specimens, eight of which are immature *Diademodon browni* skulls. I referred to these latter skulls in a paper on *Diademodon* (Brink, 1963b) and listed some notes on four of the better preserved specimens.

Amongst the specimens recovered from this site there is a peculiar skull which, although one of the first to be cleaned, has been shelved for description on account of its somewhat unusual structure; I wished to consult the literature as widely as possible and the opinions of other palaeontologists before advancing my own views.

This specimen is a reasonably complete skull with a good lower jaw in position, and there are some fragments of vertebrae associated. The anterior portion of the snout and the left zygomatic arch are missing. The dentition is clearly gomphodont, but the crown structure of every tooth is obliterated through abrasion. Unfortunately the articular regions are badly preserved on both sides.

The peculiarity of the skull lies in the fact that it has the powerful extremely advanced lower jaw structure of a diademodontid, in the elaborate development of the three posterior portions—the coronoid, articular and angular processes. In sharp contrast, however, the zygomatic arch is delicate. In gomphodonts and cynognathids the zygomatic arch is powerful, to cope with the strongly developed masseter muscles suggested by the widely expanded posterior portions of the dentaries, but in this specimen the zygomatic arches are almost procynosuchid-like by comparison.

Delicate in appearance, in structure it is advanced. The jugal interlocks

extensively with the squamosal and, while damaged, there is evidence of an elaborate external auditory meatus groove not unlike that of *Diademodon*. The arch is situated at a high level, as in *Diademodon* and unlike the procynosuchid condition. It is, in fact, a delicate, miniature *Diademodon*-like or *Trirachodon*-like arch, but it lacks evidence of a jugal process.

Although this specimen is from the middle part of the *Cynognathus*-zone in this characteristic at least it predicts a condition which becomes characteristic again of the post-*Cynognathus*-zone cynodonts from the Molteno and Manda beds. In *Luangwa drysdalli* from the Ntawere formation in the Luangwa valley of Zambia (Brink, 1963a) there is also a marked reduction of the breadth of the skull across the zygomatic arches and the arches are shortened even though they still have some appreciable height. In the present specimen the vertical thickness is reduced and the arches are short proportionally, but they still curve widely laterally.

The whole arrangement would appear to lend support to Crompton's views (1963) on the forces exerted and the directions of pull of the jaw muscles to ease the strain on the suspension while the latter is being converted into the mammalian condition; and perhaps the arrangement in the present specimen can be interpreted as one where the articular process of the dentary is in a more advanced stage of interference in the suspension than in other contemporaries. This is only a deduction, because the suspension regions are too badly preserved in this specimen to permit any definite conclusions.

Cragievarus kitchingi gen. et sp. nov.
(Figures 41, 42 and 43)

Type. Reasonably complete skull, lacking the anterior part of the snout and left zygomatic arch, and damaged across the occiput, but with a good lower jaw and including some fragments of skeletal bones, catalogued under Field Number 3776 and Museum Number 368 in the collection of the Bernard Price Institute, derived from the middle of the *Cynognathus*-zone beds on the farm Cragievar in the Burghersdorp district of South Africa.

Diagnosis. Medium-sized gomphodont with unimpressive molariform post-canine teeth; formula i4 : c1 : pc2 + 7? for the upper jaw and i3 : c1 : pc-0 + 7 for the lower jaw; diademodontid in general shape and structure, but with dentaries even more powerfully expanded and with zygomatic arches conspicuously reduced.

Measurements. The following is a comprehensive list of measurements, in millimeters, useful for comparison:

Approximate total length of skull, as reconstructed	142
Approximate maximum breadth of skull across squamosals, as reconstructed	91
Minimum breadth of snout	26

Interorbital breadth	32
Minimum breadth across parietals posteriorly	10
Maximum breadth across parietals anteriorly	17
Antero-posterior length of orbit	24
From level of posterior borders of orbits to interparietal notch	41
Minimum width between postcanines	19
Width between last postcanines	38
From occipital condyles to posterior border of secondary palate	72
Breadth across pterygoid processes	37
Breadth between fenestrae ovales	22
Distance covered by seven molariform upper cheek teeth	27
Distance covered by seven molariform lower cheek teeth	30
Maximum length of dentary	125
Maximum vertical height of dentary	60
Minimum vertical height of dentary	15
Breadth of symphysis	17
Length of symphysis	41

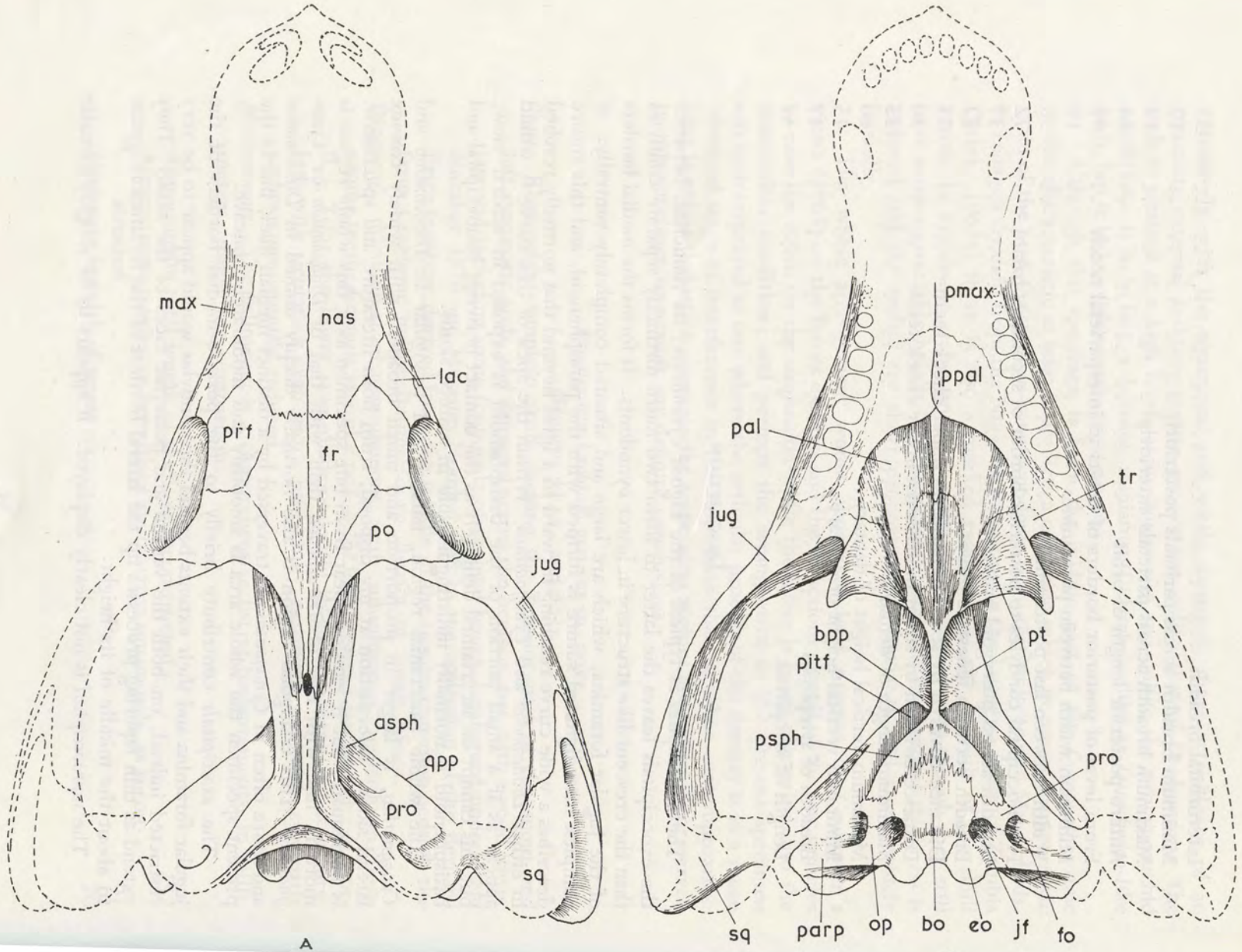
Description

The *basioccipital* is typical of the higher cynodonts; its reduction between the exoccipitals leaves the latter to form two more distinctly separate condyles than the crescent-like structure in lower cynodonts. It forms the medial borders of the jugular foramina, which are large and situated completely ventrally. A complex interdigitated suture is formed with the parasphenoid, and this suture describes a wide curve reaching forward to a level beyond that normally reached in either *Diademodon* and *Cynognathus*. Within the apex of this curve it would appear as if a small portion of the basisphenoid is exposed in ventral view, but this cannot be ascertained definitely as the contact between basioccipital and basisphenoid is normally indistinguishable in mature skulls.

The whole basicranial region, narrow and triangular in *Diademodon* and *Cynognathus*, is larger in proportion and much broader, with widely convex lateral sides. Information at my disposal, from both literature and specimens, is inadequate, but it would appear from one specimen as if this whole region is more in line with that of *Trirachodon* than with that of *Diademodon* or *Cynognathus*. This triangular region is also normally deeply domed in *Diademodon* and more often in *Cynognathus* is traversed by a distinct median keel, but in the present specimen the whole area is smoothly and moderately concave.

The *exoccipitals* contribute briefly to the postero-medial borders of the jugular foramina and their extents beyond the condyles would appear to be very restricted indeed, on both the ventral and posterior faces of the skull. They extend as thin tapering processes up the lateral borders of the foramen magnum to about the middle of its height.

The *supraoccipital* is not clearly displayed. It appears to be roughly circular


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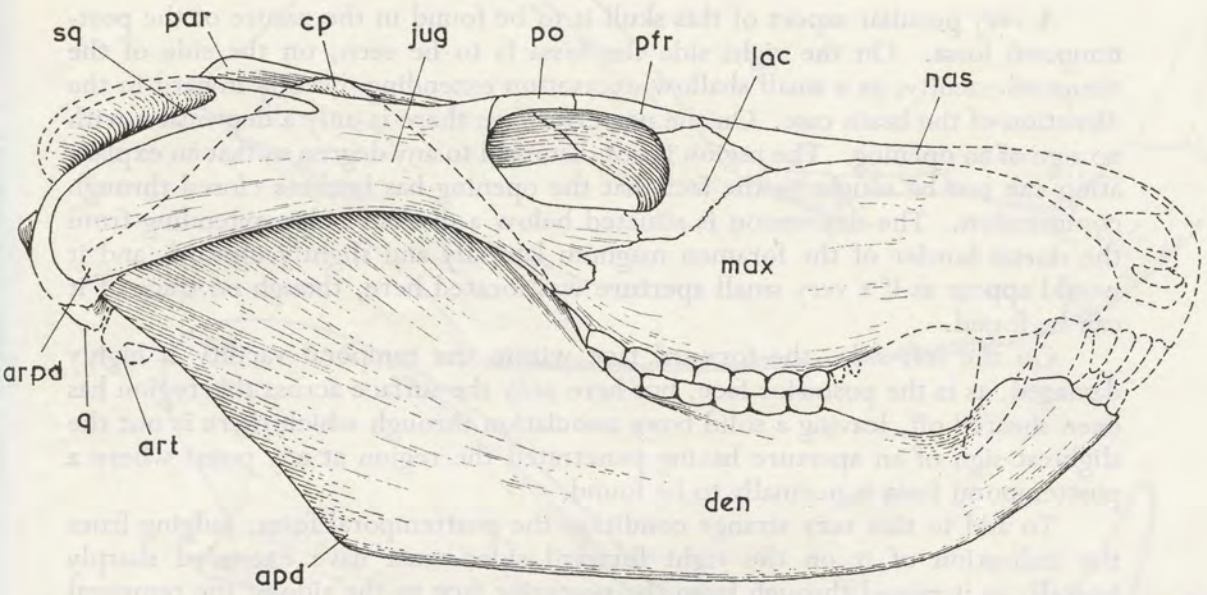


FIG. 42—Side view of the skull of *Cragievarus kitchingi* gen. et sp. nov., natural size. For abbreviations see figure 41.

in outline, forming the dorsal border of the foramen magnum, leaving the portions of the border between itself and the exoccipitals to the opisthotics. In height and size it appears to be similar to the interparietal above, the latter being somewhat broader. Sutures with the interparietal and tabulars are heavily interdigitated.

The *opisthotics* are damaged at their lateral extremities, but on the whole the paroccipital processes are shaped as portrayed in figure 41B. Although reconstructed, they are figured in line with what the specimen conveys. The crest between the posterior and ventral faces is not as sharp as in either *Diademodon* or *Cynognathus*. The arrangement forward over the roof of the middle ear and in the region of the fenestra ovalis is not clear. On the posterior face of the skull the opisthotics are elaborately covered by the tabulars.

◁ FIG. 41—A, Dorsal; and B, Ventral view of the skull of *Cragievarus kitchingi*, gen. et sp. nov., natural size.

Abbreviations: apd—angular process of the dentary; arpd—articular process of the dentary; art—articular; asph—alisphenoid; bo—basioccipital; bpp—basipterygoid process; cp—coronoid process; den—dentary; eo—exoccipital; fo—fenestra ovalis; fr—frontal; jf—jugular foramen; jug—jugal; lac—lachrymal; max—maxillary; nas—nasal; op—opisthotic; pal—palatine; par—parietal; parp—paroccipital process; pitf—pituitary fossa; pmax—palatal plate of the maxillary; po—postorbital; ppal—palatal plate of the palatine; prf—prefrontal; pro—prootic; psph—parasphenoid; pt—pterygoid; q—quadrate; qpp—quadrate process of the pterygoid; sq—squamosal; tr—transverse bone; v—vomer.

A very peculiar aspect of this skull is to be found in the nature of the post-temporal fossa. On the right side the fossa is to be seen, on the side of the temporal vacuity, as a small shallow excavation extending directly inward in the direction of the brain case. On the posterior face there is only a depression with no sign of an opening. The region is not distorted to any degree so that an explanation can not be sought in the fact that the opening has become closed through compression. The depression is situated below a distinct ridge extending from the dorsal border of the foramen magnum laterally and slightly upward, and it would appear as if a very small aperture was located here, though no trace of it can be found.

On the left side, the forward face within the temporal vacuity is highly damaged, as is the posterior face, but here only the surface across this region has been sheared off, leaving a solid bony association through which there is not the slightest sign of an aperture having penetrated the region at any point where a posttemporal fossa is normally to be found.

To add to this very strange condition the posttemporal fossa, judging from the indication of it on the right forward side, must have extended sharply laterally as it passed through from the posterior face to the side of the temporal vacuity, but in both *Diademodon* and *Cynognathus* it extends inward.

The *prootic* of the left side could not be exposed for fear of destroying interesting evidence regarding the posterior region of the dentary, and although exposed on the right side, its outline, exact form and relationship are not clear. In *Cynognathus* and *Diademodon* the prootic is inclined to be small and deeply hidden below the parietal flange, but in the present specimen it is larger and more visible in dorsal view, as in lower cynodonts, but this may be due to displacement of the bone after death.

The *tabulars* overlap the posterior faces of the paroccipital processes quite elaborately, especially laterally. The condition is similar to that described by Broili and Schröder (1935) for *Diademodon mastacus* and very unlike that described by these authors (1934) for *Cynognathus platyceps*.

The *interparietal's* exact extent and outline, especially on the margins of the occipital flanges, can not be ascertained clearly, due to damage. It would appear to be somewhat broader than the supraoccipital below and on the whole its disposition seems to correspond with that of a typical gomphodont.

The *parietals* are also typical of a gomphodont like *Diademodon*, especially in the arrangement around the pineal. Although the occipital flanges are damaged on both sides, the only possible way to reconstruct them is in line with the *Diademodon* condition, perhaps even more in line with that of *Trirachodon* and unlike that of *Cynognathus*. Proportionally the breadth across the brain case is greater than that of *Diademodon* and *Cynognathus*, and more comparable with that of *Trirachodon* and the lower procynosuchid cynodonts. In both *Diademodon* and *Cynognathus*, as well as in *Trirachodon* and the lower cynodonts like *Leavachia*, the parietals have a greater height at the level of the prootic than farther forward at the level of the alisphenoid. In the present specimen the height is greater in

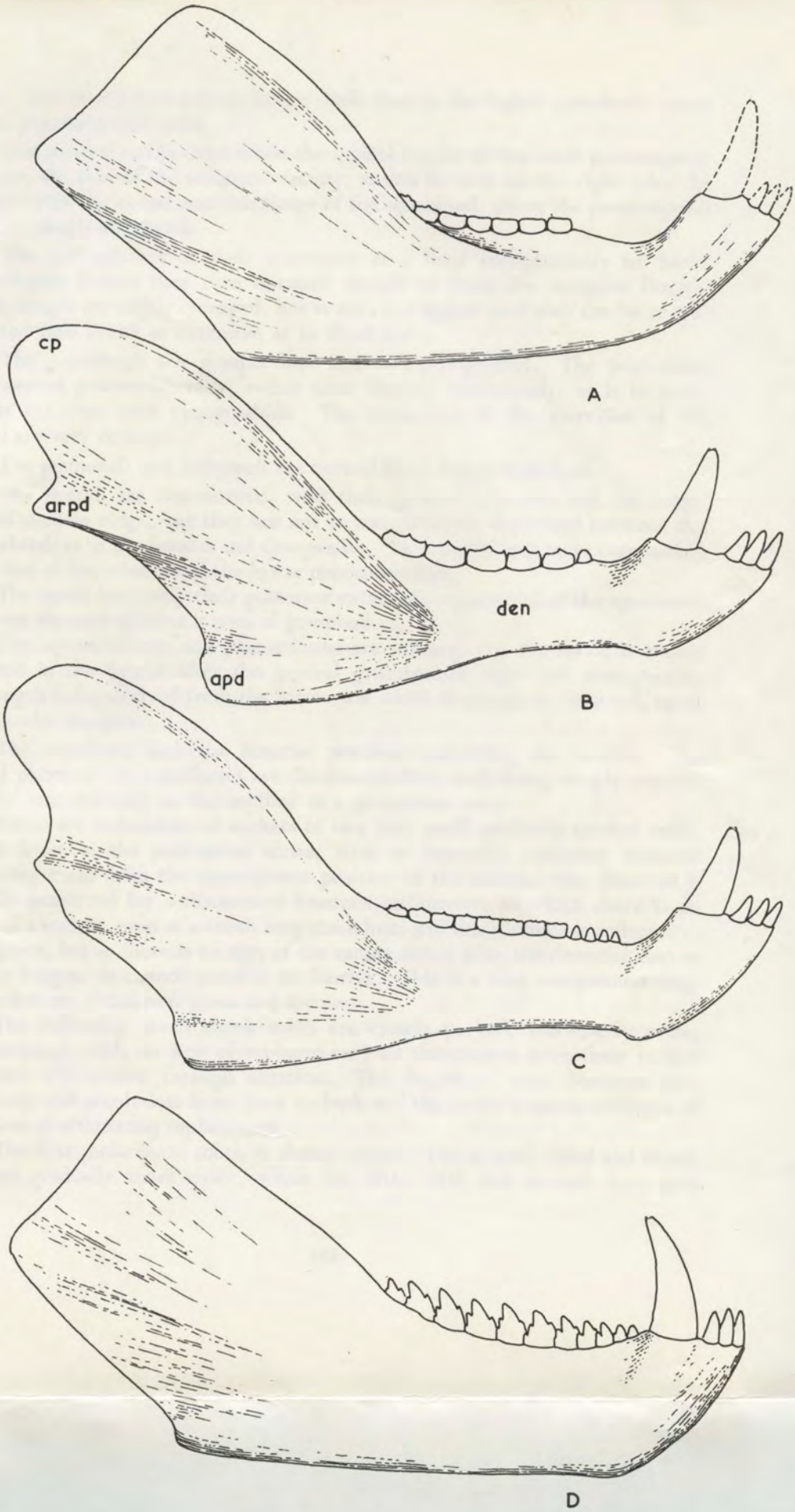


FIG. 43—Side views of dentaries of: A—*Cragievarus kitchingi;* B—*Luangwa drysdalli* (Brink, 1963); C—*Diademodon rhodesiensis* (Brink, 1963b); and D—*Cynognathus platyceps* (Broili & Schröder, 1934). A is natural size and the others are brought to the same size for comparison. For abbreviations see figure 41.

front. The pineal is at a level farther back than in the higher cynodonts, more at the procynosuchid level.

The parietal reaches and forms the medial border of the small posttemporal fossa on the side of the temporal vacuity, as can be seen on the right side. Its contact with the dorsal occipital flange of the squamosal, above the posttemporal fossa, is clearly displayed.

The parietals are at their narrowest at a level conspicuously far back, immediately before they turn outward sharply to form the occipital flanges. These flanges are highly damaged, but it does not appear as if they can be reconstructed into crests as extensive as in *Diademodon*.

The *postorbitals* are gomphodont and not cynognathid. The postorbital bars extend postero-laterally, rather than directly transversely, as is to some extent the case with cynognathids. The extensions in the direction of the pineal are very delicate.

The *prefrontals* and *lachrymals* are normal for a higher cynodont.

The *frontals* are also normal, with their general concavity and the longitudinal median ridge, but they are not as conspicuously depressed between the postorbitals as in *Diademodon* and *Cynognathus*. The condition is more comparable with that of *Trirachodon* and the lower procynosuchids.

The *nasals* have only their posterior extremities preserved in the specimen, and here the arrangement is normal gomphodont.

The *septomaxillaries* and *premaxillaries* are missing, and the snout is reconstructed in the figures after the general gomphodont shape and arrangement, the length being derived from the lower jaw which is complete, forward, up to the alveolar borders.

The *maxillaries* lack the anterior portions containing the canines. The palatal plates of the maxillaries are *Diademodon*-like, each being deeply concave and the two meeting on the midline in a prominent crest.

There are indications of sockets of two very small evidently conical teeth, at the front of the postcanine series, with an unusually extensive diasteme separating them from the approximate position of the canine. The diasteme is actually preserved for a distance of fourteen millimeters in which there is no trace of a socket, even of a tooth long since lost, and this distance is reflected in the figures, but as there is no sign of the canine either side, the diasteme may in fact be longer. It cannot possibly be shorter. This is a very conspicuous diagnostic feature of this new genus and species.

The following seven cheek teeth are closely packed, moderately ovate, flat crowned, with no sign of replacement; all the crowns have their surface structure obliterated through abrasion. The degree of wear becomes progressively and evenly less from front to back and the series bears no evidence of any form of alternating replacement.

The first molariform tooth is almost round. The second, third and fourth become gradually more ovate, while the fifth, sixth and seventh turn pro-

gressively more sectorial. Unfortunately the dentaries are intimately compressed against these posterior teeth.

The *transverse* bone is not visible and is presumably like that of *Diademodon*, entirely confined to the notch between the pterygoid and jugal. The dentaries are intimately pressed into these notches on both sides.

The *jugals* constitute one of the peculiarities of this specimen. Contrary to the condition in other higher cynodonts, both gomphodont and cynognathid, they contribute to a very delicate zygomatic arch which rises with an arc to a high level. Posteriorly the jugal does not bend down as sharply as in *Diademodon*. On the whole the zygomatic arch appears to be completely out of step with the powerful dentaries and if the lower jaw of this specimen had been discovered completely dissociated from the skull, it would have been difficult to discover that they belong to the same species.

The *squamosals* contribute their share to the zygomatic arches, but they do not penetrate nearly as far forward as in *Diademodon* or *Cynognathus*, let alone *Trirachodon* or *Luangwa* where the extent of interlock with the jugals is even greater. Although the zygomatic arch as a whole is, in its delicate nature, reminiscent of a lower cynodont, its structure is in miniature that of a *Diademodon* and its shape that of *Trirachodon*. Less curved, at a higher level, its structure is still typical and although the fold over the external meatus groove is damaged, what remains there is clearly indicative of an arrangement greatly similar to that of *Diademodon*.

The rest of the squamosal, as far as preserved on the right side, seems to be quite typical.

The *quadrates*, *quadratojugals* and *stapes* are missing from both sides and the regions in their environment are highly damaged.

The *vomer* can only be seen against the roof of the internal nares and the arrangement is typical of a higher gomphodont.

The *palatines* and the whole structure behind the secondary palate are very similar to that of *Diademodon*. The palatal plates overlap slightly, obviously due to some distortion. The region immediately behind the secondary palate is wider and more smoothly curved than in *Diademodon*, more like the condition in *Trirachodon*. In *Diademodon* this region is not only narrower but more distinctly square, and the two palatal plates meet firmly in the midline.

The *pterygoids* are also like those of *Diademodon* or *Trirachodon* in general appearance, mostly across the pterygoid processes. These processes are long and delicate, and the concavities on their antero-medial slopes are less conspicuous than in *Trirachodon*. Their posterior faces are not in the same plane as is often the case in *Diademodon*, but incline sharply forward and outward, a tendency shown on a lesser scale by *Trirachodon*.

In both *Diademodon* and *Cynognathus*, and to a slightly lesser extent in *Trirachodon*, the pterygoids remain extremely narrow up to the basipterygoid region and only after the alisphenoids take over, the latter's extensions to the quadrates turn sharply outward. The condition in the present specimen is

more like that of lower cynodonts. The basisphenoid processes are wide and powerful, and the pterygoids tend to reach straight for the quadrates. Although there is clear interference on the part of the alisphenoids farther back, it would appear that the pterygoids themselves still reach the quadrates, as is characteristic of *Protacmon*.

The *alisphenoid* of the right side is exposed over its dorsal region and would appear to be typically diademodontid. Below, it definitely interferes with the pterygoid extension to the quadrate, but it seems as if it does not reach as far laterally.

The *parasphenoid* forms a keel somewhat deeper than in the higher cynodonts, another feature in which this region generally shows affinity with more primitive cynodonts.

The lower jaw is very advanced indeed, but little can be made of the accessory bones; in what little there is to be seen the arrangement seems to be perfectly in line with that of *Diademodon*. The splenial is a very delicate flake of bone and it clearly does not reach the symphysis.

The *dentary* has a few peculiarities, even though it is very typical of an advanced cynodont. The symphysis is extremely long and the jaw is very narrow across this region. On the whole it is *Diademodon*-like, and extremely unlike *Trirachodon* or *Luangwa*, but it lacks the distinct chin of *Diademodon*. The diasteme behind the canine is longer (45 mm) than in any other related form on record, and the dentary is rather slender through this region. By contrast, the dentary is deeper in the region of the cheek teeth than in other gomphodonts, yet not as deep as in the cynognathids. Posteriorly, the general shape of the dentary is more like that of *Cynognathus*, with less conspicuous differentiation between coronoid, angular and articular processes. The articular process reaches farther into the articular region and would appear to have had nearly direct contact with the squamosal.

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ON TWO NEW SPECIMENS OF LYSTROSAURUS-ZONE CYNODONTS

By A. S. Brink

Abstract

In this paper the skulls of two new specimens of *Lystrosaurus*-zone cynodonts are described. One is a skull of *Notictosaurus luckhoffi* Broom, and it is pointed out that the other two species, *N. gracilis* and *N. trigonocephalus*, are respectively the young and the adult of the genotype. N. *gracilis* was described on only one small skull amongst more than three skulls and skeletons intimately associated in one block with the skull and skeleton of the adult, only the skull of which was subsequently described as *N. trigonocephalus*. At the time of description this block was in different fragments and the authors of the new species were not conscious of their association. The second new specimen is a close ally, but different enough to be recognised as a separate genus. While it cannot satisfactorily be contrasted with *Cynosuchoides whaitsi*, it is identified and described as belonging to this genus and species. Our knowledge thus far of this form is based on one imperfectly preserved skull.

Introduction

In February 1964, on passing through the Lootsberg Pass near Bethesda Road, between Graaff Reinet and Middelburg, Cape Province, Mr J. W. Kitching recovered the skull and some fragments of the skeleton of a cynodont. Three months later, in May, he found an occasion to search the same area and, amongst others, recovered a second cynodont specimen. Both these specimens were found in *Lystrosaurus*-zone strata, the latter larger specimen at the *Cistecephalus*-zone contact and the former smaller specimen some 400 ft. higher. On preparation the larger specimen turned out to be a galesaurid and while it cannot be conclusively contrasted with *Cynosuchoides whaitsi*, it is described as such, even though this genus and species is inadequately known and described on an unsatisfactory skull.

The first, smaller specimen from the higher level is a good example of *Notictosaurus luckhoffi*. The genotype was described by Broom in 1936 on a skull and lower jaw collected by R. Luckhoff (this specimen was at first accommodated in the Luckhoff Collection, which was subsequently incorporated into the Rubidge Collection, and is numbered L1/R.C.107). The type is from *Cistecephalus*-zone beds six miles east of Bethesda Road station, hence not far removed from the locality of the new specimen.

In 1946 Mr J. W. Kitching collected two specimens from exactly the same locality on the farm Elim in the Burghersdorp district (*Lystrosaurus*-zone), and confusion immediately arose when they were recorded in the Field Catalogue under separate numbers, 472 from Elim and 478 from Honingkrans, which is a different name for the same farm. Only in 1952 when Mr Kitching returned to the same farm did he recover the block from which the two skulls were derived. This block contains in addition to the skeletons of the skulls already

recovered, also the skulls and skeletons of at least two additional immature specimens. This block was recorded in our Field Catalogue as No. 2513. At the time the two skulls were described it was not known that they had been intimately associated and that there was more material available.

Broom and Robinson described the smaller of the two original skulls in 1948 as *Notictosaurus gracilis* (Field No. 472, Museum No. 5). Brink and Kitching described the larger skull in 1951 as *Notictosaurus trigonocephalus* (Field No. 478, Museum No. 223). It was only when the block containing the rest of the material was discovered in 1952 that the relationship between these two specimens could be established. Quite obviously the whole specimen comprises a mother with several of her young. Not only could it be established that *N. gracilis* (one of the young) and *N. trigonocephalus* (the mother) belong to the same species but, in the light of the new specimen described below, it is quite definite that they belong to the genotype *N. luckhoffi*.

Notictosaurus luckhoffi Broom (1936)

(Figure 44 and 45)

1936, Broom, R., *Ann. Transv. Mus.*, xviii, p. 382, figs. 28-30.

1948, Broom, R. & Robinson, J. T. (*N. gracilis*), *Proc. zool. Soc. Lond.*, p. 406, figs. 11, 12.

1951, Brink, A. S. & Kitching, J. W. (*N. trigonocephalus*), *Ann. Mag. Nat. Hist.*, (12) iv, p. 1227, figs. 8, 9.

Type. Skull with lower jaw collected by R. Luckhoff in *Cistecephalus*-zone beds six miles east of Bethesda Road station, now housed in the collection of Dr S. H. Rubidge on the farm Wellwood, Graaff Reinet (No. L1/R.C. 107).

Additional described specimens. A female(?) adult intimately associated with several of her young in one block, with reasonably complete skeletons, the adult (Field No. 478/Museum No. 225) having been described as *N. trigonocephalus*, and one of the immature skulls (Field No. 472/Museum No. 5) having been described as *N. gracilis*, while the rest, contained in one block (Field No. 2513), has not yet been referred to in description.

Present specimen. Skull without lower jaw, damaged posteriorly where both squamosals and the articular regions are missing, catalogued under Field No. 3892/Museum No. 0000 in the collection of the Bernard Price Institute. It was discovered by Mr J. W. Kitching in *Lystrosaurus*-zone beds 400 ft. above the *Cistecephalus*-zone contact in the Lootsberg Pass between Graaff Reinet and Middelburg, not far from Bethesda Road station.

Generic and specific diagnosis. *Lystrosaurus*-zone galesaurid cynodont of the same size as and very similar to *Thrinaxodon*, but less advanced; snout broader and secondary palate shorter and wider, cleft as in the procynosuchids; palate behind secondary palate wide and traversed by insignificant pterygopalatine ridges; parietal region broader than in *Thrinaxodon*, as in the procy-

nosuchids, and as in the latter a parietal crest is apparent only behind the moderately oval pineal foramen; lachrymals large and extend far forward; septomaxillaries insignificantly small; no interpterygoid vacuity; dentaries as advanced as in *Thrinaxodon*; dental formula i4 : c1 : pc9 for the upper jaw, with one less incisor in the lower jaw; teeth moderately tricusped, smaller and narrower than in *Thrinaxodon*; lumbar ribs interlock as extensively as in *Thrinaxodon*, but thoracic ribs have insignificant and apparently ineffective overlapping processes, unlike those of *Thrinaxodon*.

Measurements. The following table lists the measurements of the new specimen, the type, the specimen described as *N. trigonocephalus*, and the specimen described as *N. gracilis*. All measurements are given in millimeters and those marked with a questionmark are obtained indirectly through reconstruction figures.

	New specimen	*Type*	*"N. trigonocephalus"*	*"N. gracilis"*
Total length of skull	90	68	99·5	70
Length to squamosal notches ..	86·5	68	87	69
Length to interparietal notch ..	76·5	?60	75	62
To middle of pineal foramen ..	65·5	?50	66	48
Length of snout to anterior borders of orbits	37	?28	37·5	26·5
Maximum breadth of skull	58·5	42	60	48
Breadth of snout	25	?16	27	19
Minimum breadth across parietals	12·5	?7	13	10
Interorbital width	20·5	?17	21	17

Measurements pertaining to the palate are not given, because these can only be obtained from the present specimen and can be derived from the accompanying figure. Although the palates of both immature specimens are exposed, their structure has been rendered obscure through damage.

From the above table it can be seen that the new specimen is only slightly smaller than the specimen described as *N. trigonocephalus*, while the type is slightly smaller than the immature specimens described as *N. gracilis*. Broom's figures for the type are not reproduced 1½ times natural size, as indicated, but slightly larger, while Broom and Robinson's figures for *N. gracilis* are reconstructed about 5% larger than natural size. The latter specimen is about 5% larger than the other specimens in the litter, indicating that perhaps it is a male's.

Description

The *basioccipital* is well reduced between the exoccipitals, leaving the latter to form two distinctly separate condyles of rather typical mammal-like shape. This is a distinctive feature of the galesaurids and it contrasts slightly

with the more crescent-shaped structure found in lower cynodonts, therocephalians and scaloposaurians; even in the higher cynognathids and gomphodonts the condyles are not quite as mammal-like.

Forward of the condyles the basioccipital barely contributes to the margins of the jugular foramina and passes about 2 millimeters short of the fenestrae ovales. It wedges deeply forward medianly into the parasphenoid, with which it forms a loose non-interlocking suture. Most of the other sutures similarly suggest that the specimen is not fully mature.

The basioccipital is not described for the type, nor displayed in the other specimens at hand, and no useful comparisons can be drawn.

The *exoccipitals* are not well demarcated from the basioccipital, opisthotics and supraoccipital; sutures are well fused even though most other sutures are conspicuously clear. They seem to pass very little beyond the condyles. They form more than half of the circumferences of the jugular foramina, posteriorly, and extend some short distance outward across the posterior faces of the paroccipital processes. It is not clear how much they contribute to the lateral margins of the foramen magnum, but it would appear to be not much. The specimens at hand certainly do not suggest such elaborate extensions either side of the foramen magnum as Broom observed in the type.

The *supraoccipital* is high and narrow. It is not broader than the foramen magnum. Above it wedges into the interparietal. The breadth of the supraoccipital, as illustrated by Broom for the type, is certainly not borne out by the specimens at hand.

The *opisthotics* form the anterior halves of the jugular foramina, the posterior halves of the fenestrae ovales, and extend laterally as the paroccipital processes. The post-temporal fossae are, as in *Thrinaxodon*, very small and round, and the paroccipital processes are separated from them by the tabulars, which completely encircle them. The paroccipital processes are stout and ventrally they are not excavated to form dome-like roofs over the middle ear regions as in higher cynodonts. On the whole the paroccipital processes are very similar to those of *Thrinaxodon*.

The *pro-otics* are not exposed in any of the specimens.

The *tabulars* arise prominently either side of the supraoccipital and fan out laterally to support the occipital crests from behind as widely as possible. Ventro-laterally they curve around the post-temporal fossae and enclose them completely, as Broom also observed in the type—this being also a feature of *Thrinaxodon*. On re-investigation this was found to be also the condition in "*N. trigonocephalus*", unlike Brink and Kitching's original interpretation.

The *interparietal* is lodged in a deep depression above the elevated regions covered by the tabulars and supraoccipital. As is typical of the galesaurids, its wedge-like penetration between the parietals can clearly be seen in dorsal view, for some distance along the parietal crest. Here, too, there is no significant difference between the different specimens of this genus and species.

The *parietals* would appear to be conspicuously different in the various

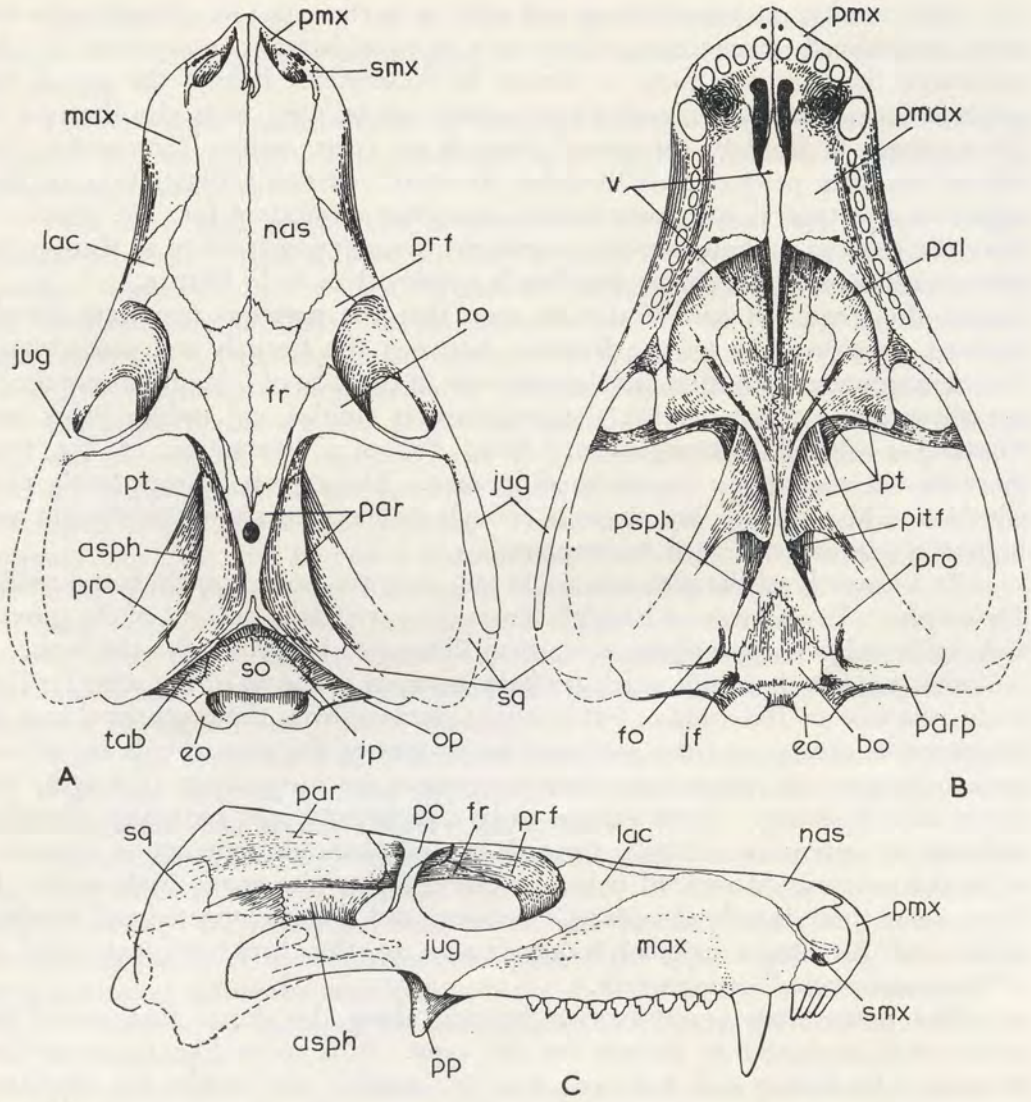


Figure 44

A—Dorsal, B—Ventral and C—Side view of the skull of *Notictosaurus luckhoffi*, natural size.

Abbreviations: asph—alisphenoid; bo—basioccipital; eo—exoccipital; fo—fenestra ovalis; fr—frontal; ip—interparietal; jf—jugular foramen; jug—jugal; lac—lachrymal; max—maxillary; nas—nasal; op—opisthotic; pal—palatine; par—parietal; parp—paroccipital process; pitf—pituitary fossa; pmax—palatal plate of the maxillary; pmx—premaxillary; po—postorbital; pp—pterygoidprocess; prf—prefrontal; pro—prootic; psph—parasphenoid; pt—pterygoid; smx—septomaxillary; so—supraoccipital; sq—squamosal; tab—tabular; tr—transversebone; v—vomer.

specimens of this species, but the apparent differences are due to bad preservation, preparation and interpretation. The actual arrangement for all the specimens is as illustrated in the accompanying figures.

The pineal is moderately large and oval, as in the type; its elongation in the other two described specimens may be due to some lateral compression. In the specimens they are not quite as narrow as illustrated. Behind the pineal the parietals form a crest, along which no suture can be seen, as is also the case in *Thrinaxodon*. In front of the pineal there is no crest, unlike *Thrinaxodon*; the region becomes progressively broader forward. Broom's illustration of this region in the type is too narrow and somewhat misleading for "*N. gracilis*". Here the crest as a whole is more prominent, conspicuously more so than in the other specimens in the litter, but this is apparently a male feature.

In this region it can clearly be seen that the parietals penetrate deeply forward on either side of the frontals, between the frontals and postorbitals. This arrangement cannot be clearly made out in the case of "*N. trigonocephalus*", but there are indications that the structure is similar and unlike Brink and Kitching's original interpretation. From Broom's description of the type there would also appear to be no difference. The region is imperfectly preserved in "*N. gracilis*", but there is enough evidence to show that Broom and Robinson's interpretation is incomplete.

At a lower level the parietals are broad, as in the procynosuchids and unlike *Thrinaxodon*. The narrowest breadth across the parietals is in front of the pineal, and this breadth is appreciably more than illustrated by Broom for the type.

The *postorbitals* do not reach far back towards the level of the pineal. This is also the case in *Thrinaxodon*, but here the distance from the postorbital bars to the pineal is greater and the posterior extensions of the postorbitals are consequently longer. In *Notictosaurus* these extensions are insignificant in length, but appreciable in depth. There appears to be a slight backward extension dorsally, and also an extension ventrally towards the alisphenoids, but not as extensive as in the specimen described below as belonging to the genus *Nythosaurus*. In *Thrinaxodon* there is only the dorsal extension, and this is elongated and slender. Brink and Kitching's original interpretation of this backward extension in "*N. trigonocephalus*" is incorrect.

The postorbitals reach farther forward along the dorsal margins of the orbits than suggested by Broom for the type. It is more like the condition illustrated by Broom and Robinson for "*N. gracilis*" and unlike the condition illustrated by Brink and Kitching for "*N. trigonocephalus*", the latter being a misinterpretation as a result of damage.

The postorbitals contribute their share to rather delicate postorbital bars, which curve backward in all the specimens, except "*N. trigonocephalus*" where they are straight, but this is evidently due to some distortion.

On the whole there would appear to be no difference between the postorbitals in the various specimens.

The *frontals* are also similar in all the specimens. They are larger than in *Thrinaxodon*. Together they wedge forward between the nasals and they also penetrate slightly between the nasals and prefrontals. They are extensively flanked from behind by the parietals.

The *prefrontals* constrict the frontals along their anterior halves. The *post-orbitals* form small wedges penetrating the prefrontals on the dorsal borders of the orbits.

The *lachrymals* reach broadly forward for a distance which can be taken as peculiar to this genus. The condition in the other described specimens is unfortunately not clear.

The *nasals* are, unlike the condition in *Thrinaxodon*, not conspicuously broader posteriorly than anteriorly. They are also not greatly constricted in the middle. Anteriorly they are not extensively flanked by the septomaxillaries, but the premaxillaries penetrate deeply between them. In *N. gracilis* the nasals have fallen away, exposing an intranarial cast traversed by very deep grooves. These grooves indicate the presence of well developed fronto-nasal turbinals.

The *premaxillaries* are well preserved, including an intact internarial bridge, as is also the case in "*N. trigonocephalus*". In both the latter and the new specimen the whole region of the external nares is conspicuously similar. There is not much height above the incisors. There are four small incisors and the foramen above the first incisor is distinct on either side. On the inside, behind the incisors, the palatal contributions of the premaxillaries are as figured. There are long slender extensions flanking and supporting the anterior end of the vomer, with the elongated anterior palatal openings either side. The premaxillaries also flank the palatal plates of the maxillaries for short distances along the lateral margins of these openings.

There are small but well defined and deep excavations for the reception of the lower jaw canines, and the premaxillaries form their anterior walls. This structure can only be seen in the new specimen.

The *septomaxillaries* are conspicuously small—much more so than in *Thrinaxodon;* very little is seen of them on the surface. A very delicate extension is lodged between the nasals and maxillaries, and they stop short on contact with the premaxillaries. The only substantial part of the septomaxillaries, other than parts extending inside the nasal cavity, is the shelf across the lower regions of the nares, but these are damaged on both sides. Conditions are exactly similar in "*N. trigonocephalus*".

The *maxillaries* carry a normal sized canine and nine post-canine teeth on each side. All the teeth in the present specimen are extremely fragile and could not be satisfactorily exposed; in an endeavour to do so some of the teeth have been damaged. Others not properly exposed suggest a structure of a main cusp with a smaller cusp in front and behind, as Broom observed in the type. The teeth are all sectorial. The anterior and posterior teeth seem to be smaller with less distinctly developed cusps, but the gradation in size is perfectly even; all the teeth seem to be erupted to their full extent and there is no sign of tooth replacement.

The palatal plates of the maxillaries do not meet in the midline and the result is a typical cleft palate structure that is more characteristic of the procynosuchids and unlike the more typical galesaurid condition as found in *Thrinaxodon*.

The palatal plates of the maxillaries reach closer to the midline posteriorly than anteriorly, where they leave room for the elongated anterior palatal openings.

While the lachrymals place restrictions on the expansion of the maxillaries across the lateral faces of the snout, they nevertheless extend boldly backward to a level beyond the middle of the orbits, and to well beyond the last teeth.

The *transverse bones* are highly reduced and confined to the angles between the pterygoids and jugals, which is a typical higher cynodont feature.

The *jugals* extend far forward below the orbits and across the posterior extensions of the maxillaries. There is a definite angle to the ventral margin of the jugal below the orbit. This has not been noticed in previously described specimens, but judging from those at hand these angles have been damaged through weathering or bad preparation. The zygomatic arch is missing on the left while on the right only the jugal's contribution is preserved.

Both *squamosals* are missing, together with the hinge bones and stapes, but these are in fair condition in "*N. trigonocephalus*". Here it can be seen that the squamosals contribute boldly to the zygomatic arches, with the major contribution dorsally, extending far forward and partly covering the jugal contribution laterally. In addition there is an extension reaching forward ventrally to the jugal. On the posterior face there is a fair amount of sculpturing to produce an external auditory meatus groove.

The *quadratojugal* and *quadrate* in "*N. trigonocephalus*" are quite in line with Broom's interpretation for the type. The quadratojugal, with a portion of the quadrate below it, are visible in lateral view, but not to the same extent as in the procynosuchids.

The *vomer* is a flat vertical plate anteriorly, where it is extensively clasped by processes of the premaxillaries. Farther back, between the palatal plates of the maxillaries, its ventral edge becomes broader and exceeds in width the cleft in the palate. This is contrary to the procynosuchid cleft palate, where the cleft is wider than the vomer's ventral margin. Still farther back the vomer becomes a sharp keel again, reducing in depth until it peters out as a partition on reaching the pterygoids. In this region, behind the secondary palate, the vomer is broadly expanded dorsally to contribute to the roof area over the internal nares.

The *palatines* contribute meagrely to the secondary palate—not extending its length effectively. It is also normal, in procynosuchids and galesaurids, for the palatines to extend substantially backward and inward across the pterygoids, across bold ridges to even bolder bulges, but in the present specimen these extensions are very elementary indeed. The ridges and bulges are also not at all prominent. The whole region behind the secondary palate is very wide and shallow.

The *pterygoids* are average, as illustrated, lacking the prominent bulges and ridges with which the palatines are normally associated (they are present, but very small indeed). A very conspicuous feature is the definite absence of an interpterygoid fossa. The extension to the quadrate is exposed on the right side, ventrally only, and the region of the basipterygoid processes is covered by a vertebra.

The *alisphenoids* are broad and not very high. A distinct groove extends across the alisphenoid-parietal suture, the same groove which in procynosuchids extends across the lateral face of the parietal at a much higher level. The anterior free margin of the alisphenoid is deeply concave, the upper projection reaching far forward to meet the lower, backward projecting angle of the postorbital. The lower anterior projection reaches as far forward, above the basipterygoid process. The posteroventral projection, below the large foramen for the fifth nerve, seems to cover the lateral face of the quadrate extension of the pterygoid quite extensively for a great distance. Dorsally to the foramen for the fifth nerve the alisphenoid forms an intricate suture with the prootic, suggesting that there is very little overlap.

The *parasphenoid* is obscured by a vertebra lying intimately across the basipterygoid region. Farther back it expands in the normal fashion in the direction of the fenestrae ovales, with the basioccipital penetrating it deeply from behind.

The *lower jaw* is missing in the present specimen. In "*N. trigonocephalus*" it is present, complete, but somewhat distorted and not yet satisfactorily cleaned. While the dentaries do not extend much farther back than in the procynosuchids, their posterior regions are more advanced in the style of the higher cynodonts, showing a distinct differentiation between angular, articular and coronoid projections. The coronoid projection reaches farthest back, as illustrated for this specimen by Brink and Kitching, and unlike Broom's interpretation for the type. The angular process is small but very pronounced. The articular process is feeble, but nevertheless distinct. Anteriorly the symphysis is short and there is a distinct chin in side view. The poorly preserved dentition can be interpreted as being perfectly in line with that of the type.

The other lower jaw bones are poorly preserved and unsatisfactorily exposed. The general impression is that the whole post-dentary structure is similar to that of *Thrinaxodon*.

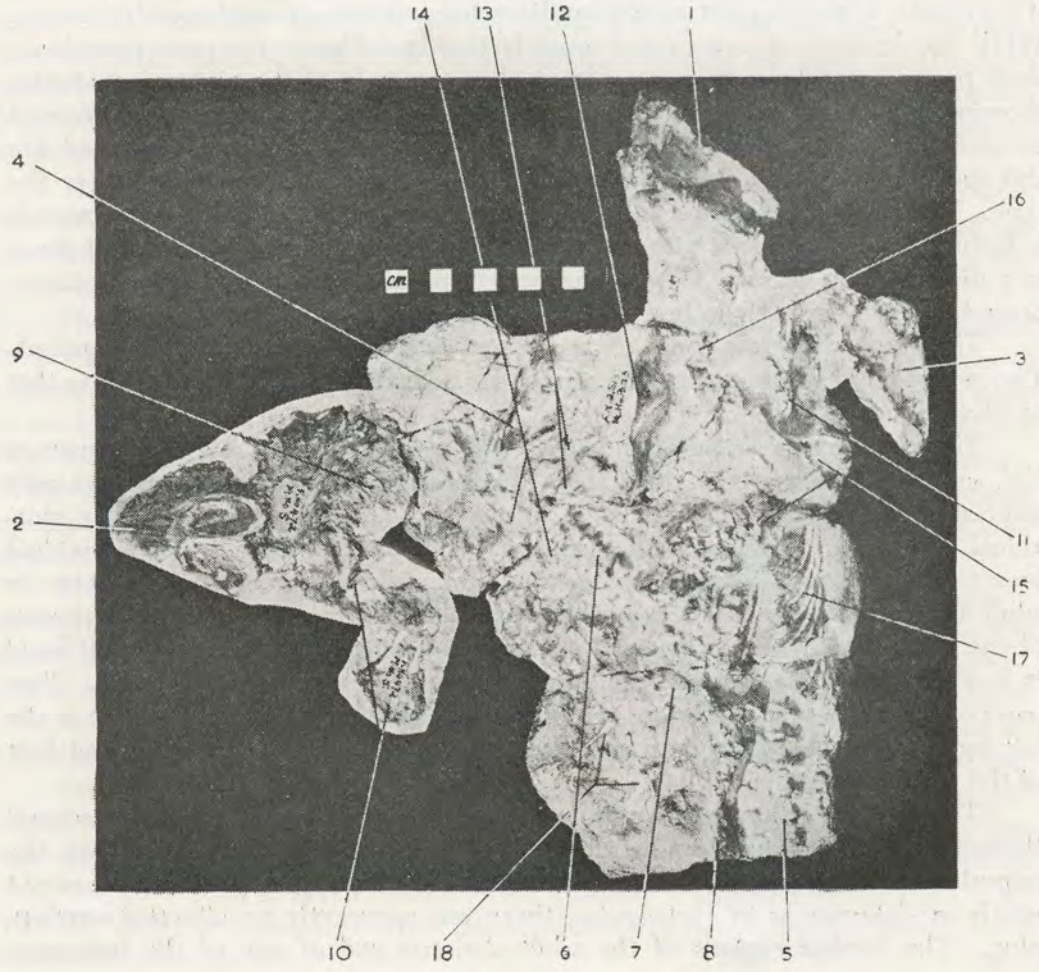
The *postcranial skeletons* of the adult "*N. trigonocephalus*" and her immature "*N. gracilis*" young are in a fair state of confusion where they are haphazardly associated in one block of matrix. It would be a laborious task to prepare individual bones for satisfactory description. However, most of the individual bones can be recognised and several lend themselves for comparison between adult and young. There is a beautifully exposed left front leg, and the humerus of the right side, which obscures the radius and ulna of its side. The left hand is in a fair condition, but the right hand's bones are somewhat scattered. Two paws of the immature specimens are preserved in fair condition. The one is the left foot of one individual and the other would appear to be also the hind foot of the second specimen.

The thoracic ribs of the adult are exposed only distally, but from several thoracic ribs belonging to one of the immature specimens, exposed on the opposite side of the block, it can be seen that the overlapping processes were not nearly as elaborate as in *Thrinaxodon;* there was apparently no effective overlapping. The lumbar regions of the adult skeleton and of one of the immature

specimens could be exposed satisfactorily along their ventral sides, and from these it is clear that the lumbar ribs were involved in an intricate interlocking system as advanced as in *Thrinaxodon*. Two lumbar vertebrae, with their ribs, belonging to the new specimen, show clearly that the lumbar ribs were firmly fused to the vertebrae.

By comparing these skeletons with some *Thrinaxodon* skeletons at hand, it would appear that on reconstruction a similar posture can be arrived at for both these forms. *N. luckhoffi* is about 20 per cent larger than *Thrinaxodon*. On careful comparison numerous detailed differences can no doubt be demonstrated, but the major differences are the smaller overlapping processes on the thoracic ribs and apparently heavier limbs and larger feet in *N. luckhoffi*.

The accompanying photographs, with the legends, demonstrate the above observations.



Legend to Figure 45

1. Skull of adult, described as *N. trigonocephalus*.
2. Skull of young, described as *N. gracilis*, referred to as Specimen A in this legend.
3. Skull of second young, referred to as Specimen B in this legend.
4. Skull of third young.
5. Lumbar region, ventrally, of adult.
6. Lumbar region, ventrally, of Specimen A.
7. Pelvic girdle of Specimen A.
8. Tail of Specimen A.
9. Thoracic ribs of Specimen A.
10. Pectoral girdle and front limb bones of Specimen A.
11. Hand of Specimen B.
12. Right humerus of adult.
13. Radius and ulna of the right fore-limb of the adult.
14. Right hand of adult.
15. Left arm and hand of adult.
16. Pectoral girdle of adult.
17. Thoracic ribs of adult.
18. Scattered limb bones of Specimen A.

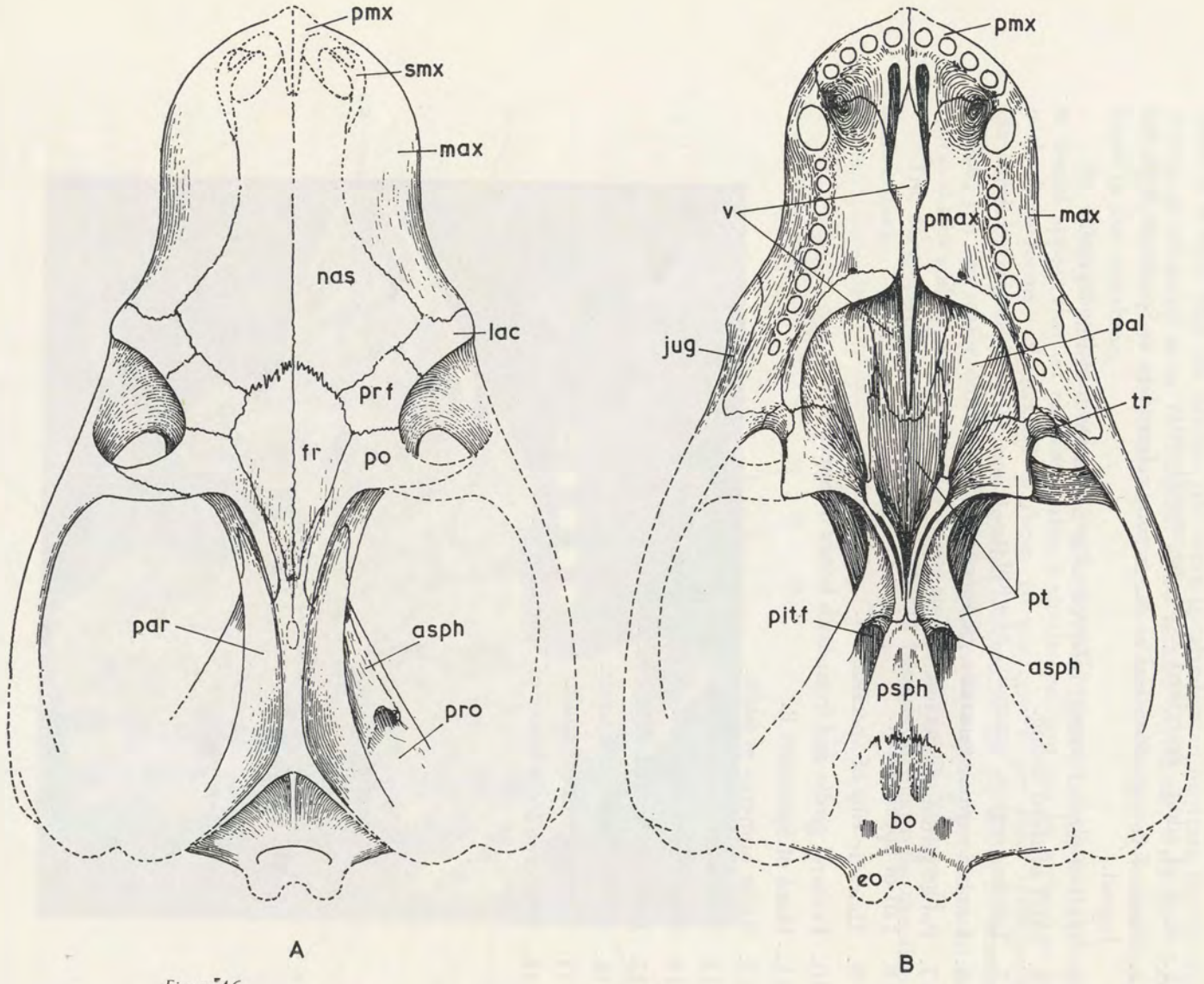


Figure 46
A—Dorsal and B—Ventral view of the skull of *Cynosuchoides whaitsi*, natural size. For abbreviations see figure 26.

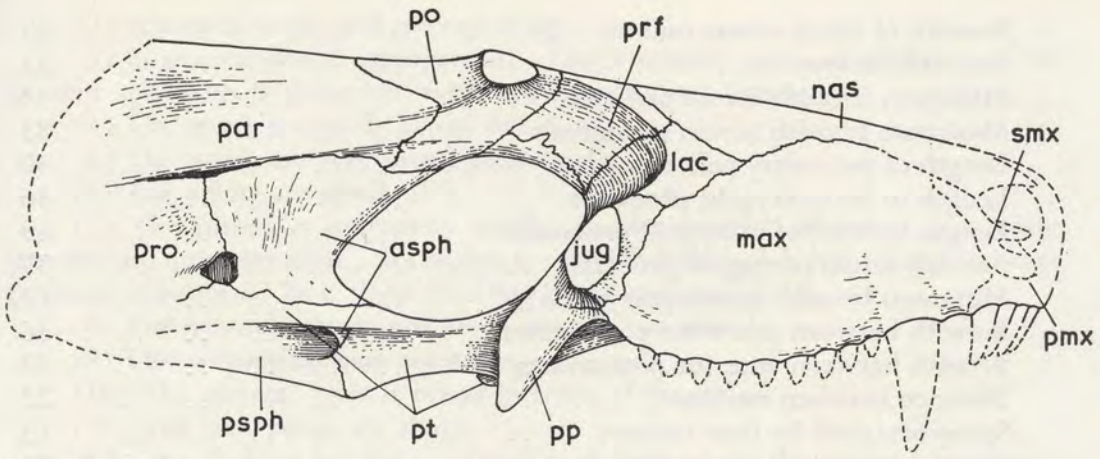


Figure 47
Side view of the skull of *Cynosuchoides whaitsi*, natural size. For abbreviations see figure 26.

Cynosuchoides whaitsi (Haughton)
Figures 46 and 47

1918, Haughton, S. H. (*Cynosuchus whaitsi*), *Ann. S. Afr. Mus.*, xii, p. 197, fig. 53.
1931, Broom, R., *Rec. Albany Mus.*, iv, p. 164.
1932, Broom, R., Mammal-like Reptiles, p. 267, fig. 89A-C.

Type. A fair specimen in the South African Museum, Cat. No. 4333, from *Cistecephalus*-zone beds on the farm Weltevreden, Graaff Reinet.

Present specimen. Variously damaged but nevertheless good skull, without lower jaw, discovered by Mr J. W. Kitching in 1963 in *Lystrosaurus*-zone strata, near the *Cistecephalus*-zone contact, on the farm Tweefontein at the foot of the Lootsberg Pass near Bethesda Road station. It is catalogued in the collection of the Bernard Price Institute under Field No. 3926 and Museum No. 371.

Diagnosis. Large galesaurid with a short and broad snout; secondary palate cleft, ventral margin of the vomer broader than the cleft; parietal region not crested in front of pineal; postorbitals with additional extensions reaching down to the alisphenoids and contacting them firmly; pineal very small and not nearly reached by postorbitals; dental formula i4 : cl : pc 9, with apparently one less incisor in the lower jaw.

Measurements. The following is a list of measurements in millimeters; those marked with a questionmark are arrived at indirectly through the reconstruction figures:

Greatest length of skull	?124
Length to squamosals	?119
Length to interparietal notch	107
Length to level of posterior borders of orbits	65
Length to level of anterior borders of orbits	47

Breadth of snout across canines		37
Interorbital breadth		31
Minimum breadth across parietals		14
Maximum breadth across squamosals		?83
Length of secondary palate		40
Length to basipterygoid processes		86
Length to level of pterygoid processes		69
Breadth across pterygoid processes		37
Minimum breadth across pterygoids		11
Breadth between posterior postcanines		36
Breadth between anterior postcanines		23
Distance between canines		22
Space occupied by four incisors		13
Space occupied by nine postcanines	Left	29
	Right	30

Description

The present specimen is of exactly the same size as the type and comes from approximately the same locality and horizon. Weltevreden, the type locality, is also near Bethesda Road station and very high in the *Cistecephalus*-zone. While the present specimen comes from *Lystrosaurus*-zone beds near the *Cistecephalus*-zone contact, the type comes from *Cistecephalus*-zone beds near the *Lystrosaurus*-zone contact. The two localities are in the same general neighbourhood.

The specimen agrees perfectly well with Broom's (1932) reconstruction, except for the fact that he interpreted a completely closed secondary palate. From Haughton's (1918) original description it can be seen that only the left side of the palate is preserved in the type; there would appear to be no evidence for a closed secondary palate. Haughton reconstructed the snout narrower than it should be, thereby bringing the median margin of the palatal plate on to the midline. Broom (1932) found evidence for reconstructing the snout much broader, but he kept the secondary palate closed. The present specimen clearly demonstrates the true condition.

In numerous respects the present specimen agrees perfectly with the type, but in basic structure it is also so close to the previously described *Notictosaurus* that there can be no dispute over the inclusion of *Cynosuchoides* in the Galesauridae, even should *Cynosaurus suppostus* remain as a single, imperfectly known specimen under the family Cynosauridae. However, the thought is expressed here that *Cynosaurus suppostus*, on careful reinvestigation, may prove to be a galesaurid too, in which case the family Cynosauridae will cease to exist.

The present specimen agrees with the type:

(1) In size and general proportions.

(2) In area of origin and geological age.

(3) In general dental arrangement. Unfortunately not a single tooth in the present specimen is preserved with crown structure intact.

(4) The snout is equally broad and short.

(5) The nasals are very broad posteriorly.

(6) The orbits are small.

(7) The pineal is extremely small. In the present specimen it is compressed and quite invisible; the region is somewhat damaged, but its approximate position is indicated by a slight swelling in the parietal crest.

(8) The postorbitals do not reach near to the pineal.

(9) The postorbital bars are strong.

(10) The parietal crest is broad in front of the pineal.

(11) The lachrymals are short.

(12) The frontals are long, extend well back along the parietal crest but, do not reach to the level of the anterior borders of the orbits.

(13) There is no interpterygoid fossa.

(14) The pterygoids are for a long distance narrow before the quadrate extensions swing outward.

(15) The basipterygoid processes do not contribute to the anterior margins of the pituitary fossae.

The present specimen differs from the type:

(1) In that the palate is cleft, but the type has evidently been wrongly interpreted.

(2) There are two additional postcanine teeth, but this can be due to age.

(3) The transverse bones are smaller.

The present specimen agrees with Notictosaurus, or with the Galesauridae in general:

(1) In the nature of the cleft palate.

(2) In dental formula and arrangement.

(3) In the width of the parietal crest in front of the pineal.

(4) In the extent to which the frontals reach back along the parietal crest.

(5) In the extent to which the parietals reach forward either side of the frontals.

(6) In the shortness of the upper posterior projections of the postorbitals.

(7) In that the postorbitals extend additionally backward and downward to meet the alisphenoids.

(8) In the exactly similar shape and structure of the alisphenoids.

The present specimen differs from Notictosaurus:

(1) In size, general shape and age.

(2) In the more massive postorbitals.

(3) In the smaller pineal.

(4) In the shorter lachrymals.

(5) In the nasals being broader posteriorly.

(6) In the more heavily ridged posterior palate, and the extension of the palatines across these.

(7) In the narrower basipterygoid region.

From these observed characteristics and by further careful comparison of the figures, it is quite clear that there is no reason why *Cynosuchoides whaitsi* should not be incorporated into the family Galesauridae. There is also no definite feature on which the present specimen can be specifically distinguished from the type of *Cynosuchoides whaitsi*.

A NEW LARGE BAURIAMORPH FROM THE CYNOGNATHUS-ZONE OF SOUTH AFRICA

By A. S. Brink

Abstract

The specimen forming the subject of this paper is the anterior two-thirds of a very large *Bauria* skull. It is described as a new species, *Bauria robusta*. It is pointed out that the skull is perhaps as much as 20 per cent larger than the largest known specimen of *Bauria cynops*, which in turn is about 15 per cent larger than the average of all other known specimens of the genotype. Many of the measurements are derived from reconstructed figures and if these measurements should prove to be less, the new skull would undoubtedly prove to be proportionally different, in which case its recognition as a new species would be more substantial. The features on which the specimen can at present be recognised as a new species are size, the greater number of cheek teeth (11 as compared with 9 in *B. cynops*), the weaker canines and the absence of an interpterygoid vacuity.

Introduction

In January 1955 Mr J. W. Kitching recovered from *Cynognathus*-zone beds on the farm Grootdam (Betseba) in the Burghersdorp district a skull of a particularly large *Bauria* specimen. It is unfortunately not well preserved. It would appear as if it had been exposed to weathering for some time before it became suitably embedded for fossilization. The bone surfaces are poor and so riddled with cracks that hardly a single suture is clearly displayed. In dorsal view everything posterior to the level of the middle of the orbits is missing, while in ventral view the pterygoids are preserved up to the basisphenoid processes. The right dentary is virtually complete, but the left has been deprived of more than its ventral half, and the damage extends across the region of the "chin".

The dentition is satisfactorily displayed for determining the general arrangement but, while the lower jaw is intimately in position, a detailed study of the crowns is not possible.

The region of the external nares is highly damaged. Otherwise the skull seems superficially to have suffered no compression or distortion in any direction.

Bauria robusta sp. nov.
(Figure 48)

Type. Poorly preserved but otherwise satisfactory, apparently undistorted, anterior two-thirds of skull with damaged lower jaw, derived from middle *Cynognathus*-zone beds on the farm Grootdam (Betseba) in the Burghersdorp district, and catalogued under Field No. 1685 and Museum No. 369 in the collection of the Bernard Price Institute.

Diagnosis. Skull as a whole more robust and about 20 per cent larger than the largest specimen of *Bauria cynops;* eleven postcanine teeth; canines small; powerful cheek bulges with deep depressions below; no interpterygoid vacuity.

This specimen can virtually be diagnosed on size alone. Of the described specimens of *Bauria cynops*, the specimen in the American Museum of Natural History (No. 5622) is the largest (see table of measurements, Brink, 1963), and substantially larger than the others on record, but the present specimen is yet larger by a very conspicuous margin.

Measurements. In the following table the measurements of the present specimen are given, in millimeters, in the first column. In the second column the measurements for the specimen in the American Museum of Natural History are given, taken from the table of measurements referred to above (Brink, 1963). In the third column the average is given for the four other specimens also dealt with in the above table.

Measurements given in brackets in the first column are arrived at indirectly through restoring the skull after the proportions of *Bauria cynops* as figured by Brink (1963), and as reflected in the present figures.

	B. robusta	*No.* 5622	*Average B. cynops.*
Maximum length of skull	(168)	140	121
Maximum breadth of skull	(112)	89	78
From premaxillaries to occipital condyle	(164)	132	116
To back of interpterygoid boss	95	84	70
To posterior border of secondary palate	?58	52	41
To interparietal notch	(151)	122	110
To level of lateral tips of postorbitals	(117)	91	83
To level of anterior borders of orbits	72	62	53
Breadth of snout across canines	40	31	28
Interorbital width	32	29	24
Distance between lateral tips of postorbitals	(65)	57	48
Breadth across pterygoid processes	62	50	47

Description

From these measurements it can be seen that the American Museum specimen is intermediate in size between the new specimen and the average of the rest of the known *B. cynops* specimens.

Most of the above measurements for the new specimen are arrived at indirectly, but there are enough actual measurements, including quite a number not listed, to show that the new specimen is about 15-20 per cent larger than the

American Museum specimen, which in turn is about 10-15 per cent larger than the average. Yet, longitudinal measurements across the palate would appear to be very little greater than the corresponding measurements in the American Museum specimen. This is the only tangible evidence of a feature which is quite apparent to the eye; the fact that the snout appears to be stouter, higher and shorter than in *B. cynops*. The implication is that the posterior portion of the skull which is reconstructed in the figures, could also be shorter, broader and stouter, in which case many of the inferred measurements could be unreliable. The new specimen will then be not so conspicuously larger, but indeed more robust and out of proportion to *B. cynops*, a better specific diagnostic feature than size alone.

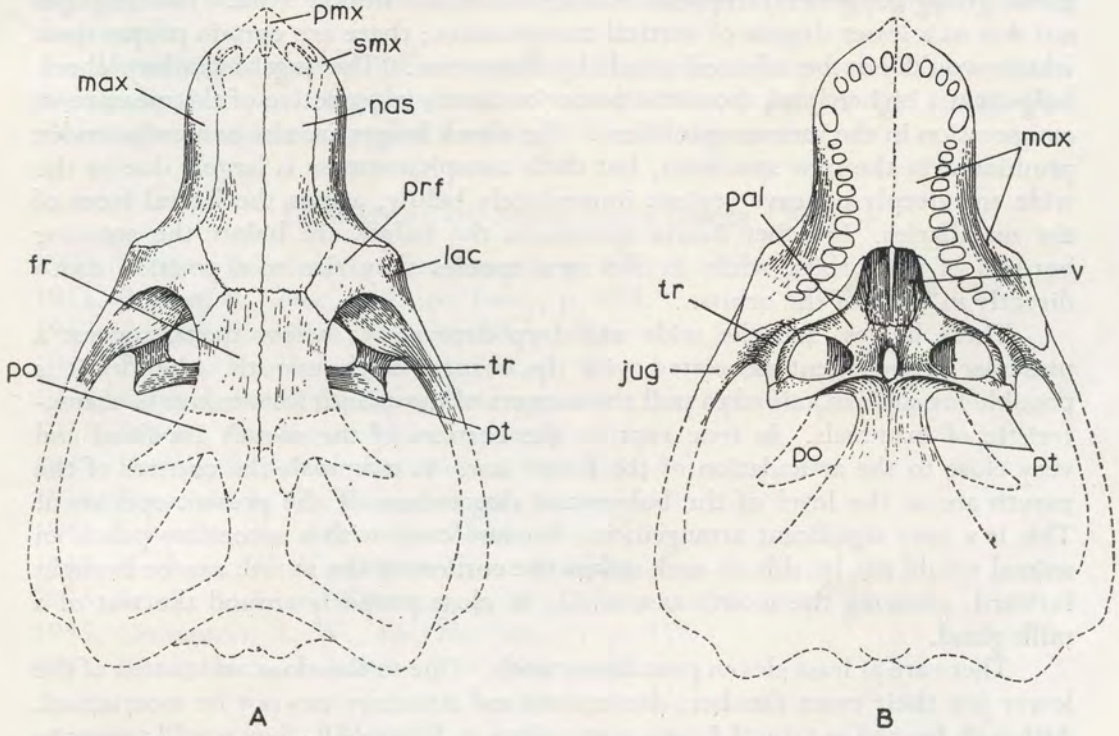


Figure 48
A—Dorsal and B—Ventral view of the skull of *Bauria robusta* sp. nov., posterior regions outlined according to *Bauria cynops* (Brink, 1963). Half natural size.
Abbreviations: fr—frontal; jug—jugal; lac—lachrymal; max—maxillary; nas—nasal; pal—palatine; pmx—premaxillary; po—postorbital; prf—prefrontal; pt—pterygoid; smx—septomaxillary; tr—transverse bone; v—vomer.

The whole region of the external nares is highly damaged, affecting mostly the anterior ends of the nasals, the septomaxillaries and the internarial bridge. The nares can be reconstructed, on what is preserved, directly in line with the typical *Bauria* condition, but there appears to be one significant difference. The

septomaxillaries do not reach down as near to the incisors as is the normal condition. The premaxillaries are exposed above the incisors for a height of eleven millimeters.

The incisors are damaged. In cross section they seem to be only slightly smaller than the canines, which is a normal *Bauria* feature, and on visualizing them as complete, or reconstructed, they would nearly match the canines in length.

Sutures over the dorsal surface can be followed with the greatest difficulty. The general impression gathered is that depicted in figure 48A, which is perfectly in line with the general *Bauria* arrangement.

The snout as a whole is conspicuously higher than in the other known specimens, giving the general impression of a shorter and stouter skull. The height is not due to a lesser degree of vertical compression; there are certain proportions which would not be affected much by distortion. The jugal-maxillary cheek bulge is at a higher level above the posterior teeth, irrespective of the measure of compression in the various specimens. The cheek bulges are also somewhat more prominent in the new specimen, but their conspicuousness is largely due to the wide and deeply concave regions immediately below, across the lateral faces of the maxillaries. In other *Bauria* specimens the bulges are below the anterior borders of the orbits, while in the new species they rise to a position more directly in front of the orbits.

These bulges, and the wide and deep depressions below them, suggest a muscular arrangement associated with the corners of the mouth, whereby it is possible for such an animal to pull the corners of the mouth forwards as is characteristic of mammals. In true reptiles the corners of the mouth are fixed and very close to the articulation of the lower jaw. In mammals the corners of the mouth are at the level of the bulges and depressions of the present specimen. This is a very significant arrangement, because even with a secondary palate an animal would not be able to suck unless the corners of the mouth can be brought forward, allowing the mouth as a whole to close properly around the teat of a milk gland.

There are at least eleven postcanine teeth. Due to the close association of the lower jaw their exact number, dimensions and structure can not be ascertained. Although figured as typical *Bauria* postcanines in figure 48B, they would appear to be slightly narrower.

The secondary palate could not be exposed and in the process of preparation the posterior margin has been damaged. Its position is nevertheless clear. The region behind the internal nares is shorter and broader by comparison with other *B. cynops* specimens. There is the characteristic pterygoid median boss from which the palatines radiate anterolaterally to support the maxillaries, but from a comparison between the accompanying figure 48B and figure 7 (Brink, 1963) for *Bauria cynops*, a distinct difference is apparent, both in structure and proportions.

Further comparison between these two figures will show a difference

between the transverse bones. These bones are, however, not clearly displayed in the present specimen.

The pterygoids close firmly behind the median boss, leaving no trace of an interpterygoid fossa. The median boss itself is also not as large and outstanding as in *Bauria cynops*.

The lower jaw has the typical *Bauria* bulged structure and peculiar twist, but although damaged anteroventrally, the dentaries do seem to form a more prominent and more anteriorly situated chin.

The skull would appear to be slightly distorted, not in overall proportions, but where the palate and lower jaw seem to have been pressed forward, relative to the dorsal portion. This distortion may account for the chin being more angular and farther forward and the palate as a whole being proportionally shortened.

However, in spite of differences that can thus be accounted for in terms of distortion, there are enough structural peculiarities to warrant the recognition of this specimen as the type of a new species, *Bauria robusta*.

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1963, Brink, A. S., *Palaeont. Afric.*, viii, p. 39.

A NEW ICTIDOSUCHID (SCALOPOSAURIA) FROM THE *LYSTROSAURUS*-ZONE

By A. S. Brink

Abstract

This paper describes a specimen recently discovered in *Lystrosaurus*-zone strata in the Bergville district of Natal. While a contemporary of *Scaloposaurus*, it has retained much of the general structure of the earlier Ictidosuchidae of the *Cistecephalus*-zone and in a few minor respects it shows affinity with the Therocephalia, beyond the characteristics of the infra-order. The specimen consists of a good skull with lower jaw, the whole pectoral girdle with the right fore limb, and a length of anterior vertebral column with ribs; these are figured as preserved. The skull is additionally figured in three views with distortion corrected. The specimen is identified as a new genus and species, belonging to the family Ictidosuchidae of the infra-order Scaloposauria, and the name *Olivieria parringtoni* is proposed.

Introduction

During several visits to some soil erosion dongas on the farm Admiralty Estates in the Oliviershoek Pass between Harrismith in the Orange Free State and Bergville in Natal, Mr J. W. Kitching has extracted a number of interesting Karroo fossils—interesting not only because many have turned out to be new forms, but also from the point of view of their association. One particular donga has yielded several *Lydekkerina* amphibians, thirteen good specimens of *Thrinaxodon*, a *Cyniscops*-like Gorgonopsian not yet described, the scaloposaurid *Tetracynodon darti* described by Sigogneau in 1963, which was discovered about four feet away from and at exactly the same height as the specimen described in this paper. This particular locality is at the very top of the *Lystrosaurus*-zone.

In 1960 the author figured and briefly analysed some scaloposaurian specimens in a paper which dealt mainly with a serially sectioned snout of a therocephalian. At that time the author felt hesitant over the relationship between the ictidosuchids, scaloposaurids and bauriamorphs, and the ictidosuchids were described as if they fall within the range of the Therocephalia. Since then the author has come to the conclusion that the Ictidosuchidae fit in substantially with the scaloposaurid-bauriamorph line, and proposed in 1963 that the whole range be called the Scaloposauria, with the two main subdivisions, the Ictidosuchoidea and the Bauriamorpha. The Ictidosuchoidea includes the two families Ictidosuchidae and Scaloposauridae.

Crompton had earlier (1955) proposed that *Ictidosuchoides intermedius* be transferred to the genus *Ictidosuchops*. This entails a transfer from the family Ictidosuchidae to the family Scaloposauridae. In 1960 the author agreed, at least as far as some described specimens of *Ictidosuchoides intermedius* are con-

cerned, to the generic transfer, but felt reserved over the implications of a family transfer.

In the light of the new specimen described in this paper, it is proposed that the genus *Ictidosuchops* be transferred to the family Ictidosuchidae.

Olivieria parringtoni gen. et sp. nov.
(Figures 49 and 50)

Type. Complete skull and anterior portion of skeleton (Field No. 3849/Museum No. 379) discovered in 1963 by Mr J. W. Kitching very high in *Lystrosaurus*-zone beds on the farm Admiralty Estates in the Oliviershoek pass between Harrismith and Bergville.

General. The specimen is named generically after the significant locality, and specifically after Dr F. R. Parrington who, at the moment of writing, is in the process of describing a very similar specimen which Mr J. W. Kitching also recovered from *Lystrosaurus*-zone beds. It is unlikely that we are describing two specimens which may turn out to be of the same genus and species, because the two localities are substantially different and some 400 miles apart.

Diagnosis. Slightly smaller than *Ictidosuchoides longiceps* and slightly larger than *Ictidosuchops intermedius*. In general structure and proportions it agrees better with the latter, but it has the complete postorbital bars of the former as is also the case in *Ictidosuchus*. Dentary very straight; coronoid processes not curved up as much as in these two genera, and ending more squarely. Outer face of the dentary characterised by a strong ridge extending from what can be recognised as an "articular angle" to beyond half the length of the dentary. Anterior free margins of the nasals deeply concave and generally at a sharp angle to the midline. Nasals constricted in the middle and expanded posteriorly. Frontals form little of the dorsal borders of the orbits. Dental formula i5 : c3 : pc3 for the upper jaw and i4 : c1 : pc4 for the lower jaw (six incisors in the upper jaw is more characteristic for the Ictidosuchidae). The highly reduced postcanine series is taken as the most significant characteristic of generic diagnostic value. Parietal crest narrow; pineal large. Elementary secondary palate widely open.

Measurements. In the following table the measurements of the present specimen are compared with the average of the three best specimens of *Ictidosuchops intermedius* in the collection of the Bernard Price Institute (Nos. 267, 268, 343—see table I, Brink, 1960), and the average of the three specimens of *Ictidosuchoides longiceps* (see table II, Brink, 1960), the only specimens at hand of which dimensions are adequately known (all measurements in millimeters).

	Present specimen	*I. intermedius*	*I. longiceps*
Length of skull to occipital condyle . .	102	103	139
Length to pineal foramen	74	78	107
Length of snout to anterior borders of orbits	49	52	70
Maximum breadth of skull	66	64	79
Minimum breadth of snout	27	22	27
Interorbital width	21	18	20?
Tip of snout to interpterygoid fossa . .	70?	67	88
Distance occupied by upper incisors	14	12	17
Distance occupied by three upper canines	12	9	11
Distance occupied by three upper postcanines	8	—	—
Distance across pterygoid processes	37?	35	41
Distance between palatal ridges of palatines	13	7	15
Narrowest parietal constriction . .	10	12	10

Description

The *basioccipital* is not exposed in the present specimen.

The *exoccipitals* are covered by the two halves of the pro-atlas and could not be exposed. In figure 49C they are illustrated according to indirect deduction, guided by conditions in *Ictidosuchops intermedius* (Crompton 1955) and *Tetracynodon darti* (Sigogneau 1963), but proportionally according to the surrounding structures. They would appear to be shorter in their dorso-lateral extensions either side of the foramen magnum.

The *supraoccipital* is basically the same as in *Ictidosuchops*, *Ictidosuchoides*, *Tetracynodon* and *Bauria*, but there are differences in detail. On the whole it is broad and low and the present specimen shows more clearly that it is covered dorsally by the interparietal. Laterally, too, it is well overlapped by the tabulars. It differs from *Ictidosuchops* in that it does not contribute substantially to the dorsal borders of the posttemporal fossae, the condition being more like that in *Ictidosuchoides* and *Tetracynodon*. In *Bauria* (Brink 1963) it contributes more substantially to the medial margins of these fossae. It differs from *Tetracynodon* in surface sculpture, and corresponds further with *Ictidosuchoides* in the slight sign of a median ridge. This ridge is more conspicuous in *Ictidosuchops*. There is a good fusion between the supraoccipital and opisthotics, as in *Ictidosuchoides*, unlike the more delicate contacts of *Ictidosuchops* and *Tetracynodon*.

The *opisthotics* seem to agree with both *Ictidosuchops* and *Ictidosuchoides*. In the former the contact with the supraoccipital is more delicate and in the latter the processes themselves are more delicate. In *Tetracynodon* the paroccipital

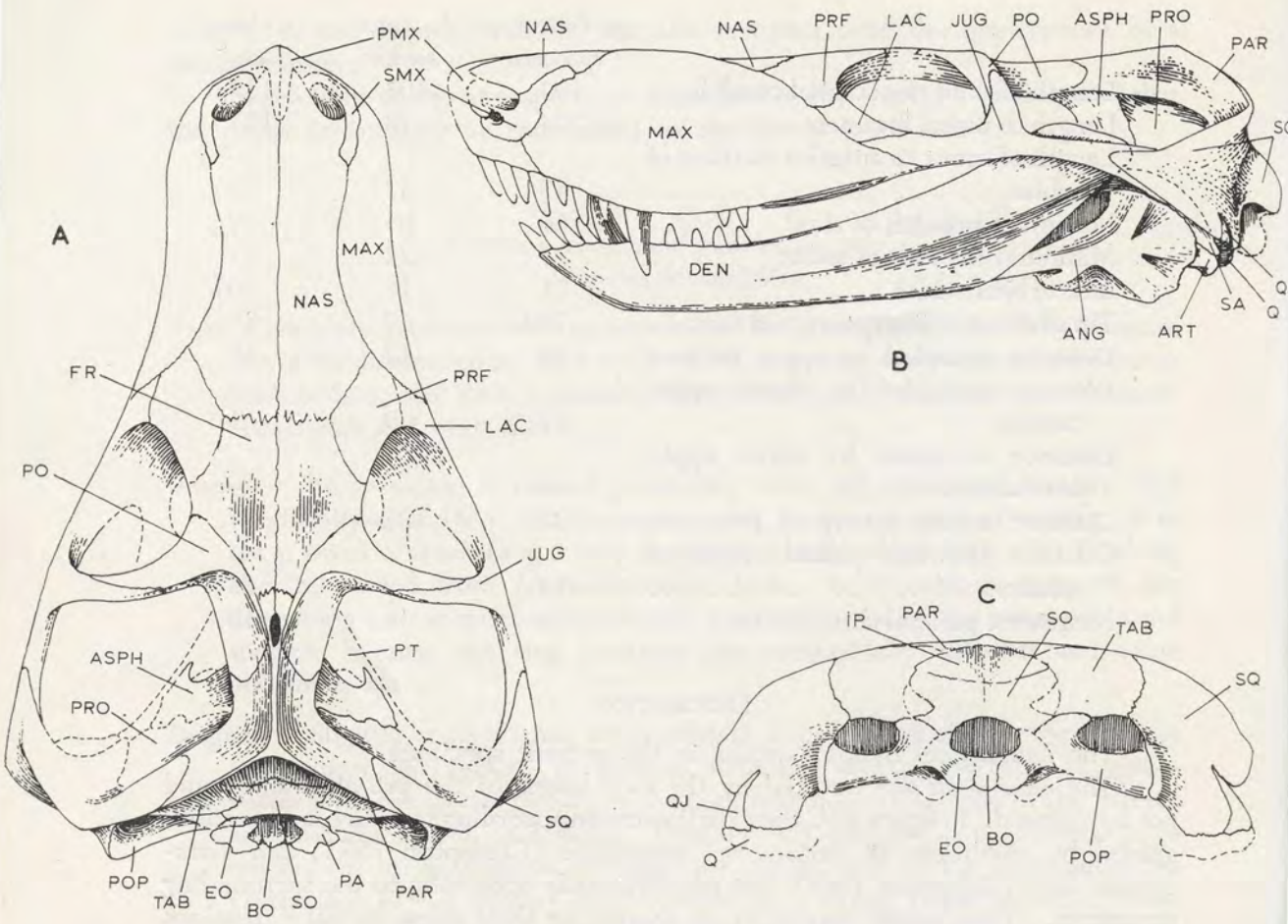


Figure 49

A—Dorsal; B—Side and C—Posterior views of the skull of *Olivieria parringtoni* gen. et sp. nov., half natural size.

Abbreviations: Ang—angular; art—articular; asph—alisphenoid; bo—basioccipital; den—dentary; eo—exoccipital; fr—frontal; ip—interparietal; jug—jugal; lac—lachrymal; max—maxillary; nas—nasal; pa—proatlas; par—parietal; pmx—premaxillary; po—postorbital; pop—paroccipital process; prf—prefrontal; pro—prootic; pt—pterygoid; q—quarate; qj—quadratojugal; sa—surangular; smx—septomaxillary; so—supraoccipital; sq—squamosal; tab—tabular.

processes are shorter. The lateral blunt ends of these processes abut boldly against prominent flanges of the squamosals, as is the case in *Ictidosuchoides* and *Bauria*. This condition is not portrayed in the illustrations of *Ictidosuchops* (Crompton, op. cit.) and *Tetracynodon* (Sigogneau, op. cit.).

The *prootics* are not exposed. In figure 49A they are merely indicatedas lying in the space behind the alisphenoids.

The *tabulars* differ reasonably from the condition depicted for *Ictidosuchops* and *Tetracynodon*. In specimen No. 344 of *Ictidosuchoides longiceps* (Brink 1960)

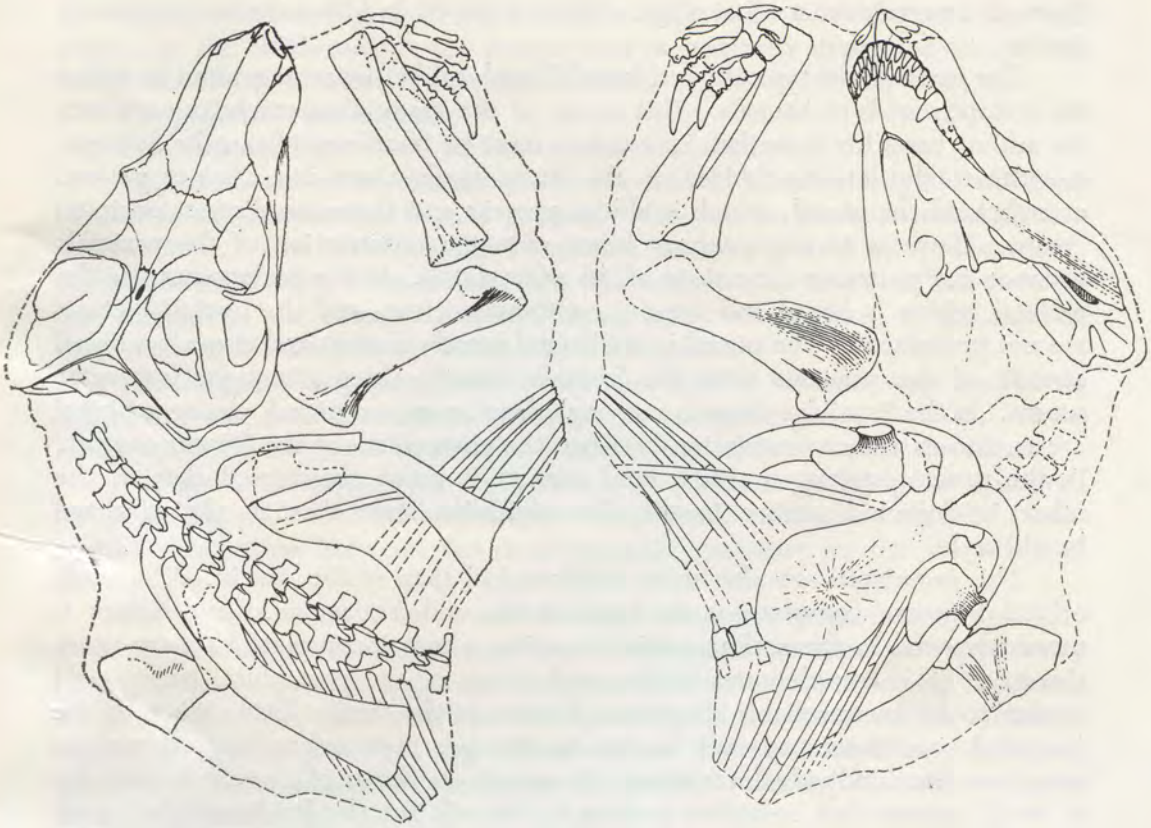


Figure 50
Left: Dorsal view and right: Ventral view of the specimen of *Olivera parringtoni*, gen. et sp nov., as preserved. Half natural size.

the regions of the tabulars are damaged, but there seems to be a marked correspondence. The tabulars reach inward above the interparietal, shortly below the crests formed by the parietals. The tabulars also send extensions inward across the supraoccipital, in the direction of the dorsal border of the foramen magnum. They form the dorsal borders of the posttemporal fossae and do not extend farther laterally than the lateral borders of these fossae. In this respect there is a marked contrast with *Bauria*. The surfaces are smooth where the tabulars meet the squamosals, as in *Ictidosuchoides*, and unlike *Tetracynodon*, *Ictidosuchops*, and especially *Bauria*, where medial edges of the external auditory meatus valleys are carried farther up. As in the ictidosuchids and unlike the typical scaloposaurids and baurids, the squamosals, rather than the tabulars, form the lateral borders of the posttemporal fossae.

The *interparietal* is broader and lower than in *Ictidosuchops*, and it tapers to left and right to points below the upper medial projections of the tabulars. In straight posterior view the parietals are barely visible above its dorsal margin.

There is a prominent median ridge. The conditions in *Ictidosuchoides* are exactly similar.

The *parietals* are typically ictidosuchid and unlike the arrangement in either the scaloposaurids or baurids. This is one of the many characteristics on which the author bases his view that *Ictidosuchops* must be transferred from the Scaloposauridae to the Ictidosuchidae. In the latter family there is a distinct parietal crest behind the pineal, which is always present, and there are distinct occipital crests. There is to a greater or lesser extent a constriction of the parietals between the posterior extensions of the postorbitals. In the Scaloposauridae the parietal region is broad and smooth, without a crest, and the occipital crests are not prominent. The pineal is small (and mostly absent) and there is a broad contact of the parietals with the frontals, mostly along a straight transverse suture. In the Bauriidae there is a strongly fused crest, no pineal, strong occipital crests, and extreme constriction between the postorbitals at the frontal contact. In the present specimen this frontal contact is more constricted than in the other ictidosuchids, more in the therocephalian style than in the advanced baurid style.

The *postorbitals* are also more ictidosuchid than scaloposaurid. The postorbital bars are complete as in *Ictidosuchoides* and *Ictidosuchus*. *Ictidosuchops* is more advanced in the scaloposaurid direction where incomplete bars are more the rule. The completeness or incompleteness of the postorbital bars would appear to be an unreliable diagnostic feature at the family level; some of the recorded conditions may even be due to damage. It is not unlikely that there may have been individual variation. However, in terms of present knowledge it would appear that complete arcades is the rule for the Ictidosuchidae, with incomplete arcades the exception, while the reverse is the case in the Scaloposauridae. In the Bauriidae the arcades are more definitely open.

In the present specimen ridges are carried across the postorbitals from the parietal crest and outward along the posterior margins of the arcades. Although slight indications of these can be seen in some *Ictidosuchops* specimens, the rule is a condition more like that of the scaloposaurids. In this feature, and the strength of the arcades, the present specimen displays an extra affinity with the Therocephalia.

The *frontals* are reasonably normal for an ictidosuchid. They do not contribute as substantially to the dorsal borders of the orbits. In this respect there is also some affinity with the Therocephalia, where the contribution is exceptionally small. In the present specimen the dorsal orbital border is a sharp edge, as in *Ictidosuchoides* and the Therocephalia in general. In *Ictidosuchops* it inclines to become rounded as in the scaloposaurids. In *Bauria* it is also a sharp edge.

The fronto-parietal suture is shorter transversely, because of the narrower crest. This is also more reminiscent of the condition in the Therocephalia. In the ictidosuchids this region is generally broader, and it is even broader in the scaloposaurids, while the in the bauriids, taking *Bauria* as the classic example, it is narrow.

Each parietal is depressed and a rather conspicuous crest is formed between them. In the ictidosuchids the frontal area is generally depressed and in the scaloposaurids it is mostly smoothly convex.

The *prefrontals* are normal.

The *lachrymals* are low, and short antero-posteriorly.

The *nasals* are more constricted in the middle of their lengths, and they expand more posteriorly, than is generally the case in the scaloposaurids and ictidosuchids. This is also a therocephalian feature, shared by *Ictidosuchoides;* in *Ictidosuchops* the condition is more like that in the scaloposaurids. The anterior free margins of the nasals are more concave and more inclined to the midline than in any of the other forms in the whole infra-order.

The *septomaxillaries* penetrate deeply and broadly between the maxillaries and nasals, and these extensions terminate in conspicuous square ends. These bones are fairly large and contribute much to the surfaces below the nares.

The *premaxillaries* carry 5 teeth each. The internarial bridge is damaged, but it clearly projected forward with a sharp bend. There are signs of a substantial penetration between the nasals dorsally, contrary to the condition in *Ictidosuchops*.

The *maxillaries* carry two small anterior canines, a large canine, and only three postcanine teeth. The maxillary dentition is perhaps this specimen's most distinctive generic diagnostic feature. Otherwise the maxillary is normal for this family. The palate could not be exposed properly, the lower jaw obstructing the anterior region, but the indications are that the elementary secondary palate is in the ictidosuchid condition, not properly closing with the vomer as in the scaloposaurids.

The *transverse* bones are not properly exposed.

The *jugals* are delicate, as is typical of the ictidosuchids and scaloposaurids. They contribute to the postorbital arches, which is more an ictidosuchid than a scaloposaurid feature.

The *squamosals* overlap the jugals more broadly than in the ictidosuchids, more in the therocephalian style. In the infra-order Scaloposauria delicate extensions of the squamosals reach forward more dorsally to the jugals, but in the present specimen the broader squamosal contributions to the zygomatic arches lie more laterally. The bulk of the squamosals show in posterior view, where the whole surfaces form broad and shallow external auditory meatus valleys. Medially, on the posterior face, the squamosals pass smoothly over to the tabulars, but lower down they form bold projections curving back and abutting against the blunt ends of the paroccipital processes. Their lower margins are excavated in two places either side to accommodate the roots of the quadrates and quadratojugals. On the side of the temporal fossae the dorsal processes reach normally inward to join the parietal flanges. The lower prootic processes are not exposed.

The *quadratojugals* and *quadrates* are unsatisfactorily displayed, but enough can be seen to conclude that the arrangement is in line with *Ictidosuchops*. The

quadratojugal can be seen in side view. It penetrates upward, wedgelike, into a deep notch in the squamosal. The quadrate is inserted more anteriorly in the squamosal, so that its foot-piece cannot be seen in posterior view.

The *stapes* could not be exposed.

The *vomer* is exposed only posteriorly, between the palatines. The median keel in this region is continuous with a median interpterygoid keel.

The *palatines* are sufficiently exposed to indicate an arrangement not different from *Ictidosuchops* or *Ictidosuchoides*. At this level the elementary secondary palate is still very widely open.

The *pterygoids* form more of a median keel than a restricted bulge between them. Either side of this keel, on the borders of the suborbital fossae, the pterygoids form small but very conspicuous ventrally projecting processes. In other related forms these are only slight prominences on longitudinal ridges. The suborbital vacuities are large. The pterygoid processes are vaguely exposed and their relationship with the transverse bones cannot be seen, the lower jaw making detailed preparation difficult. More posteriorly a hyoid bone obstructs the region of the interpterygoid fossa which could consequently not be exposed. The quadrate processes are also too deeply buried in matrix and obstructed by other structures to be successfully excavated.

The right *alisphenoid* is exposed. It is high, narrow, and lies far back, as is typical of the ictidosuchids. Its anterior free margin is deeply concave. Its posterior margin is not sufficiently exposed to show its relationship to the prootic.

The *orbitosphenoid* and *parasphenoid* bones could not be exposed.

The lower jaw is in a good condition, but the more important structural details are obscured by the fact that it is in intimate articulation with the skull.

The *dentary* carries 4 incisors, one canine, and 4 postcanine teeth. It forms a reasonably sharp chin, more conspicuous in ventral view than in side view. The delicate, thin, elongated *splenials* reach to the symphysis, to which they contribute.

The dentaries are reasonably straight, with somewhat square coronoid processes. A strong ridge extends from what can be recognised as an articular angle for a long distance forward along the lateral face. The *angular* bone is well preserved and displayed externally on the left side. Its interesting sculpture is accurately portrayed in figure 49B. The other lower jaw bones are not satisfactorily exposed.

Discussion

The present specimen belongs to the family Ictidosuchidae. Its nearest allies are *Ictidosuchoides*, *Ictidosuchus*, *Ictidosuchops*, and other forms which may, on closer investigation, be found to be more at home in this family than in the Scaloposauridae. Although a much later form—a contemporary of *Scaloposaurus* and *Tetracynodon*—it is not conspicuously more advanced in the direction of this

family, compared with its earlier relatives. In fact, in some details it is less advanced than its own relatives, and in these features somewhat reminiscent of the Therocephalia.

Ictidosuchops is here regarded not as a member of the family Scaloposauridae but of the Ictidosuchidae. In terms of structure and chronology it is more closely related to *Ictidosuchoides* and *Ictidosuchus* than to any of the more typical scaloposaurids.

The author favours the inclusion of all ictidosuchid-bauriamorph forms under the Infra-order Scaloposauria, which can be split into two superfamilies, the earlier Ictidosuchoidea and the later Bauriamorpha. The Ictidosuchoidea in turn contains at least the two families Ictidosuchidae and Scaloposauridae, while the Bauriamorpha contains at least the family Bauriidae. These three families can be distinguished as follows:

Ictidosuchidae	*Scaloposauridae*	*Bauriidae*
Generally *Endothiodon-Cistecephalus*-zone forms, to *Lystrosaurus*-zone by exception. (Middle to late Permian)	Generally *Lystrosaurus-zone* (Late Permian to early Triassic).	Mostly *Cynognathus*-zone (Middle Triassic).
Secondary palate elementary and still wide open.	Elementary secondary palate closing.	Secondary palate closed. (Maxillaries only).
Pineal present and large.	Pineal disappearing in some.	Pineal absent.
Postorbital bars still closed in some.	Postorbital bars mostly open.	Postorbital bars open.
Dentition simple, multiple canines.	Dentition simple, multiple canines.	Single canines, molariform postcanines.
Fronto-parietal region constricted.	Fronto-parietal region broad.	Fronto-parietal region constricted.
Parietal region crested.	Parietal region broad and rounded.	Parietal region crested.
Definite occipital crests.	Inconspicuous occipital crests.	Definite occipital crests.
Sharp dorsal orbital borders.	Rounded dorsal orbital borders.	Sharp dorsal orbital borders.

The infra-order Scaloposauria can be distinguished from the infra-order Therocephalia on the following grounds:

(1) Postorbital bars delicate to incomplete.

(2) Zygomatic arches delicate.

(3) Frontals form substantial portions of dorsal orbital borders.
(4) Alisphenoids somewhat primitive.
(5) Suborbital fossae large.
(6) Interpterygoid fossa present and generally large.
(7) Dentaries weakly developed posteriorly.
(8) Posttemporal fossae large.
(9) Nasals generally not much constricted, or expanded posteriorly.
(10) Parietal crest not as thin and high, absent in one family.
(11) Greater number of postcanine teeth.
(12) Different multiple canine arrangement.

The Scaloposauria is nevertheless more closely related to the Therocephalia than to other infra-orders, on the following grounds:

(1) The frontals contribute to the dorsal orbital borders.
(2) There is no contact between the lachrymals and nasals.
(3) The zygomatic arches are weak.
(4) The post-dentary bones are in a very similar condition.
(5) The dentaries are in the same stage of development.
(6) The elementary secondary palate can be brought into relationship.
(7) The occipital condyle is characteristically trilobed.
(8) The dentitions are reasonably related.

The present specimen, although chronologically a contemporary of the more typical scaloposaurids, has a slight therocephalian affinity in the reduced postcanines, the constricted nasals, the strong postorbital bars, the large pineal, the stronger contribution of the squamosals to the zygomatic arches and the lesser contribution which the frontals make to the dorsal orbital borders.

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MIOSPORE ZONES IN KARROO SEDIMENTS OF TANZANIA

By George F. Hart

Microstratigraphy Research Unit, University of the Witwatersrand

Abstract

Miospore complexes from Karroo rocks of parts of the Songwe-Kiwira Coalfield and Ketewaka-Mchuchuma Coalfield, Tanzania, are described and correlated one with the other. The complexes are assigned to the lower part of the Permian System.

Introduction

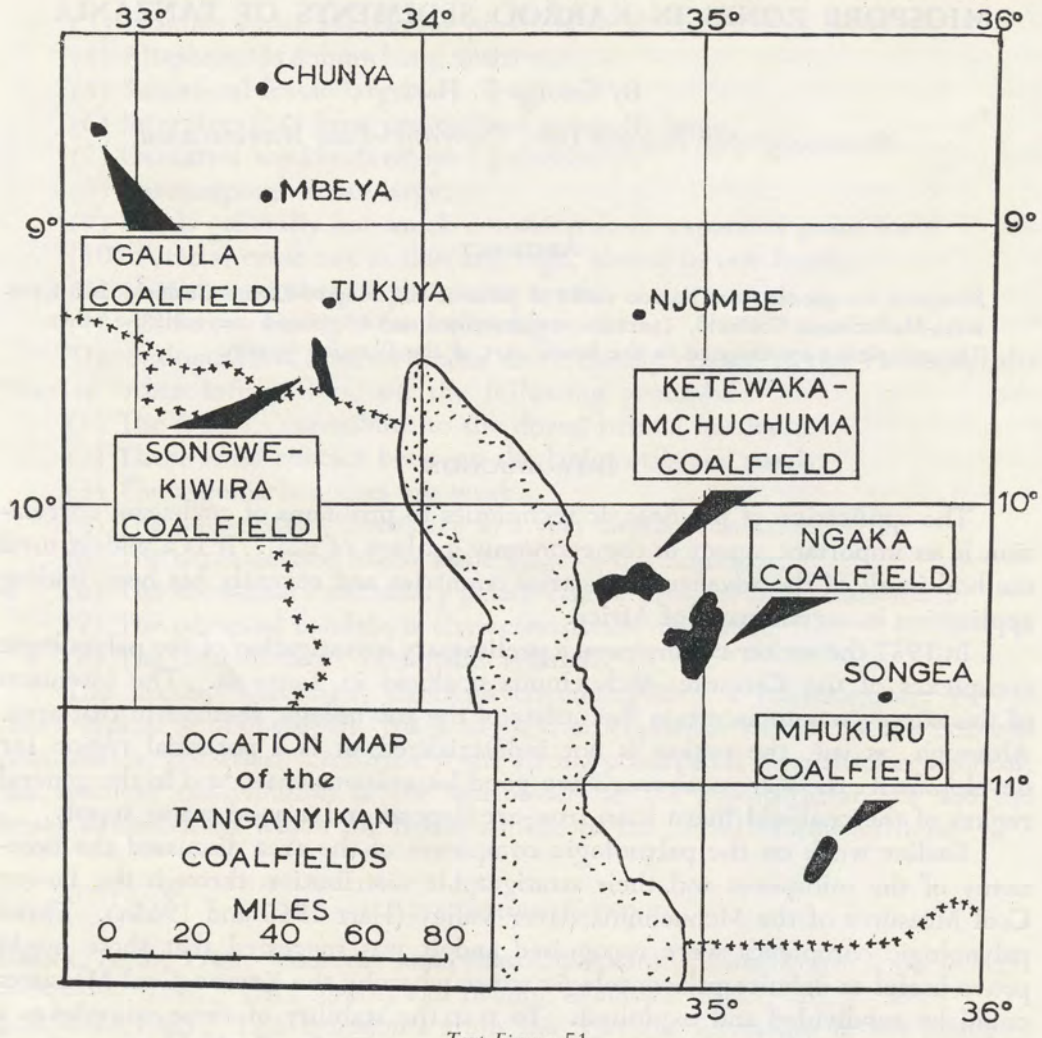
The application of palynologic techniques to problems of coal-seam correlation is an important aspect in the economic geology of coal. It is a widely used method in all of the advanced industrial countries and recently has been finding application in certain parts of Africa.

In 1957 the writer commenced a preliminary investigation of the palynologic complexes of the Ketewaka-Mchuchuma coalfield in Tanzania. The intention of this survey was to ascertain the utility of the palynologic method in that area. Although, as yet, the region is not industrialized, it is a potential region for development: the $K2e_1$ coal-seams are good bituminous coals, and in the general region of the coalfield there is an iron-ore deposit and a good water supply.

Earlier work on the palynologic complexes of the area discussed the taxonomy of the miospores and their stratigraphic distribution through the Lower Coal Measures of the Mchuchuma River Valley (Hart 1960 and 1965a). Three palynologic complexes were recognised and it was suggested that these might prove useful as definite palaeontologic zones whereby the Karroo Coal-Measures could be subdivided and exploited. To test the stability of these complexes a short succession of Karroo rocks from the Songwe-Kiwira Coalfield was analysed for miospores. The location of this test-area is about 160 km. from the Mchuchuma River Valley (see text-figure 51).

This report presents the results of this test and at the same time describes the palynologic complex from a farther site in the Mchuchuma Coalfield (i.e. the Nyakapenda River Valley). The results confirm the great practical value of miospore analysis for the correlation of Karroo strata.

The material analysed for miospores consisted of 14 samples of shale, coaly shale or coal from the Songwe-Kiwira Coalfield (Assemblage number 139-152) and 54 samples of coal from the Mchuchuma Coalfield (Assemblage numbers 8-20, 65-105). All of the former and 35 of the latter yielded an abundant and well preserved microflora of miospores and cuticle, and these were subjected to standard analysis (Hart 1962).



Text-Figure 51

The Mchuchuma Coal-Field Palynologic Complexes

The characteristics of the Mchuchuma Coal-field palynologic complexes as seen in the Mchuchuma River Valley were given by Hart (1965a). These results are summarized in text-figures 52 and 53 and the general features of each complex may be summarized as follows.

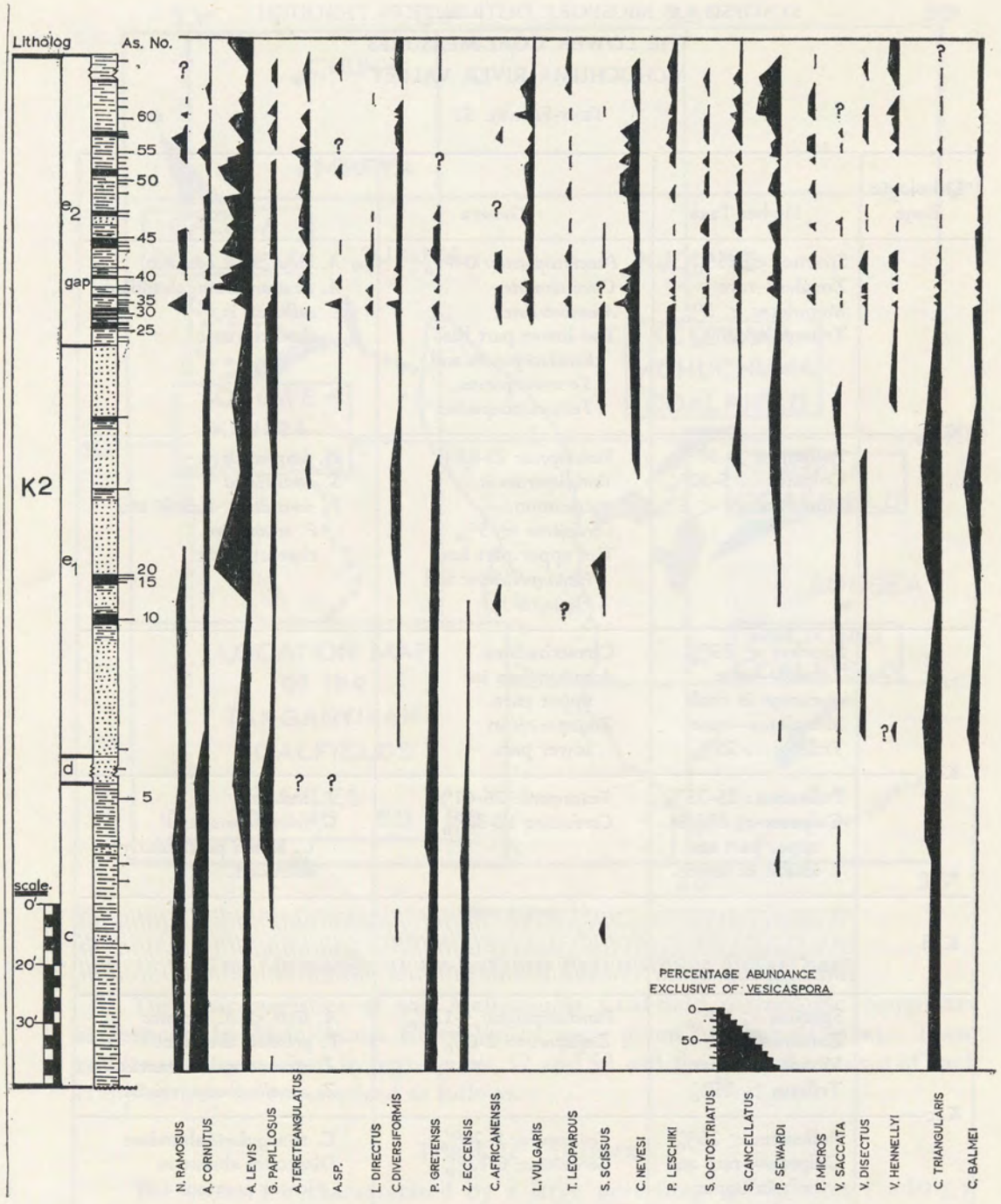
The K2c Complex

The strata are characterized by a large percentage of Sporites (>50%), and particularly in the abundance of Triletes (>25%). The Pollenites are not very common (usually <25% with a maximum of 35%) and are chiefly represented by *Vesicaspora* (8-28%) and *Cordaitina* (6-13%).

SYNOPSIS OF MIOSPORE DISTRIBUTION THROUGH
THE LOWER COAL-MEASURES
MCHUCHUMA RIVER VALLEY

TEXT-FIGURE 52

Lithologic Zone	Higher Taxa	Genera	Species
$K2e_2$	Sporites $<$ 25% Zonales—rare Monoletes $<$ 5% Triletes $\leqslant$ 20%	*Punctatisporites:* 0-4% *Cirratriradites* *Acanthotriletes* The lower part has *Baculatisporites* and *Verrucosisporites*. *Tuberculatosporites*	*A. levis* $>$ *A. cornatus* *A. tereteangulatus* abundant *L. colliensis* is characteristic.
	Pollenites $>$ 50% Colpates . . 5-10% Monosaccites $<$ 5%	*Vesicaspora:* 29-68% *Vestigisporites is* common. *Cordaitina* $<$ 5% The upper part has *Hamiapollenites* and *Florinites*	*H. karrooensis* *S. octostriatus* *P. sewardi*, *P. leschiki* and *F. eremus* are characteristic.
$K2e_1$	Sporites $\leqslant$ 25% Zonales—rare except in coals Monoletes—rare Triletes . . 25%	Cirratriradites *Acanthotriletes* in upper part. *Zinjisporites* in lower part.	
	Pollenites: 25-75% Colpates $<$ 5% in upper part and absent in lower.	*Vesicaspora:* 26-61% *Cordaitina* 10-30%	*V. saccata*, *C. triangularis*, and *C. balmei* particularly abundant.
K2d	////////	////////	////////
K2c	Sporites $<$ 50% Zonales—rare Monoletes—rare Triletes $>$ 25%	*Punctatisporites:* 4-12% *Zinjisporites:* 2-6%	*A. levis* $<$ *A. cornutus* *P. gretensis* abundant *Z. eccensis* and *Z. restricta* *Z. zonalis* characteristic
	Pollenites $<$ 25% Colpates—rare and only in upper portion.	*Vesicaspora:* 8-28% *Cordaitina:* 6-13%	*C. triangularis* abundant Disaccites absent in lower portions and very rare in upper portions.



Text-figure 53

A very characteristic feature of any K2c assemblage is the presence of *Zinjispora* (*Z. eccensis* 2-6%, *Z. zonalis* 1–2.5%, and *Z. restricta* rare).

Associated species include: *Cordaitina triangularis* (3-17%), *C. balmei* (r-3%), *Apiculatisporis levis* (2-17%), *A. cornutus* (10-18%), *Punctatisporites gretensis* (4-12%), *Neoraistrickia ramosa* (3-11%) and *Calamospora sp.*

A notable feature is that Disaccate genera, apart from the omnipresent *Vesicaspora*, are absent from the Lower K2c beds and very rare in the Upper K2c beds. The Colpates begin to form part of the upper assemblages in the K2c strata.

The $K2e_1$ Complex

The lowest part of the $K2e_1$ complex shows facets similar to the K2c complex; and the highest part facets similar to the $K2e_2$ complex.

The Monosaccites and Sporites, dominant in the lower beds, are replaced by a preponderance of Disaccites in the upper beds. A general assessment of the major taxa shows that the Sporites are $\leqslant$ 25% of the total assemblage (Triletes, about 25%), and the Pollenites are 25-75% (Colpates $<$ 5% and Monosaccites 10-30%).

Vesicaspora varies from 26-61%, *Striatoabietites* 2-3% and *Cordaitina* 2-29%.

The $K2e_2$ Complex

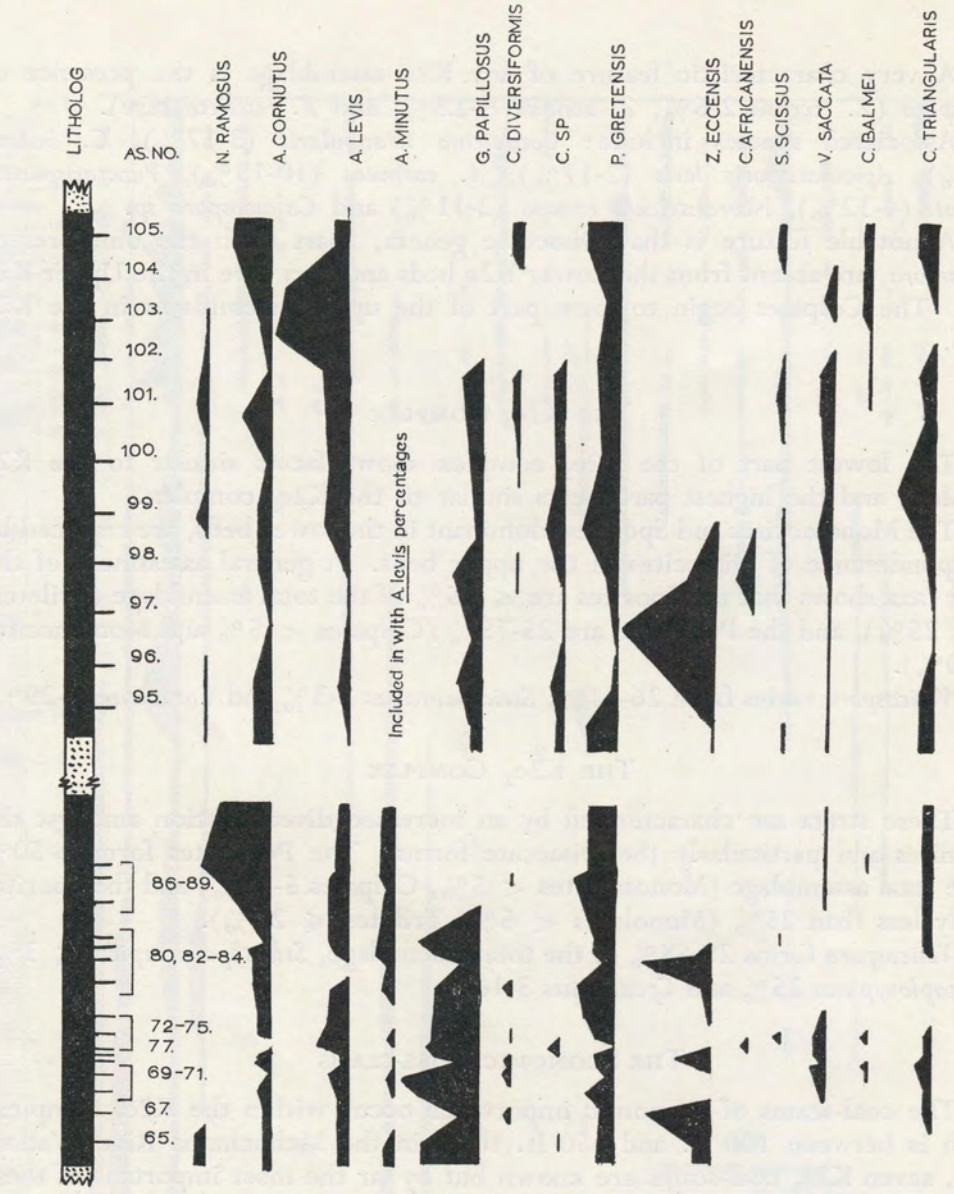
These strata are characterized by an increased diversification amongst the Pollenites and particularly the Disaccate forms. The Pollenites form $>$50% of the total assemblage (Monosaccites $<$ 5%, Colpates 5-10%) and the Sporites usually less than 25% (Monoletes $<$ 5%, Triletes $\leqslant$ 20%).

Vesicaspora forms 29-68% of the total assemblage, *Striatopodocarpites* $\leqslant$ 3%, *Protohaploxypinus* 25% and *Cycadopites* 3-16%.

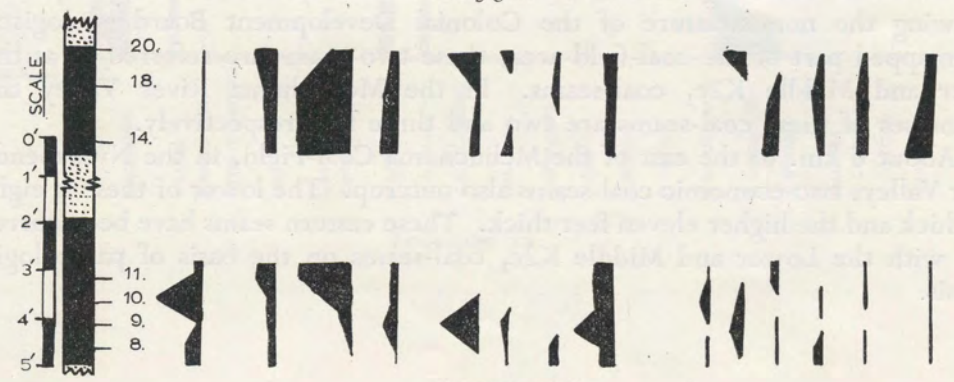
The Economic Coal-seams

The coal-seams of economic importance occur within the $K2e_1$ complex, which is between 100 ft. and 150 ft. thick in the Mchuchuma River Valley. In all, seven $K2e_1$ coal-seams are known but by far the most important of these are two seams occurring between 40-80 ft. from the base of the $K2e_1$ deposits. Following the nomenclature of the Colonial Development Board geologists, who mapped part of the coal-field area, these two seams are referred to as the Lower and Middle $K2e_1$ coal-seams. In the Mchuchuma River Valley the thicknesses of these coal-seams are two and three feet respectively.

About 6 km. to the east of the Mchuchuma Coal-Field, in the Nyakapenda River Valley, two economic coal-seams also outcrop. The lower of these is eight feet thick and the higher eleven feet thick. These eastern seams have been correlated with the Lower and Middle $K2e_1$ coal-seams on the basis of palynologic analysis.



Text-figure 55



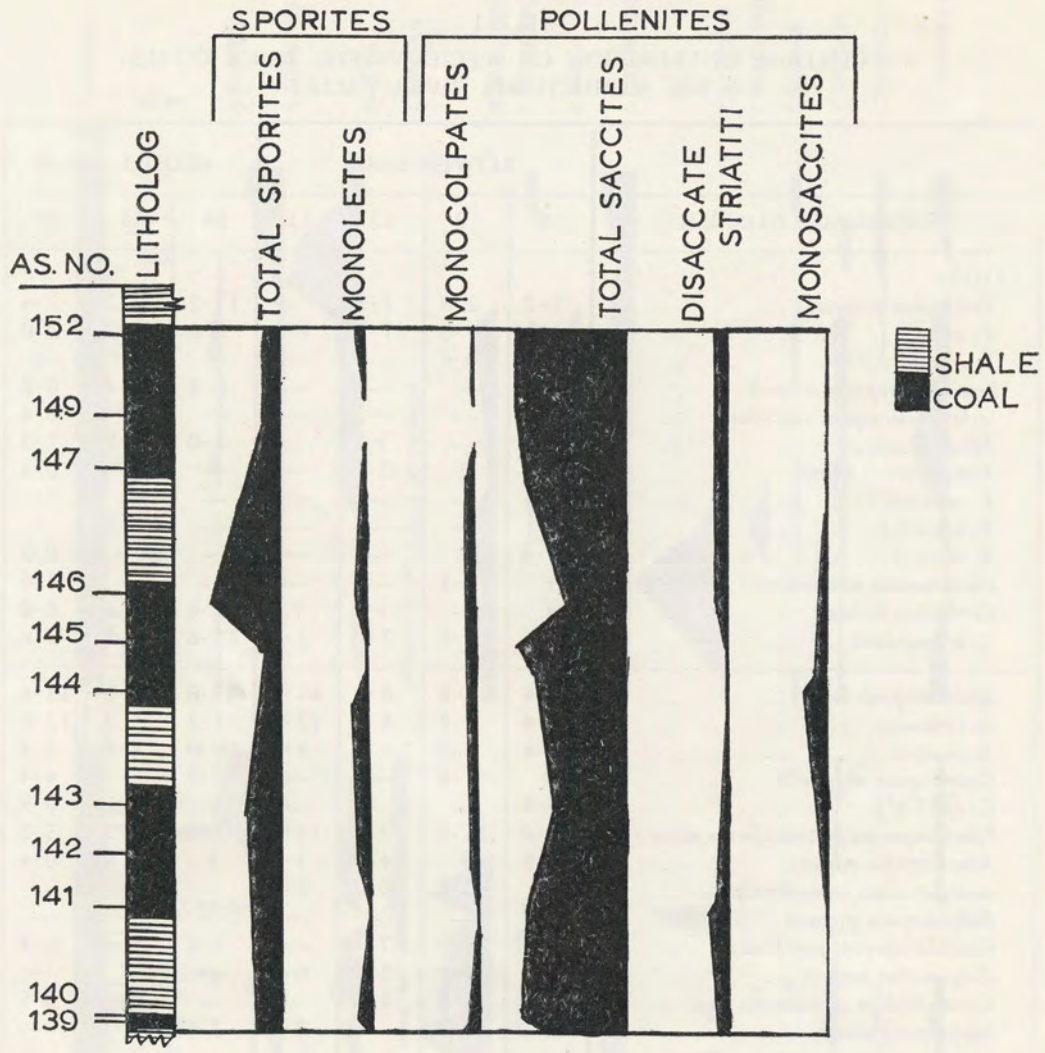
Text-figure 54

TABLE I

PERCENTAGE DISTRIBUTION OF SPECIES IN THE THICK COALS OF THE MCHUCHUMA RIVER VALLEY

	LOWER SEAM				MIDDLE SEAM		
ASSEMBLAGE NUMBER	8	9	10	11	14	18	20
TAXON:							
Vesicaspora potoniei	1·2	2·8	2·5	—	17·2	1·2	2·4
V. ovata	42·4	4·0	17·5	1·2	9·6	20·0	2·0
V. sulcata	0·4	0·4	—	—	—	—	—
Protohaploxypinus sewardi	—	—	—	—	0·4	2·4	0·8
Striatopodocarpites cancellatus	—	—	—	—	—	—	0·4
Vittatina saccata	2·0	—	r	—	2·0	4·8	1·2
Vestigisporites balmei	0·4	?	0·5	—	—	—	0·4
V. methoris	0·4	—	—	—	—	—	—
V. hennellyi	—	—	—	—	—	0·8	—
V. thomasi	0·4	?	—	—	—	—	0·8
Limitisporites monstruosus	r	0·4	—	—	—	—	1·6
Cordaitina balmei	r	—	r	r	1·6	2·4	0·8
C. triangularis	2·4	3·6	2·0	2·8	15·6	6·8	3·6
Apiculatisporis levis	0·4	6·8	8·5	45·6	33·6	38·0	13·6
A. cornuutus	2·4	2·8	5·5	17·6	1·2	5·2	12·0
A. minutus	0·4	7·2	1·5	4·0	10·0	6·8	2·4
Calamospora nigretella	r	2·8	—	—	0·8	—	4·4
C. sp. "A"	0·8	—	—	—	—	0·8	0·8
Punctatisporites gretensis forma minor	5·6	25·6	7·0	13·6	2·0	1·2	5·2
Neoraistrickia ramosa	2·8	r	24·0	3·2	r	0·4	0·4
Acanthotriletes tereteangulatus	—	0·4	5·0	2·4	—	—	—
Deltoidospora giganta	1·2	—	—	—	—	—	—
Granulatisporites papillosus	28·0	27·2	7·5	—	1·6	0·4	20·4
Zinjisporites eccensis	r	—	2·0	0·4	—	—	—
Cirratriradites africanensis	2·0	5·6	1·0	—	—	—	8·8
Schizosporis scissus	r	0·4	—	2·0	3·6	1·2	—

Text-figure 54 and Table 1 summarize the detailed palynologic characteristics of the two seams in the Mchuchuma River Valley, and figure 55 and Table 2 the main characteristics in the Nyakapenda River Valley. The similarities are quite prominent and in general may be expressed as follows. The Sporites are the most prominent taxa in the assemblages. The Triletes are abundant but the Monoletes are represented by only one genus: *Schizosporis*. Within the Pollenites the Monosaccites are important but the Disaccites, exclusive of *Vesicaspora*, are insignificant. The Colpates are restricted to the Middle seam in the Mchuchuma River Valley and the middle and upper part of the Lower seam in the Nyakapenda River Valley.



Text-figure 56

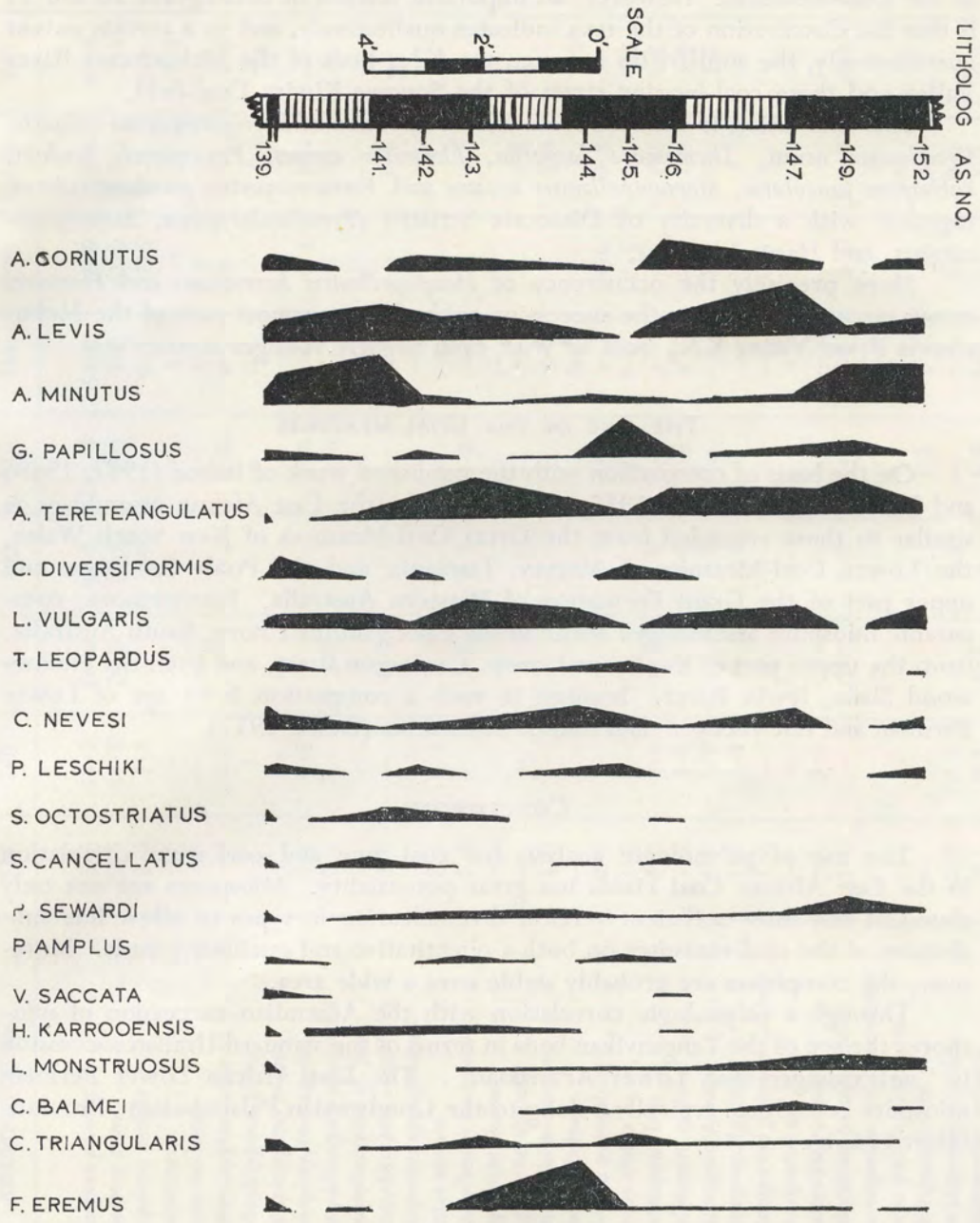
This parallelism in the sequences of miospore assemblages indicates that palynologic analysis has great potential value as a means of locating and exploiting the Tanganyikan Coal-measures. A comparison between the two seams from the Nyakapenda and any of the coals from the rest of the measures does not show a similar pattern.

The Songwe-Kiwira Coal-field Palynologic Complex

The results of the investigations into the Songwe-Kiwira coal-measures are given in text-figures 56 and 57, and table 3. An examination of figure 56 indi-

cates that Pollenites are the main components in the microflora, forming 65-95% of the total assemblage. Within this taxon the Saccites are most prominent (30-82%) with the Monosaccites and Colpates persistent but not abundant.

On the other hand the Sporites usually form less than 20% of the total



Text-figure 57

assemblage: but may extend up to 45% in odd samples. The Triletes are well represented and the Monoletes occasionally common (0-4%).

The quantitative distribution of individual species and genera throughout the succession is of little importance at the present stage in the investigation of the Coal-measures. However, an important feature of text-figures 56 and 57 is that the distribution of the taxa indicates qualitatively, and to a certain extent quantitatively, the similarities between the $K2e_2$ beds of the Mchuchuma River Valley and these coal-bearing strata of the Songwe-Kiwira Coal-field.

This conclusion is deduced from the occurrence of *Laevigatosporites vulgaris*, *Cycadopites nevesi*, *Thymospora leoparda*, *Florinites eremus*, *Pityosporites leschiki*, *Pakhapites fasciolatus*, *Marsupipollenites striatus* and *Verrucosisporites pseudoreticulatus;* together with a diversity of Disaccate Striatiti (*Protohaploxypinus*, *Striatopodocarpites*, and *Hamiapollenites*).

More precisely the occurrence of *Hamiapollenites karrooensis* and *Florinites eremus* tentatively equates the succession with the uppermost part of the Mchuchuma River Valley $K2e_2$ beds or with even slightly younger strata.

The Age of the Coal-measures

On the basis of comparison with the published work of Balme (1957, 1959) and Balme and Hennelly (1955, 1956a, 1956b) the East African assemblage is similar to those recorded from the Greta Coal-Measures of New South Wales, the Lower Coal-Measures of Mersey, Tasmania, and the Poole Sandstone and upper part of the Grant Formation of Western Australia. Furthermore, comparable miospore assemblages occur in the Lake Phillipsia Bore, South Australia, from the upper part of the Lyons Group, Carnarvon Basin, and from the Holmewood Shale, Irwin River. Implicit in such a comparison is an age of Lower Permian and not younger than middle Artinskian (Balme 1957).

Conclusions

The use of palynologic analysis for coal-zone and coal-seam correlation in the East African Coal Fields has great potentiality. Miospores are not only abundant but show sufficient vertical diversification in types to allow fine subdivision of the coal-measures on both a quantitative and qualitative basis. Moreover, the complexes are probably stable over a wide area.

Through a palynologic correlation with the Australian succession of miospores the age of the Tanganyikan beds in terms of the standard Uralian succession is "not younger than Lower Artinskian". The East African Lower Permian miospore complexes typically belong to the Gondwanian Palaeobotanic Province (Hart 1965b).

TABLE III

Percentage Distribution of species through the Coal-Measure succession exposed at Ilima Colliery

ASSEMBLAGE No.	139	140	141	142	143	144	145	146	147	149	152
Taxon:											
Vesicaspora potoniei	35·5	14·5	46·0	48·0	42·0	55·0	16·0	25·6	67·0	41·0	48·0
Vesicaspora ovata	20·5	58·5	20·0	14·0	9·0	7·0	62·0	7·2	5·0	33·0	26·0
Pityosporites leschiki	2·0	1·5	—	1·0	—	0·5	1·0	—	—	—	2·0
Pityosporites sp.	—	—	—	—	—	r	—	—	1·0	—	r
Pityosporites rarus	—	—	—	—	—	r	r	—	—	—	—
Protohaploxypinus sewardi	r	—	?	1·0	1·0	0·5	r	?	1·0	1 0	1·0
Protohaploxypinus globus	—	?	—	—	—	—	—	r	—	—	r
Protohaploxypinus micrus	r	—	—	?	—	—	—	—	—	—	1·0
Protohaploxypinus amplus	0·5	0·5	—	—	1·0	—	0·5	0·4	—	—	—
Striatopodocarpites octostriatus	0·5	—	2·5	r	1·0	—	—	?	—	—	—
Striatopodocarpites cf. fusus	—	—	?	—	—	—	—	—	—	—	?
Striatopodocarpites cancellatus	1·5	—	0·5	?	—	r	—	0·8	—	—	—
Lueckisporites nyakapendensis	—	—	—	—	—	—	?	—	—	—	—
Vittatina saccata	0·5	0·5	—	—	—	—	—	?	—	—	—
Hamiapollenites karrooensis	1·0	—	1·0	0·5	1·0	—	—	r	—	—	—
Vestigisporites balmei	—	—	—	—	—	—	—	?	—	—	—
Vestigisporites thomasi	—	—	?	—	—	—	—	0·8	—	—	—
Limitisporites monstruosus	1·0	—	—	—	r	?	r	0·8	r	1·0	1·0
Cordaitina balmei	—	—	—	—	—	0·5	?	?	1·0	—	—
Cordaitina triangularis	0·5	r	—	0·5	1·0	r	1·0	0·8	—	r	—
Florinites eremus	1·5	—	r	—	?	9·0	1·5	r	1·0	—	2·0
Apiculatisporis levis	1·0	3·5	6·0	5·0	6·0	r	—	7·2	9·0	0·5	1·0
Apiculatisporis cornutus	1·5	2·0	—	2·0	3·5	r	—	11·2	1·0	—	1·0
Apiculatisporis minutus	4·0	3·0	—	1·5	—	—	1·0	r	1·0	3·5	5·0
Calamospora nigretella	1·5	3·0	—	1·5	—	—	1·0	r	—	—	—
Punctatisporites gretensus f. minor	1·0	—	—	?	—	—	0·5	r	—	—	—
Punctatisporites sp.	—	—	—	—	—	?	—	—	—	—	—
Neoraistrickia ramosa	r	0·5	?	—	—	—	—	r	—	—	—
Acanthotriletes tereteangulatus	1·5	—	2·0	6·0	11·0	3·0	0·5	12·0	4·0	4·0	0·5
Verrucosisporites pseudoreticulatus	—	—	—	—	—	—	—	r	—	—	—
Verrucosisporites cf. trisectus	—	—	—	—	—	—	—	—	?	—	—
Deltoidospora directa	—	—	—	—	1·5	r	?	10·4	?	—	?
Granulatisporites papillosus	2·0	0·5	—	1·5	—	r	4·0	0·8	—	1·0	—
Laevigatosporites vulgaris	r	0·5	0·5	r	3·5	2·0	—	3·2	3·0	—	2·0
Thymospora leoparda	?	0·5	—	1·0	—	0·5	0·5	0·4	—	—	?
Cycadopites nevesi	6·0	3·5	r	1·5	1·5	5·0	1·0	0·8	3·0	—	0·5
Marsupipollenites striatus	—	—	—	r	r	r	—	0·8	—	—	—
Pakhapites fasciolatus	2·0	r	—	—	—	—	—	—	—	—	—

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KEY TO TEXT-FIGURES

Figure 51
Location map of the Tanzanian Coalfields.

Figure 52
Synopsis of Miospore distribution through the lower coal-measures exposed in the Mchuchuma River Valley.

Figure 53
Distribution of main species through the Mchuchuma River Valley succession.

Figure 54
Distribution of main species through the Mchuchuma River Valley $K2e_1$ thick coal-seams.

Figure 55
Distribution of main species through the Nyakapenda River Valley $K2e_1$ thick coal-seams.

Figure 56
Distribution of major taxa through the Songwe-Kiwira coal-seams exposed at Ilima colliery.

Figure 57
Distribution of main species through the Songwe-Kiwira coalfields exposed at Ilima colliery.

TABLE II

Percentage Distribution of Species in the thick coals of the Nyakapenda River Valley

Assemblage Number	65	67	69	70	71	72	73	74	75	77	80	82	83	84	86	88	89	95	96	97	98	99	100	101	102	103	104	105
Taxon:																												
Vesicaspora potoniei	—	—	—	0·5	2·0	4·0	3·0	2·0	?	1·0	—	—	—	—	—	—	—	—	—	—	—	—	—	?	?	6·0	5·0	?
V. ovata	7·0	18·0	6·0	3·5	16·0	8·0	6·0	6·5	13·5	4·0	1·0	3·0	2·0	?	—	r	—	31·0	25·1	9·0	28·0	r	r	6·8	4·0	10·0	33·0	4·4
V. sulcata	1·0	1·0	—	?	r	?	?	—	?	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—
Protohaploxypinus sewardi	—	—	—	—	0·4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	?	?	—	r	—	r
P. amplus	—	—	—	—	—	—	—	—	0·5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Lueckisporites nyakapendensis	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	?	—	—	r	0·1	r	—	—	—
Vittatina saccata	—	—	?	1·0	4·0	0·4	3·0	4·0	2·0	0·5	—	—	—	—	—	0·8	r	r	r	r	r	4·8	3·4	7·6	6·4	—	1·0	?
Vestigisporites balmei	—	?	—	—	—	0·4	—	—	0·5	—	—	—	—	—	—	—	—	r	r	—	—	—	—	—	1·0	—	—	—
V. cf. rudis	—	—	—	—	—	?	—	—	—	—	—	—	?	—	—	—	—	r	?	—	—	—	—	r	1·0	—	—	—
V. methoris	—	—	—	—	?	?	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—
V. hennellyi	—	1·0	—	—	—	?	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
V. thomasi	—	?	—	—	?	—	—	—	1·0	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2·4
Limitisporites monstruosus	—	?	—	0·5	r	0·4	—	1·0	0·5	—	—	—	2·0	—	—	—	—	?	r	—	?	—	?	r	—	—	?	—
Cordaitina balmei	—	—	—	0·5	1·2	—	—	—	1·0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	?	3·2	2·0	4·0	5·6
C. triangularis	—	3·0	2·0	5·0	10·4	6·4	2·0	3·0	4·0	—	—	—	2·0	2·0	—	2·0	2·0	8·0	4·0	r	1·6	10·0	30·5	7·6	14·2	?	3·0	10·8
Apiculatisporis levis	6·5	4·0	9·0	10·0	1·6	3·2	7·0	24·0	19·0	15·0	12·0	—	5·0	12·0	8·0	10·0	7·5	r	6·4	r	r	20·4	16·0	22·0	23·2	58·0	38·0	10·0
A. cornutus	3·0	1·0	8·0	r	3·6	6·0	4·0	—	5·0	6·0	13·0	10·5	18·0	r	—	46·4	61·0	10·0	7·6	r	4·8	6·0	1·4	22·4	2·0	6·0	12·0	25·2
A. minutus	6·5	—	2·0	0·5	0·4	0·4	—	2·0	—	?	5·0	4·0	10·5	12·0	r	2·8	7·0	—	—	—	—	—	—	—	—	—	—	—
C. nigretella	—	1·0	—	1·5	r	0·8	—	—	r	—	1·0	—	—	—	—	0·8	—	—	—	—	r	—	r	1·0	1·0	—	—	1·6
C. sp. "A".	—	2·0	—	—	—	?	—	7·0	—	—	—	—	—	—	—	—	—	2·9	5·5	r	r	9·6	3·5	1·0	1·0	—	—	?
Punctatisporites gretensis forma minor	12·5	7·0	24·0	5·0	9·2	13·2	16·0	—	10·5	21·0	31·0	7·0	14·5	19·0	14·0	34·8	20·5	18·0	3·2	r	5·8	24·4	21·2	10·6	15·8	9·0	6·0	23·6
Neoraistrickia ramosa	1·0	—	—	?	0·4	—	3·0	—	2·0	8·0	—	—	—	—	—	—	—	r	r	—	—	4·8	r	5·2	1·2	2·0	—	—
Acanthotriletes tereteangulatus	?	—	—	—	—	—	—	—	0·5	—	—	—	—	—	—	—	—	—	—	—	—	—	?	r	2·0	—	—	?
Daltoidospora giganta	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	?	r	—	r	1·0	r	1·0	—	—	—	—
Granulatisporites papillosus	44·5	10·0	46·0	66·0	19·6	18·4	33·5	45·0	33·5	36·0	35·0	10·0	36·5	50·0	4·0	—	—	3·0	13·1	4·4	16·0	4·0	5·5	6·8	13·2	—	—	—
Zinjisporites eccensis	9·5	40·0	—	—	13·2	27·5	19·5	—	—	r	1·0	62·5	6·5	?	40·0	—	—	r	18·0	77·0	16·8	r	—	—	—	—	—	—
Z. zonata	1·0	2·0	—	—	3·2	2·0	1·0	—	—	—	—	1·0	—	—	20·0	—	—	—	1·0	2·0	r	—	—	—	—	—	—	—
Cirratriradites africanensis	—	—	—	—	?	—	—	3·0	—	—	—	—	—	—	—	—	—	—	r	—	7·8	r	—	—	—	—	—	—
Schizosporis scissus	—	—	—	—	—	—	—	—	1·0	—	—	—	—	?	4·0	—	—	—	—	—	r	?	—	r	1·2	—	—	1·0

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