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# STRUTHIOUS REMAINS FROM NORTHERN CHINA AND MONGOLIA; WITH DESCRIPTIONS OF STRUTHIO WIMANI, STRUTHIO ANDERSSONI AND STRUTHIO MONGOLICUS SPP. NOV.

BY

PERCY ROYCROFT LOWE

B. A., M. B., CANTAB.

WITH A

## NOTE ON REMAINS OF CARINATE BIRDS

BY

DOROTHEA M. A. BATE

PLATES I-IV AND 7 TEXT-FIGURES

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PALÆONTOLOGIA SINICA



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# PART I.

## OSTEOLOGICAL.

Plates I—III.

In a paper entitled "Essays on the Cenozoic of Northern China" Dr. J. G. ANDERSSON (1923 — p. 71) records that Dr. WIMAN of the University of Upsala has reported to him (*in litt.* 1921) an extremely interesting find of Struthionid remains amongst the material which ANDERSSON had sent to him from the Hipparion beds at Locality 30, T'ai Chia Kou in Pao Te Hsien in North West Shansi, on the Yellow River. This proved to be the central portions of both sides of the pelvis of a very large ostrich embedded in a mass of deep red Hipparion clay. It is this fossil pelvis which forms the subject of the following remarks, and on which is based my name *Struthio wimani* for a new species of ostrich. (See p. 18.)

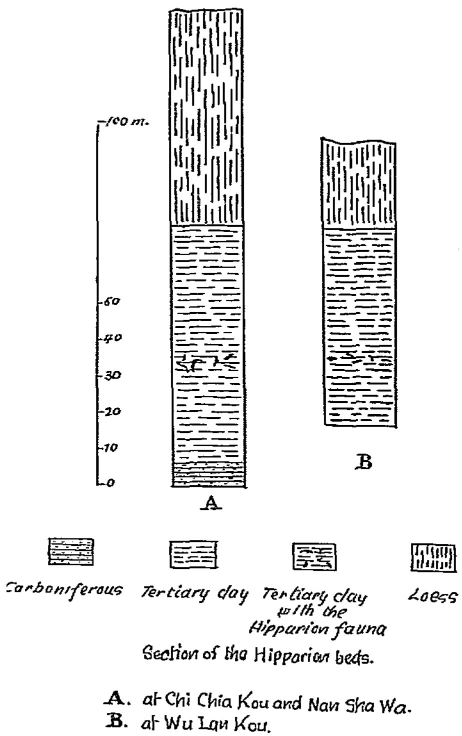
Dr. ANDERSSON (loc. cit. p. 107), in a summary of a report furnished by Dr. O. ZDANSKY on the famous bone deposits of Pao Te Hsien remarks that "these deposits are by far the richest of the Hipparion localities. The beds are beautifully exposed in numerous ravines and Dr. ZDANSKY has surveyed this region with an accuracy which has not its equal in our exploration of the other Hipparion areas."

Hipparion clays, he says, are widely distributed in this part of N. W. Shansi and the adjacent parts of Shansi, but only in three areas are there bone accumulations found in them, the rest of the deposits being otherwise entirely barren.

The T'ai Chia Kou, we further learn, is a "plateau land dissected by an intricate system of ravines in the bottom of which the substratum of Hipparion clay is almost everywhere visible." This clay is of a much deeper red and of a harder and more compact ("rocky") nature than the overlying loess. In the fossil block under consideration I found that it is as much as the point of a knife can do to make an impression on it. We further learn from ZDANSKY's report that the fossil remains of the Hipparion fauna occur at a certain level illustrated in text-fig. 1, in an excellent state of preservation and include:—

| | | | | | |
|---|---|---|---|---|---|
| A. *Perissodactyla.* | Hipparion. | B. *Artiodactyla.* | Deer | D. *Proboscidea.* | Mastodon. |
| | Aceratherium. | | Antelopes. | | Stegodon. |
| | Sinotherium. | C. *Carnivora.* | Hyaena. | | Elephas. |
| | Anchitherium. | | Viverridæ. | E. *Aves.* | Struthionid. |
| | | | Felidæ. | | |
| | | | Machairodus. | | |

Palæontologists are, I believe, now generally agreed that this represents a Pontian fauna (cf. GRABAU, 1927). The accompanying figure is taken from ZDANSKY's report (cf. ANDERSSON loc. cit. p. 108).




Text-fig. 1. Diagram of section of Hipparion beds in North West Shansi. (after ZDANSKY).

It seems necessary to draw attention to the above facts in order to stress the point that the fossil mass with which we are about to deal was found in hard Hipparion clay, associated with an Hipparion fauna and not in the loose overlying loess in which so many large fossil Struthionid eggs, either whole or fragmentary, have been lately found. These fossil egg-shell remains have always been referred to the fossil genus *Struthiolithus*, which was founded upon and has so far been known solely by the remains of eggs laid by a bird whose bones have not as yet been discovered (see Part II). The immediate problem, therefore, which confronts the palæontologist at the present moment is to determine the relations of the ostrich which laid the "*Struthiolithus*" eggs to the bird whose pelvis has been found fossil in Hipparion beds at Locality 30, T'ai Chia Kou in North West Shansi. The solution of this problem, as far as the writer is personally concerned, has not been rendered easier by the fact that he has not been able to examine egg-shell fragments which have beyond any question of doubt been recovered from Pontian strata and also from the fact that no struthionid bone remains have been found in the loess. A somewhat intensive examination of the pelvis, found in Hipparion clay along with the remains of the Pontian fauna alluded to above, has also rendered it at least doubtful if it differs sufficiently in its morphological features to justify its being regarded as properly referable to any other genus than *Struthio.* From a systematic point of view this is somewhat unfortunate as it would certainly have been convenient if there had been sufficient justification for our regarding all the Eurasiatic struthionid remains which have so far been found fossil as being properly referable to some such genus as *Struthiolithus;* which genus might naturally have been presumed to have stood in relation to the *Struthio* of the African continent as some antecedent or more primitive forerunner. No fossil ostrich bones or complex of bones, such as the pelvis in question, have however, yet been discovered which in my opinion justify such a proceeding, although it does not follow that the future discovery of basi-cranial or other bones may not do so.

For the rare privilege of examining and describing the fossil struthionid remains taken from the Hipparion clay I am very much indebted to the kindness of Professor C. Wiman, of Upsala. I may say at once that there can be no shadow of doubt as to the correctness of his pronouncement that they were Struthionid, the only point to determine being — was the bird to which they belonged identical generically with the Recent *Struthio* or not. I would also like to take this present opportunity of expressing my sincere appreciation to Miss D. M. A. Bate, in charge of Fossil Birds in the British Museum, for the invaluable help rendered to me in writing these notes.

## THE PELVIS.

The fossilised components of such parts of the pelvis as have been preserved are held together and imbedded in a mass of very hard brick-red clay (Hipparion) which weighs just over ten pounds. Only the hard and thin cortical surface of the component bones has been preserved, and this has a polished ivory-like appearance, while its cream-like colour and beautiful patina contrasts vividly with the deep brick-red of the hard clay in which the fossil is imbedded, or which has taken the place of all the cancellous bony tissue. In a word the general appearance presented forcibly reminds us of fossilised remains from Pikermi. The fossilised mass comprises the following parts:—

(1) A large portion of the synsacrum which extends from the broken end of the posterad or post-axial portion of the body of the second lumbar vertebra to the fourth sacro-caudal.

(2) A considerable portion of the pre-acetabular iliac plates of either side.

(3) Both acetabula in an almost complete and perfect state of preservation, except that only the truncated bases of both anti-trochanters are represented.

(4) The proximal fragmentary ends of the pubis and ischium of either side, where they fuse with their respective peduncles.

(5) A small portion of the post-acetabular part of the ilium of the right side and a larger portion of the left.

(6) A corresponding portion of the *area dorsalis* between them.

Of these separate parts of the pelvis which we have just enumerated, we shall now pass to a more detailed description:—

I. **The Synsacrum:**— It may be said at once that no essential morphological difference is apparent between such parts of the synsacrum which have been preserved in this Chinese fossil ostrich and a corresponding portion in the synsacrum of the Recent *Struthio*, of which eleven examples representing various species have been used for comparison.

In the vertical section at the pre-axial end of the fossil mass the transverse processes of the second lumbar vertebrae may be seen extending outwards and backwards to fuse with the pubic peduncle of the ilium of either side. (These processes are marked with a cross in Pl. I fig. 1.) Special attention is drawn to the fact that immediately anterad of their junction with the ilia a narrow groove or gutter runs upwards and forwards along the extreme ventral edge of the pre-acetabular iliac plates precisely as it does in the pelvis of the Gambian and other ostriches in the British Museum collection. This may seem to be a small point but I think it is important for that very reason as indicating close genetic affinity.

In the vertical section at the pre-axial end of the fossil mass (cf. Pl. I fig. 1) may also be seen the diapophyses and neural spine of the first lumbar vertebra as well as the truncated ends of the two pre-acetabular iliac plates. The diapophyses have the same angle of inclination and join the inner surfaces of the iliac plates in exactly the same way as they do in the Recent *Struthio*. In *Struthio* the transverse process of the third lumbar vertebra fuses with the distal or ventral end of the pubic peduncle of the ilium on its internal surface, a condition of things to be observed in the fossil under notice. Anterad and posterad of the transverse process of the third lumbar vertebra, in the fossil, are two foramina of the same relative size position and shape as in the Recent *Struthio*. (Cf. Pl. III.) Immediately anterad of the third transverse process may also be seen a wide and shallow groove extending forwards inwards and downwards on the lateral surface of the centrum of the vertebrae in front of it. These grooves as well as the two parallel ridges extending backwards along the ventral surface of the lumbar vertebrae are faithfully reproduced in the Recent *Struthio*.

The large and conspicuously wide transverse processes of the 4th lumbar occupy a more ventral position than either the second or third; their ventral surfaces are very nearly flush with the ventral surface of the centrum of their corresponding vertebrae and they fuse with the proximal end of the pubis of either side; all this being exactly as in the Recent *Struthio*.

The transverse processes of the fifth, sixth and seventh lumbar vertebrae in *Struthio* slightly converge to become associated in a fusion with the ischium by separate facets; the seventh transverse processes are more slender than the fifth and sixth and in some cases barely fuse; they are also directed forwards. In the fossil the morphology seems to me to have been similar but there has been too much crushing to be positive. On the right side the base of the seventh transverse process seems to indicate an original forward inclination. Owing to the imperfect condition of the fossil I should hesitate to say that I can identify the 8th transverse processes which in *Struthio* are much reduced and consequently azygotic.

In the fossil, although there has been a good deal of shearing and destruction in the region of the true sacral vertebrae I can see nothing in the morphology of this important section of the synsacrum to make one suspect that it differed in any way from that obtaining in the genus *Struthio;* and for the sake of brevity I may say the same of the sacro-caudal region.

II. **The Pre-acetabular Iliac Plates:**— A considerable portion of the pre-acetabular division of the ilium of both sides is represented, both iliac plates being truncated anteriorly at about the level of the first lumbar vertebra. Neither of these iliac plates extend quite so far upwards as to meet dorsally, the fossil being somewhat badly preserved along the iliac or neural ridge. I think it is true to say that a first inspection of this part of the fossil would almost certainly produce the impression that the height of the neural spine and the vertical depth of these plates, as measured vertically from the ventral surface of the body of the second lumbar vertebra to the iliac ridge is such as to give a generic distinction to the pelvis as a whole, a distinction which seems at first sight to differentiate it from pelves belonging to any of the species comprising the genus *Struthio* with the possible exception of the fossil ostrich from Samos *(S. karatheodoris).*

It will be seen, however, from a study of actual measurements (cf. tables pp. 21—22) that this impression may be more apparent than real, since the transition between *S. syriacus*, the smallest recent species, and *S. camelus,* the largest, is continuous; while the gap between *S. camelus* and the fossil pelvis from China does not seem to be very evident, although it would seem to be true that a larger gap exists between the fossil and the largest of the present struthious species *(S. camelus)* than between the various present-day species themselves.

On the other hand if there is any character in the fossil which would seem to justify its reference to some such genus as *Struthiolithus* it is this greater vertical depth of the pre-acetabular iliac plates and their corresponding neural spines.

In order to put this important point to a satisfactory test a similar vertical section as that exposed at the pre-axial end of the fossil mass was prepared from the pelvis of a present-day ostrich viz. *S. camelus*. The second largest pelvis in the British Museum collection was chosen, the largest, an example from the Niger, being mounted for exhibition in the galleries and so unavailable for our purpose. The one chosen was that of a Gambian male, 356 A; but it must be noted that it was immature, as was obvious from the fact that the cartilage at the distal ends of the pubis and ischia had not ossified and in fact had been lost in the process of maceration. In Plate I figures 1 & 2 the pre-axial section of the fossil ostrich is shown side by side with a corresponding section of this young Gambian male.

From these sections the proportionally greater height of the neural spine in the fossil, as compared with similar measurements in the Gambian ostrich, at first sight seem obvious not to say impressive, especially when it is noted that the greatest transverse width from one iliac plate to the other is in either case very nearly similar (cf. table in text below). It will be observed, however, that similar comparative figures are given in this table of another ostrich (adult) which demonstrate that there is practically as much difference in the height of the neural spines in these two present-day ostriches as there is between those of the fossil ostrich and the immature example from the Gambia, a consideration which is further accentuated by a reference to some of the tables of comparative measurements given on pp. 21—24. Thus although at first sight the immediate impression gained from a study of the fossil was the proportionately great depth of the pre-acetabular iliac plates in relation to the width from one plate to the other and to the rest of the pelvis, the figures just quoted and those available in the tables below make it very difficult to convince oneself that there was a definite gap which could not be bridged in the measurements obtaining in Chinese Pontian and Recent ostriches.

It must be remembered, moreover, that this Chinese Pontian ostrich was an obviously larger ostrich than any of the present-day African species or sub-species, so that if its pelvis could be accurately re-constructed any *relative* difference between the height of its neural spines or pre-acetabular iliac plates might fade away, more especially when we consider the great difference in size which exists between the largest African ostriches (*S. camelus* from the Gambia) and the Syrian ostrich *S. syriacus* (cf. Table 3). It is well known too that as we go north so representatives of a species tend to grow larger. Systematists of the present day seem to agree in regarding all the various forms of the African ostrich as being merely sub-species of one single species *Struthio* and if this is justifiable we may have had one species group in Eurasia and another in Africa or the African species may have simply been a smaller and later representative of the Eurasiatic.

As far as other points are concerned the typical struthious flattening of these iliac plates in the fossil is well seen, especially on the left side. On the right side there has been some considerable accidental crushing in a direction inwards and forwards. On both plates two conspicuous muscular ridges, well seen in Pl. II fig. 2, are to be specially noted descending from the iliac ridge and gradually converging to the pre-acetabular process of the acetabular rim; ridges which it may be observed are most faithfully reproduced in detail in the Recent *Struthio*. This introduces an interesting point.

*Chinese Pontian ostrich two-toed:*— In the modern ostrich *(Struthio)* the ambiens muscle takes origin neither from the pectineal process nor from the pubic peduncle, but there is a special and isolated tuberosity for this purpose on the outer surface of the pre-acetabular iliac plate some little distance antered of both these processes. In the fossil the iliac plates have not been preserved so far forward as to include this tuberosity, yet judging from the surrounding morphology of the parts concerned and the faithful way in which other ridges and vascular grooves on the iliac plates are exactly reproduced in the fossil as compared with the modern ostrich it seems justifiable to conclude that the ambiens muscle had a similar mode of origin in the fossil as it has in the present-day bird. The further inference may perhaps be justified, viz. that had the Pontian ostrich been three-toed and not two-toed like the present *Struthio* the balance as well as the muscular and tendinous relations of its entire lower extremity would have been affected and would have been reflected in the muscular ridges and depressions as well as the vascular grooves of the iliac plates. As, on the contrary, they are so precisely similar to what obtains in the Recent *Struthio* I infer that this Chinese Pontian ostrich was two-toed. This conclusion seems to be further justified by the fact that in *Aepyornis* and *Dinornis*, both three-toed birds, the roughened surface denoting the origin of the ambiens muscle is situated at the base of the pubic peduncle of the ilium while the muscular ridges and vascular grooves for the anterior and posterior external iliac veins may be briefly described as being entirely non-struthious, using that term in its strict generic sense.

III. **The Anti-trochanters:**— In addition to the pre-acetabular iliac plates of both sides, the truncated bases of both anti-trochanters are well shown on a lateral inspection of the fossil and at once impress one with the obviously larger proportions of this fossil ostrich as compared with the Recent *Struthio*. Measurements are given in the tables below p. 23. It may be stated that the anti-trochanters of either side are not on the same level. That of the right side, together with the salient angle (supra-trochanteric process) of the *area dorsalis* overlapping it, seems to be, more or less, in its normal position, or to have been slightly thrust upwards and inwards — this upward thrust being especally noticeable as regards the supra-trochanteric process; that of the left side seems to have been forced downwards outwards and slightly forwards. This distortion or "shearing" to which the fossil has been subjected is best observed by looking at it from either directly in front or behind.

IV. **The Acetabula:**— In front of the truncated base of the anti-trochanter the acetabulum of either side forms the most conspicuous object in a lateral view of the fossil and both have been preserved in a surprisingly perfect condition considering the pressure to which they must have been subjected. Attention, however, is drawn to the pear-shaped form of the right acetabular ring (cf. Pl. I fig. 3) — the diameter in the line of the anti-trochanter being greater than in that drawn at right angles to it (cf. measurements below). An important point to note is that the level of the acetabular rim in its lowermost arc in relation to the axis of the lumbar vertebra is exactly as it is in the Recent *Struthio*.

On the lower segment or arc of the acetabular ring of either side, the fractured proximal ends of the pubis and ischium are evident and were obviously in every respect disposed as in the Recent *Struthio*.

Both pubic and ischiatic iliac peduncles are represented on either side in a fairly complete condition but a point to be noted is that the pubic peduncle is inclined backwards at a quite noticeable angle to the axis of the synsacrum. This contrasts with what obtains in the Recent *Struthio* where the inclination seems to me to approach much nearer to a right angle with the spinal axis.

On observing the fossil mass from directly in front the acetabular cavity is seen to be situated at a lower level on the left side than on the right. This is especially noticeable when the lower segments of the two rings are compared. Correlated with this lowering of the lower segment of the ring of the left side there has been a little inversion as well, and this apparently has had the effect of causing the pubic and ischiadic heads of the left side to be also rotated inwards and downwards to some slight extent, an effect seen by observing the fossil from directly in front. The consequence of this shearing or distortion has been to make the pubis and ischium fuse with the lumbar vertebrae at different angles, that of the right side (the normal) making a larger angle with the ventral line of the lumbar vertebrae than the left. I do not think the angle made by the right side (the normal) differs to any material extent from that obtaining in the Recent *Struthio*. The position of the acetabular ring in relation to the pre- and post-acetabular portions of the ilium and such landmarks as the anti-trochanteric and supra-trochanteric processes does not seem to differ at all from that to be noted in the Recent *Struthio*, so that we may conclude with a considerable degree of certainty that the post-acetabular portion of the pelvis greatly exceeded the pre-acetabular in length.

Another character which seems to render the purely struthious nature of the bird whose fossil remains we are examining a matter of certainty is the fact that in this Pontian ostrich not only is the acetabular ring completely patent, but one may view through the open ring, exactly as one may do in the present day ostrich, the lateral portions of the bodies of several lumbar vertebrae- e. g. the 4th., 5th., 6th. and 7th., together with such para- and diapophyses as have been preserved to them — the very conspicuous parapophysis of the 5th. lumbar being especially noticeable, as it is in the modern *Struthio*. On the right side one is moreover able to get a clear view of the neural spines of the corresponding vertebrae, a view rendered clearer by the non-preservation of the diapophyses of the 5th., 6th. and 7th. lumbar vertebrae of this side. Moreover, not only may the conspicuous parapophysial processes of the fourth and fifth lumbar vertebrae be observed but the respective foramina in relation with them and others, precisely as in the Recent *Struthio*. Another point to be noted is that the diapophysis of the fourth lumbar vertebra is inclined at a slightly different angle and is conspicuously stouter in contrast with those of the next three posterad of it which must have been slender and weak, if we may judge by the only one preserved (left side). This again is just as it is in the Recent *Struthio*.

The similarity between the fossil and the Present-day *Struthio* is further accentuated by observing that in the inter-vertebral foramen between the fifth and sixth lumbar vertebrae the very groove in which the spinal nerve lay as it issued from the spinal canal has precisely the same direction and moulding (cf. Pl. II fig. 2).

When in fact one bears in mind the vast interval of time which must have intervened since this fossil form lived the similitudes which may be noted through this open acetabular window are indeed amazing; and this, I think, is one of the most impressive lessons to be learned from this fossil.

V. **The Post-acetabular Ilia:**— Passing backwards from the acetabular fossae to the post-acetabular portions of the ilium of either side we note that only a small portion of that of the right side has been preserved, viz. that immediately posterad of the acetabulum. On the left side a much larger portion exists. The morphological characters of what remains of both clearly indicate the open nature of the ilio-ischiatic fissure and the purely struthious nature of the fossil. These post-acetabular blades are connected on their dorsal aspect by an osseous bridge representing the *area dorsalis*, a point to which we shall return.

The depth of the post-acetabular iliac blade of the left side as measured from the outer border of the *area dorsalis* vertically to the ilio-ischiatic fissure appears at first sight to be a conspicuous feature of this part of the fossil in comparison with the same measurement in various species of the Recent *Struthio* (cf. Table 5 p. 22). For example in the fossil under consideration it is 73 mm.; in the fossil *Struthio karatheodoris* of Samos Island it is 72 mm.; while in *Struthio camelus* from Gambia it is 56 mm., and in *Struthio syriacus* only 52 mm.; but the gap is bridged over by a specimen of *S. camelus* from the Niger in which it is 70 mm. In fact it may be said for the sake of brevity that the whole morphology of this part of the pelvis, including what remains of the pubis and ischium and the ilio-ischiatic notch, makes it perfectly plain that not only are we dealing with a struthious bird in the strictest sense of the word but with one which only differs from present day species of *Struthio* in being much larger.

I have already referred to the posterad position of the external salient angles (supra-trochanteric processes) of the *area dorsalis* in relation to the anti-trochanters; from which it is likewise perfectly clear that we are dealing with a form which was struthious in the sense that it was similar to *Struthio* rather than to *Dromæus*, *Casuarius*, *Rhea*, *Dinornis* or *Aepyornis* in all of which the relative positions of these parts are distinctive and characteristic. One of the most peculiar features in this Chinese fossil concerns the *area dorsalis* to which I shall now refer. In the modern day ostrich the inner borders of the post-acetabular portions of the ilium of either side do not meet one another in the middle line or even make contact with the long neuro-spinal bony ridge, formed by the fusion and ossification of the neural spines, which lies centrally between them like a long bar. On the contrary in the Recent *Struthio* a wide lateral gap exists on either side between this long central continuation of the synsacrum and the post ilium. In the fossil on the other hand a complete bony bridge exists from one post-iliac blade to the other which entirely covers in these two deep lateral spaces. I do not think, however, we are justified in regarding this osseous condition of the *area dorsalis* as homologous with the like condition to be seen in *Aepyornis*, *Mullerornis* and some of the Dinornithidæ. It seems to me more likely that it merely indicates a hyperostosis of the lumbo-sacral aponeurosis or fascia in an old bird. Among a large series of pelves of *Struthio* examined, the post-acetabular ilia in two of them were on the way to be connected by a quasi-osseous bridge of the nature just alluded to.

VI. **The Pubis and Ischium:**— Turning once more to the ventral surface of the synsacrum a further reference to the remnants of the pubis and ischium will now be made. As already stated above the fragmentary proximal ends of these have been preserved on both sides (see Pls I & II figures 3 & 2), rather more on the left side than on the right. As in the Recent *Struthio* the proximal end of the pubis fuses with the lower or ventral end of the anterior iliac peduncle and thus forms part of the lower arc of the acetabular rim. Internally it also fuses with the transverse process of the fourth lumbar vertebra. So constant is this latter fusion in the various species of the Recent *Struthio* that it would seem to be the rule. The same fusion of the pubis with the fourth lumbar is apparently constant in *Aepyronis*.

In the fossil, immediately posterad of the junction of the pubis with the vertebral column, a well-marked groove or gutter runs upwards and inwards to the space between the transverse processes of the fourth and fifth lumbar vertebrae and thus serves to sharply differentiate this end of the pubis from that of the ischium as seen from this aspect. The resemblance in this respect to the Recent *Struthio* is exact.

The broken distal end of the ischium is to be noted, as we have just inferred, immediately posterad of the groove separating it from the pubis. It fuses with the posterior iliac peduncle, forms part of the lower arc of the acetabular rim and as far as one can gather from their somewhat crushed condition fuses with the transverse processes of the fifth, sixth and seventh lumbar vertebrae — its morphology in fact being, in all these respects, apparently identical with that to be noted in the Recent *Struthio*.

Finally I might add that the angles made by the proximal ends of the pubis and ischium in effecting their junction with the transverse processes of the lumbar vertebrae does not seem to differ from that to be noted in the modern ostrich. This is only to be noted on the right side, as on the left the angle made is obviously not normal owing to "shearing" or pressure which has forced both ends of the pubis and ischium downwards and inwards, thus lessening their angle of inclination to the synsacral axis.

In addition I might add there seems nothing in the measurements which I have made across the ventral surface of the lumbar centra from the proximal end of one pubis or ischium to the other or in the relative transverse measurements made from the iliac end of one transverse process to the other in the various lumbar vertebrae, to cause one to think that these measurements differ in any material way from those to be noted in the Recent *Struthio;* but it may be observed that in this respect the measurements noted in *S. australis* (the South African ostrich) as also in *S. molybdophanes* (the Somaliland ostrich), would appear to differ from those found in *S. camelus* (the North African ostrich) and others. There is, moreover, considerable variation in respect of age and sex making the subject very complex and confusing without a very large series of pelves representative of all the species of *Struthio*.

**Struthio karatheodoris.** FORSYTH MAJOR.

A word may now be said on the relationship of the Chinese Pontian ostrich, *Struthio wimani,* to the fossil remains of the ostrich found in the island of Samos and named by Dr. FORSYTH MAJOR *Struthio karatheodoris.* This ostrich was discovered in beds in association with a fauna which is now by general consent regarded by palæontologists as being Pontian (Lower Pliocene) that is to say it formed a component part of the Hipparion fauna of South-eastern Europe and Sout-western Asia and so in all probability was contemporaneous with the Chinese ostrich.

The pelvic and other remains of this Samos ostrich were described by Mr. RUDOLPH MARTIN of Basel University and his description was published in the Proceedings of the Zoological Society of London in 1903. Mr. MARTIN could see nothing to justify him in referring this Samos pelvis to any genus other than *Struthio,* a conclusion further supported by the examination of the bones of the hind limb.

There is a cast of the Samos pelvis in the British Museum from which it is plainly evident that the original pelvic remains of the Samos ostrich could not have been in anything like such a perfect state of preservation or so complete as in the fossil Chinese pelvis just described. Nevertheless, handicapped as we have been with only this cast to examine I should be strongly inclined to support Mr. MARTIN in referring the Samos ostrich to the genus *Struthio.*

It is true that at first sight I was inclined to think that the narrowness of the Samos pelvis (see measurements in Tables No. 6) in relation to the depth of the post-acetabular iliac blade (see Table No. 5) not only allied this fossil ostrich with that represented by the Chinese Pontian pelvis but that they were both, in addition, probably characterised originally by relatively deeper pre-acetabular iliac plates and longer neural spines than are present in the modern *Struthio.* If this could really be demonstrated it is evident that they might have been referred to a genus distinct from the Recent *Struthio* while in the same category with them one would have been inclined to think that there might have been included such forms as "*Struthiolithus*" *chersonensis* from South Russia; the Persian (Maragha) struthionid remains represented by a toe bone described by MEQUENMEN and *Struthio novorossicus* of ALEXEJEV (Novo-Elizabetovka, Odessa).

*A priori* one would have rather expected the Chinese Pontian ostrich and the form found fossil in Samos *(S. karatheodoris)* to have exhibited generic points of distinction from the Recent *Struthio* and if this had been the case it would doubtless have had its convenient aspect from the point of view of the systematist. Unfortunately comparative measurements do not seem to justify such a convenient arrangement since the measurements of the pelvis of an ostrich taken in the Niger basin, *Struthio camelus* — now preserved in the British Museum — seem to provide a complete transition from one category to the other.

## CONCLUDING OBSERVATIONS.

The determination of the generic status of the ostrich represented by the pelvic remains found in Pontian (Lower Pliocene) deposits of North-East China has not been unattended with doubts and difficulties. There seemed at first sight little doubt that the greater vertical measurement of the pre-acetabular iliac plates, associated as it was with the great height of the neural spines of the corresponding vertebrae and with what appeared to be a general narrowness of the side to side diameter of the entire pelvis, pointed very strongly to the fact that the Pontian Chinese ostrich was generically differentiated from the Recent *Struthio*. In support of this conclusion was the idea which formerly seems to have prevailed that anything dating as far back as, let us say, Miocene or Pliocene times must almost of necessity be at least generically distinct from present forms. In former days I am under the impression that struthionic remains from Lower Pliocene deposits would have been, so to speak, automatically differentiated in a generic sense. But we have to remember firstly that all the evidence seems to point to the fact that the pelvic remains under discussion must have belonged to a two-toed ostrich and secondly that associated with this fact it has so far been found impossible to discover characters differing generically from *Struthio* in the pelvis of the fossil ostrich *(S. karatheodoris)* found in Samos in deposits (Pontian) of the same nature as those in which this Chinese pelvis was found. It is true that the Chinese Pontian fauna may have antedated the Mediterranean Pontian and that an east to west migration may be implicit in this presumption with associated changes in the fauna. On the other hand the vast area covered at the present epoch by the single genus *Struthio* which in addition seems to have extended back unchanged to the Pontian faunal epoch of the Mediterranean appears to indicate a considerable static fixity as far as generic changes are concerned, and incidentally seems to support my contention (1928, p. 191) that in regarding the struthionids as the derelict remnants of a Proto-carinate volant ancestry it seems more than probable that their very wide distribution in space and time has too often been forgotten; while their occupation of restricted areas has been greatly over-emphasised. At any rate we have the spectacle of a flightless struthionid which apparently since the close of the Miocene times has not differed generically from *Struthio*, or if the Chinese Pontian ostrich did differ from it only differed in the sense of being a *Proto-struthio;* and this flightless bird has occupied at one time or another since that period enormous tracts of the world which comprised huge areas of Asia, Europe and Africa. In this connection the possibility of the fossil *Psammornis rothschildi* of the North-African desert being allied to the Chinese Pontian ostrich will have to be considered in the light of further evidence not at present available. We may state here, however, that judging from the type specimens of the eggs of this very large ostrich, which Lord ROTHSCHILD has very kindly allowed me to examine, it was a much larger bird than the Chinese Pontian, if egg fragments from Locality 35 (Shansi) may justly be refered to as Pontian (see Part II). So large indeed must have been the eggs of *Psammornis* that I have already discussed (1928) the possibility of their being *Aepyornithine.* I might add that Dr. K. LAMBRECHT (1929) considers this last hypothesis is supported by the discovery of a fossil bone in the Oligocene beds of the Fayûm and this is considered by him to represent the tarso-metatarsus of a three-toed struthionid to which he has given the name *Stromeria fayumensis.* Such considerations have caused me, while awaiting further evidence, to hesitate before loading palæontological nomenclature with a brand new generic name for the Chinese Pontian ostrich. Against such a proceeding are the actual comparative measurements of the pelves of various living struthious species which I have set down in the tables appended and which certainly seem to bridge over any gap, *so far at least as measurements are concerned;* while one of the facts which especially impressed me in examining this Chinese fossil pelvis was the extraordinary similarity in the minute details of so many of its characters to corresponding characters in the Recent *Struthio.* It was this almost amazing constancy over such a long period as must have elapsed since the Pontian which was the outstanding impression received — constancy in morphological detail as against variation. But whatever may be the final verdict as regards generic differentiation there can be no doubt that specifically it must have differed. In virtue of this I propose to distinguish the ostrich whose remains are represented by the pelvis found fossil at T'ai Chia Kou in Pao Te Hsien in North-West China, and which is preserved in the Upsala Museum, by the name of

**Struthio wimani Sp. nov.**

in recognition of the great work already done by Professor C. WIMAN in furthering the study of vertebrate palæontology in China.

The following further remarks may be worth consideration. As far as the osteological and oological material at present available enables one to come to any conclusions at all it seems clear that there once ranged across Asia from China to the Mediterranean basin a struthious species-group which seems to have differed if only in size from the African species-group of the present day. As far too as our present knowledge goes this Asiatic species-group first comes upon the scene in Pontian strata, that is to say in either Lower Pliocene or Upper Miocene times, according as the individual opinions, held by palæontologists in regard to the date of Pontian beds, vary.

This group is at the present moment of our knowledge represented by such fossilized remnants as the following: *Struthio wimani* of China; *S. novorossicus* ALEXEJEV (1916) of Odessa; *Struthio* sp. recorded by PRZEMYNSKI (1911) from Meotien beds in the Koyalnik Valley, near Odessa; and *Struthio* sp. from Maragha (Persia) represented by a toe-bone described by MEQUENEM. All these fossil remnants were unearthed in what appear to have been typical Pontian beds. As regards oological material no complete eggs or fragments of eggs have, as far as I am aware, been recovered from indisputable Pontian or Hipparion strata, unless indeed Loc. 34 eventually proves to be of this age. (See Part II p. 31.) In addition, it is interesting to note that an ostrich or ostriches had persisted in China and Mongolia from the Lower Pliocene upwards to early Pleistocene times or even possibly to late Pleistocene. This seems to be borne out by the following facts (1) GRABAU (loc. cit. p. 219) records the discovery of a "struthiolithid bird" from Mongolia in the Hungkureh Pliocene formation of the Tsagan-Nor basin, north of the Baga-Bogdo range of the Altais. (2) Father LICENT's discovery of a femur in the Sanmenien (Lower Pleistocene) beds of Sangkanho a femur which measured 340 millimetres over all, as contrasted with 332 mm. representing the length of the femur of *S. camelus* from the Niger in the collection of the British Museum (95. 10. 14. 1) — the largest specimen of the recent ostrich we have met with. (3) The discovery of "nests" of eggs in the loess and many fragments associated with human cultures (see below Part II). All these fossil remnants it may be safely presumed belonged to what we have called the Asiatic species-group.

Besides these, however, we have to consider the status of *Struthio asiaticus* from the Siwaliks (Upper Pliocene) of North-West India, which appears to me to have differed so slightly from the Recent ostrich that I am strongly inclined to regard it as an Asiatic outpost of the African species-group; that is to say in the same light as we should regard *S. syriacus* or the Syrian ostrich of the present day. This opinion has been arrived at after a comparative examination of the actual type specimens of the fossil bones preserved in the British Museum.

The differentiation of an Asiatic species-group would appear to be further justified by a consideration of the *distribution* of such fossil remnants of Eur-asiatic struthionids as have so far been found, influenced as it must have been by the ancient coniguration of the Pliocene land areas concerned — mountain barriers, valleys, inland seas (Pontian) and connectant straits (Troy-Aegean). This has been suggested by GRABAU's (1927) account of these isolating factors and his remarks upon the distribution of the peculiar hornless Rhinocerid — *Chilotherium* — one of the leading types of the Hipparion fauna.

It seems probable, furthermore, as GRABAU points out, that there was a great pathway of migration, even in Pliocene time, between China and Europe by way of the Takla-Maaken basin in the province of Sinkiang, that is to say to the north of Tibet and the Kwenlun ranges, or alternatively, or in addition, to the north of Tianshan through Zungaria and not by a path south of the Himalayas.

## TABLES OF MEASUREMENTS.

### Table 1: *Acetabular Ring.*

| | Anti-Trochanteric. Diameter mm. | Diameter at Right Angles. mm. |
|---|---|---|
| a) *Struthio wimani* (Chinese Pontian Fossil). | | |
| 1. Right side | 65 | 60 |
| 2. Left side | 63 | 62 |
| b) *Struthio camelus* ad. Niger. Brit. Mus. Coll. 95. 10. 14. 1 | 63 | 61 |
| c) 1. *Struthio camelus* juv. Gambia. Brit. Mus. Coll. 356 A. | 61 | 60 |
| 2. *Struthio camelus* ad. Gambia. Brit. Mus. Coll. 356 B. | 58 | 57 |
| d) *Struthio masaicus* ad Brit. Mus. Coll. | 60 | 58 |
| e) *Struthio molybdophanes* ad. Brit. Mus. Coll. 88. 3. 5. 1. | 53 | 53 |
| f) 1. *Struthio australis* ad. Brit. Mus. Coll. 356 f. | 52 | 51 |
| 2. *Struthio australis*. Brit. Mus. Coll. 1915. 3. 29. 1. | 52 | 52 |
| g) 1. *Struthio syriacus* juv. Brit. Mus. Coll. 1623. 6. 10 1. | 52 | 51 |
| 2. *Struthio syriacus* juv. Brit. Mus. Coll. 1924. 4. 8. 1. | 54 | 52 |

### Table 2: *Neural Spine.*

| | *Struthio wimani* | *Struthio camelus* (Gambia) |
|---|---|---|
| a) From base of neural spine of 1st lumbar vertebra to junction of neural spine with iliac plates | 114 mm. | 97 mm. |
| b) From base of neural spine of 1st lumbar vertebra to top of neural ridge | 136[1] „ | 122 „ |
| c) Greatest width of pre-acetabular portion of pelvis at level of 1st lumbar vertebra | 82 „ | 78 „ |

### Table 3: Measurement from ventral surface of body of second lumbar vertebra to iliac or neuro-spiral ridge.

| | |
|---|---|
| a) *Struthio wimani* (Chinese Pontian Fossil) | 164 mm.[2] / 173 „ [3] |
| b) *Struthio camelus* ad. Niger | 157 „ |
| c) *Struthio camelus* juv. Gambia | 150 „ |
| „ „ ad. „ | 140 „ |
| d) *Struthio masaicus* ad. | 136 „ |

[1] Approximate.

[2] Represents measurement to actual termination of osseous cortex short of the iliac ridge.

[3] Approximate original measurement to iliac ridge.

*Note:*— In cases of apparent discrepancy in the measurements, allowance should be made for sex and the fact that in osteological specimens sex is rarely, if ever, indicated.

| | |
|---|---|
| (e) *Struthio molybdophanes* ad. | 134 mm. |
| (f) *Struthio australis* | 131 „ |
| „ „ 1925. 5. 12. 1. | 131 „ |
| (g) *Struthio syriacus* ad? | 124 „ |
| „ „ juv. | 121 „ |

Table 4: Depth of Ilium — measurement in perpendicular line from iliac ridge to centre of upper border of acetabular rim.

| | |
|---|---|
| (a) *Struthio wimani* (Chinese Pontian Fossil) | 110 mm.[1] 124 „ [2] |
| (b) *Struthio camelus* ad. Niger | 107 „ |
| (c) *Struthio camelus* imm. Gambia | 91 „ |
| „ „ ad. „ | 89 „ |
| (d) *Struthio masaicus* ad. | 83 „ |
| (e) *Struthio molybdophanes* ad. | 86 „ |
| (f) *Struthio australis* | 93 „ |
| (g) *Struthio syriacus* ad. | 76 „ |
| „ „ „ | 75 „ |

Table 5: Depth of Post-acetabular iliac blade — measured from outer border of *area dorsalis* vertically to the ilio-ischiadic notch or fissure.

| | |
|---|---|
| (a) *Struthio wimani* (Chinese Pontian Fossil) | 73 mm. |
| (b) *Struthio karatheodoris* (Samos Fossil) | 72 „ |
| (c) *Struthio camelus* ad. Niger | 70 „ |
| (d) *Struthio molybdophanes* ad. | 59 „ |
| (e) *Struthio camelus* imm. Gambia | 56 „ |
| „ „ ad. „ | 53 „ |
| (f) *Struthio masaicus* | 54 „ |
| (g) *Struthio syriacus* ad. | 52 „ |
| (h) *Struthio australis (S. meridionalis Scl.)* | 48 „ |

Table 6: Measurement (span) (1) from one supra-trochanteric process to the other; (2) from middle line (neuro-spinal ridge) to supra-trochanteric process.

| | (1) | (2) |
|---|---|---|
| (a) *Struthio wimani* (Chinese Pontian Fossil) | 175+ mm. | 74+ mm. |
| (b) *Struthio karatheodoris* (Samos Fossil) | | 65 „ |

[1] Represents measurement to actual termination of osseous cortex short of the iliac ridge.
[2] Approximate original measurement to iliac ridge.

| | (1) | (2) |
|---|---|---|
| (c) *Struthio camelus* imm. Gambia | 140 mm. | 79 mm. |
| (d) *Struthio australis* | 125 „ | 69 „ |
| (e) *Struthio camelus* ad. Gambia | 120 „ | 66 „ |
| (f) *Struthio camelus.* Niger | 119 „ | 64 „ |
| (g) *Struthio syriacus* imm. 1924. 4. 8. 1. | 114 „ | 61 „ |
| (h) *Struthio syriacus* imm. ? 1923. 6. 10. 1 | 107 „ | 62 „ |
| (i) *Struthio masaicus* | 104 „ | 58 „ |
| (j) *Struthio molybdophanes* | 103 „ | 55 „ |

Table 7: Span from outer ridge of one anti-trochanter to the other.

| | |
|---|---|
| (a) *Struthio wimani* (Chinese Pontian Fossil) | 200 mm.[1] |
| (b) *Struthio camelus.* Niger | 199 „ |
| (c) *Struthio camelus* imm. Gambia | 190 „ |
| (d) *Struthio camelus* ad. „ | 183 „ |
| (e) *Struthio masaicus* | 184 „ |
| (f) *Struthio australis (S. meridionalis Scl.)* | 173 „ |
| „ „ 1925. 5. 12. 1. | 176 „ |
| (g) *Struthio molybdophanes* | 172 „ |
| (h) *Struthio syriacus* 1924. 4. 8. 1. | 150 „ |
| „ „ 1923. 6. 10. 1. | 148 „ |

Table 8: Span from outer surface of one anterior iliac peduncle to the other — taken at level of transverse process of second lumbar vertebra.

| | |
|---|---|
| (a) *Struthio wimani* (Chinese Pontian Fossil) | 80 mm. |
| (b) *Struthio camelus* imm. Gambia | 74 „ |
| „ „ ad. | 70 „ |
| (c) *Struthio masaicus* | 74 „ |
| (d) *Struthio molybdophanes* | 61 „ |
| (e) *Struthio syriacus* 1924 | 55 „ |
| „ „ 1923. 6. 10. 1. | 52 „ |

Table 9: Measurement across base of antitrochanter.

| | |
|---|---|
| (a) *Struthio wimani* (Chinese Pontian Fossil) | 54 mm. |
| (b) *Struthio camelus.* Niger | 48 „ |
| (c) *Struthio camelus.* Gambia | 48 „ |
| (d) *Struthio australis* | 40 „ |
| (e) *Struthio syriacus* | 36 „ |

[1] Approximate.

Table shewing maximum lengths of various struthious femurs.

| | |
|---|---|
| (1) *Struthio karatheodoris* (cf. Rudolf Martin 1903, p. 204) | 360 mm. |
| (2) Femur from Sanmenien deposit south of Kalgan (Boule 1928, p. 92) | 340 „ |
| (3) *Struthio camelus* (Gambia) Brit. Mus. Coll. 356 A, Immature male | 311 „ |
| (4) *Struthio australis.* Brit. Mus. Coll. 356 C | 304 „ |
| (5) *Struthio camelus.* Brit. Mus. Coll. 62. 12. 22. 3. | 294 „ |
| (6) *Struthio molybdophanes.* Brit. Mus. Coll. 88. 3. 5. 1. | 291 „ |
| (7) *Struthio syriacus.* Brit. Mus. Coll. 1924. 4. 8. 1. | 272 „ |

# PART II.

## OOLOGICAL.

Plate IV.

The following oological material has been submitted for study by Professor WIMAN:—

(1) A very large series of egg-shell fragments taken from Locality 34 in the district of Hsiang-Ning-Hsien in Shansi at the place called P'au-T'ao-P'o (cf. ANDERSSON, loc. cit. pp. 76 and 77).

(2) A dozen fragments from Olan Chorea (No. 2), Mongolia — collected in 3. VII. 20.

(3) A larger series of fragments, more weathered and thinner in section than in Series 1 from Ertemte or Olan Chorea (No. 3), Mongolia.

(4) Fifteen fragments from Olan Chorea (No. 4), Mongolia.

(5) A fragment from Tjel-gol-Tabool, Mongolia.

(6) Two fragments from Hentoch Obo, Doshen, Mongolia.

In additon to the above material I have also had the opportunity of examining:—

(7) a) A complete "*Struthiolithus*" egg from the Loess, preserved in the British Museum collection (A 1308) and taken from the river bank on the borders of the provinces of Honan and Chihli. Presented by the Rev. A. M. CLARKE, 1920.

b) Fragments of the same.

c) Sections of the same mounted for microscopic study.

(8) Two complete struthionid eggs from the Loess of China (Honan) now preserved in Lord Rothschild's museum at Tring.

(9) Sections of the pseudo-fossil egg (mounted for microscopic study) acquired by Mr. BIDWELL in India and known as *Struthio indicus*.

(10) Microscopic sections of eggs of *Aepyornis*, *Dinornis*, *Struthio*, *Casuarius*, *Rhea*, *Apteryx*, *Tinamou*, etc.

Finally I must add that I have unfortunately not had the opportunity of examining fragments of struthionid egg-shells which have actually been found *in situ* with remains of an undoubted Hipparion fauna, such, for instance, as were found by PÈRE LICENT in Eastern Kansu. (Cf. ANDERSSON, loc. cit. pp. 75 and 76.)

With such material therefore before me I now propose to make some remarks about:—

A. The large struthionid fossil eggs which have in recent years been found either whole or in fragments in what I will call the loess proper of northern China.

B. Certain other fragments found in other and deeper deposits as for instance in what has been designated by ANDERSSON as Locality 34. (Pontian).

C. Other shell fragments found in Mongolia.

### A. **Eggs of the Loess.** *Struthio anderssoni.*

ANDERSSON (loc. cit. pp. 55—71) has brought together records of eggs recovered from this deposit in Northern China and besides giving actual measurements of

Text-fig. 2. To show relative size of the egg of (a) *Struthio anderssoni*; A. 1308 in Brit. Mus. Ho-Nan, China, (syn. *Struthiolithus chersonensis*) and (b) *Struthio australis* (South Africa).

eighteen examples has an instructive table in which the maximum, minimum and average measurements are compared with BRANDT's specimen of *Struthiolithus chersonensis* and examples of *Struthio camelus*. Other examples which I have had the opportunity of examining are preserved in the British Museum (see text-fig. 2) and in Lord Rothschild's collection at Tring. (See p. 37.) ANDERSSON refers these large eggs of the loess to BRANDT's species *S. chersonensis* from South Russia (Cherson). In doing so he has followed C. R. EASTMAN, who in a paper "On the remains of *Struthiolithus chersonensis* from Northern China" (1898, p. 127) reported the first discovery of a fossil struthious egg to be found in China (Kalgan).

EASTMAN referred this very large egg to the genus *Struthiolithus* and the species *chersonensis*, both of which had been founded by BRANDT in 1857 upon the fossil egg found in the district of Cherson in South Russia.

Although perhaps for some reasons to be regretted, there seems to be no room for doubt that if we regard this ostrich as being generically different from *Struthio* and follow strictly the rules of nomenclature, as at present constituted, both the generic name *Struthiolithus* and the specific name *chersonensis* must stand for the South Russian ostrich, although based only on its fossil egg. It may, however, be noted here, that if we may judge from the specific diversity that characterises the genus *Struthio* of modern times, the probability of the *specific* identity between the bird which laid its eggs in North China and that which laid the egg in Chersonese Russia seems to be, to say the least, very doubtful. Be this as it may, the necessity or the justification for having based a new genus upon the egg of the Chersonese ostrich will not perhaps be obvious to all, if one is guided solely by actual evidence. No justification for it seems to have been advanced by BRANDT.

NATHUSIUS, in point of fact, (1886, p. 47) examined sections of some fragments of BRANDT's egg microscopically and came to the conclusion that their structure indicated close relationship with the present-day genus *Struthio*. I have myself compared sections of the large eggs of the upper loess of China with sections of the eggs of *Struthio* and cannot detect any indication of generic differences.

I might also state here that I have made a comparative examination of microscopical sections of the eggs of *Struthio*, *Struthiolithus*, *Aepyornis* and *Psammornis*, and I should hesitate to say that I could recognise any very satisfactory generic distinctions. For example, the primary and secondary columns in the mammillary layer of all the above genera appear to me to be built upon the same principal and to be dependent upon inorganic, not organic, laws of form and shape; while as regards such a point as the structural arrangement of the air channels I find in vertical microscopical sections far more difference between two such species as *Struthio camelus* and *Struthio molybdophanes* than there is between two such groups as *Struthio* and *Aepyornis*. As far too as it is possible for a study of the struthionid pelvic remains found in the Hipparion (Pontian) clay of China (see Part I) to throw any side light upon the generic status of the South Russian ostrich it would appear to bear out the conclusion of NATHUSIUS that there are no very cogent reasons for removing the latter from the genus *Struthio*. MARTIN RUDOLF (1903) from the study of a fossil struthious pelvis (see Part I) found in the Pontian of Samos *(S. karatheodoris)*, also came to the conclusion that there was nothing in its morphology to suggest generic distinction from *Struthio*.

If therefore the consensus of evidence seems to point to the conclusion that the early Pliocene ostrich of Eurasia cannot as yet be distinguished generically from

*Struthio*, it may well be doubted if there is any justification for differentiating in a generic sense the ostrich of the Chinese or Russian loess, a bird which even if it were late Pliocene in origin would seem to have survived until at least the Mid-Pleistocene (the period ascribed by ANDERSSON to the loess) and to have been, judging from its eggs, a smaller bird than the Pontian ostrich. On the other hand in regard to specific distinctions it seems clear, if we may judge from a comparative examination of the struthious egg-shell fragments found in various strata of different ages in China and Mongolia, that there is more than one species of ostrich represented (see below). For convenience of reference, therefore, it seems to the writer that it would probably save confusion if certain species were distinguished nomenclaturally. On osteological grounds I have already suggested the name of *S. wimani* for the Chinese Pontian ostrich (see above p. 18) and I now propose to distinguish the ostrich of the Chinese Pleistocene loess by the name *Struthio anderssoni*[1] sp. nov. and the ostrich of the Mongolian plateau by the name of *S. mongolicus*[2] sp. nov. (see below p. 34).

The external characters of the eggs of the Chinese loess proper *(Struthio anderssoni)* have already been described by EASTMAN (1898) and ANDERSSON (1923) while, as I have said above, tables of measurements of eighteen complete specimens have been published by the latter. SCHÖNWETTER has measured the thickness of two shell fragments from the Chinese loess which are now preserved in the British Museum. He found them to vary from 2.2 mm. to 2.4 mm. My own results give 2.1 mm. and 2.3 mm.[3] EASTMAN's egg from the Chinese loess measured 2.2 mm. The thickness of two fragments from the "quaternary of China" in the British Museum, A 1890, is exactly 2.0 mm. I think they are the least abraded of any fragments I have examined. In the recent northern African ostrich, *Struthio camelus*, my measurements range from 1.8 mm. to 1.9 mm. One fragment of the southern African ostrich, *Struthio australis*, gave 1.8 mm. The thickest egg of *Struthio (S. molybdophanes)* measured by NATHUSIUS gave 2.1 mm. The egg fragments he measured from South Russia *(Struthiolithus chersonensis)* gave 2.6 mm. to 2.7 mm. I have measured seventeen shell fragments from Locality 34 (Southern Shansi; Pontian) and find the average works out at 2.6 mm. The naked eye difference between shell fragments which vary between 2.1 mm. and 2.3 mm., and those which average 2.6 mm. is very striking and if the figures given by NATHUSIUS for the South Russian egg fragments are correct, viz: 2.6 mm. to 2.7 mm., then it would appear to be certain that the ostrich which laid the Chersonese egg and the ostriches which laid the eggs found in the Chinese loess, *Struthio anders-*

[1] Type in Brit. Mus. A 1308, Ho-Nan, China.
[2] Type in Coll. pal. Upsala.
[3] All measurements made by me were done with a vernier scale.

*soni* cannot have been specifically identical, while it seems more likely that the ostrich which laid the eggs from Locality 34 and the Chersonese ostrich might conceivably have been. Measurements of Mongolian egg fragments will be given below (see p. 35). I might add that in *Psammornis rothschildi* the thickness of the egg, as given by ANDREWS, is 3.2 mm.—3.4 mm. My own measurements give 3.2 mm. to 3.3 mm. *Aepyornis sp.* is, I find, 4 mm. *Dinornis*, curiously enough, appears to have had a thinner shell than *Struthio*, viz: 1.5 mm. Finally, as regards taking the average measurements in a large series of fragments from any given locality, not only may variation due to abrasion exist but, as Lord ROTHSCHILD imforms me, the eggs of struthious birds in captivity vary greatly in measurements, according to *age*. The average which I give from Locality 34, viz: 2.6 mm., may therefore be lower than the true average.

The large struthionid eggs of the Chinese loess, which I have designated *Struthio anderssoni*, may apparently, according to investigators on the spot, owe the position in which they have been found to two factors:— (1) they may have been weathered or washed from the underlying early Pleistocene (Sanmenian) or Pliocene strata, a proposition for which, considering the comparatively perfect state in which so many have been found, there does not seem to be much justification; or (2) they may have been laid by an ostrich which lived subsequently to the ostriches of these periods and whose eggs, fertile or infertile, may have been subjected to burial re-exposure and re-burial by the shifting loess. In favour of the second alternative would seem to be the following facts:—

(a) Large "*Struthiolithus*" eggs are undoubtedly found in the loess: ANDERSSON found them in that deposit himself.

(b) A conspicuous feature relating to their discovery is that so many of the eggs have been found complete.

(c) A curious fact is that two have so often been found together. In the very first find (Find 1, p. 55) which ANDERSSON records "four eggs lying close together and probably indicating an old birds' nest" are mentioned; and further ANDERSSON, p. 70, states "consequently it may be safe to say that in about every second find of these eggs more than a single specimen has been discovered".

(d) Again, the same author records (p. 66) the finding of egg fragments by his collector PAI when excavating in the culture stratum for pottery at the aeneolithic (post-neolithic) site at Yang Shao Tsun in the province of Honan. "Over an area", he says, "more than 600 metres in length and nearly 500 in width the Tertiary red clay and locally the loess is covered with a culture stratum one to five metres in thickness which contains stone and bone implements as well as innumerable fragments of pottery of many varied types". PAI found in one place in the typical ashy culture soil "no less than eighty-three fragments of *Struthiolithus* shells". Most of the fragments were small "and it is very likely that they all belong to one specimen as they were found close together". On the other hand they may have been fragments resulting from a meal or meals off more than one egg.

(e) Eggs of "*Struthiolithus*" have also been recorded by PERE LICENT and TEILHARD DE CHARDIN from Sjara-osso-gol in Eastern Ordos, along with a distinctive Pleistocene fauna which included broken bones of *Rhinoceros tichorinus*, *Gazella*, *Equus*, *Cervus*, camels, elephants *(E. primigenius)*, horns of bison and antelope and stone implements of Mousterian type (cf. GRABAU, 1927, p. 253). This culture stratum was found on a surface of blue clay at the base of the loess. Remains of hedgehogs, bats and small birds were found in cracks in the soil below it.

(f) The same author also records (p. 253) the finding of fragments of "*Struthiolithus*" eggs in Western Ordos close to the great wall near the town of Hong-Tcheng. They occurred in loess in a cliff 20 metres high and at a depth of about 12 metres below the steppe, in association with a true hearth and human artefacts apparently of Mousterian age as well as bones of horse, bison, rhinoceros, antelope, hyaena and gazelle.

Two alternatives, therefore, have to be considered, as ANDERSSON suggests, viz:—

(1) That *Struthio anderssoni* actually lived when the Yang Shao and other culture strata were formed and that the egg-shell fragments are refuse from successful hunts for the big eggs.

(2) That fossil *Struthious* eggs had been found by early man, much in the same way as we make finds at the present day.

I do not think the oological material and other evidence at present available is sufficient to justify as yet any confident assertion in regard to the alternatives raised by ANDERSSON. As far as I am aware no osseous remains of Struthionids have been found in the loess. PERE LICENT on the other hand recovered a femur from Sanmenian beds (early Pleistocene) the presence of which, in itself, might conceivably be regarded as evidence of the existence of the Hipparion ostrich all through the Pliocene. But that there existed a species of ostrich in Northern China of later date than the Pontian ostrich is I think strongly indicated by the comparative measurements in thickness of the egg-shells of the Loess proper and of fragments taken from what has been designated by ANDERSSON as Locality 34 (Pontian). Of these latter egg-shell fragments I now have the following remarks to make:—

B. **Egg-Shell Fragments from Locality 34** (Southern Shansi). *Struthio wimani.*

(1) Some Macroscopic features.

As regards the fine series of egg-shell fragments from this locality sent by Prof. WIMAN, there seems, unfortunately, to be a doubt as to whether they were originally associated with the "Big horse teeth and large leg bones" which were found "embedded in gray reddish loess-like clay" at the locality specified (cf. ANDERSSON, loc. cit. p. 76); and further, whether these last mentioned remains were in fact Pontian or Post-Pontian. PERE LICENT and TEILHARD DE CHARDIN regards this "locality 34" I understand, as "probably Pontian". The shell fragments were found "lying on the surface of the very steep slope" along with bones and teeth of rodents, the horse bones being found "inside the earth". Some examples, however, of the shell fragments seem "to have been incrusted with a hard clayey substance after they were broken". From their uncorroded appearance it appears to me highly probable if not almost certain, that they had been recently washed out of the reddish clay.

Be their age what it may, however, this much can be said about them, viz. that with the exception of certain specimens, thinner than the rest, of which more anon, these shell fragments have a thickness which averages some 2.6 mm. and therefore indicates a larger and heavier egg than that found in the superficial loess *(Struthio anderssoni)* or of the Recent *Struthio.* Their larger circumferential arc also makes this obvious. They are almost exactly intermediate in point of thickness between the eggs of *Struthio camelus* or the Northern African ostrich and the eggs of the fossil *Psammornis rothschildi* of the Sahara. (For some comparative measurements see p. 28.)

Some of the bigger fragments, more or less equiquadrilateral in shape, measure roughly 40 mm. by 40 mm. They are all highly mineralised, and if allowed to fall on one another "clink" like hard metal. That they had only recently been weathered out from an argillaceous bed is, I think, obvious from their comparatively "fresh" colour, the comparative polish or unabraded condition of their external surface or skin, and the unweathered or comparatively unaffected appearance of the internal or mammillary surface. In respect of the surprisingly good state of preservation of the external and internal surfaces it may be stated that they seem to me to resemble rather closely in this respect eggs of *Dinornis* and *Aepyornis* rather than the obviously more weathered and more discoloured eggs of the Loess *S. anderssoni* which are much greyer. In the egg fragments from Locality 34 there is still left a definite trace of the yellow-ochre or "old ivory" coloration of the external skin and in nearly all cases there is a sharp contrast between the external and internal surface. It is clear that these fragments have never been exposed to the action of blown sand for any length of time.

The external surface is a buffish-stone colour, somewhat similar to the coloration of a buff envelope or a dull clay colour as contrasted with the polished, more ivory-like colour of the eggs of the Recent *Struthio*, whether that ivory-like coloration be pale or rich yellow. The internal surface is a pale reddish or pinkish buff.

Judging from a considerable number of fragments the amount of erosion or abrasion to be noted either on the external or internal surfaces or the fractured edges is so small as to be quite remarkable. The outer surface is smooth and almost gives the impression that organic matter might be present although the high filmy polish of the egg of the Recent ostrich is of course absent. On many of the fragments there is a thin concretion or "smear" of a pinkish red "earth" while on nearly all there are a great number of fine "knife point" incisions or markings of whose nature it is not easy to be certain. Some suggest the same sort of "knife point" incisions which are so very conspicuous a feature of the external surface of the eggs of *Dinornis* (Moa) and which represent the longitudinal external openings of pores. But in *Dinornis* these "knife point" incisions are undoubtedly the openings of pores and it is to be noted that they are very uniform in length and disposed with considerable regularity in parallel directions. In the egg fragments from Locality 34 the incision-like markings are generally much more numerous, very irregularly arranged and do not give one the impression of being natural purposive or organised structures. Nevertheless the structural features of what are undoubtedly cross sections of air canals are to be noted and are curiously reminiscent of what obtains in the case of the general surface of an *Aepyornis* egg, that is to say there are quite a number of circular openings of canals disposed in couples but connected by a trough-like furrow which is the general arrangement in *Aepyornis*. Doubtless this Aepyornithine appearance in the egg-shell fragments from Locality 34 is simply due to abrasion and to the fact that one is viewing the cross sections of the air canals at a deeper level than one ever has the opportunity of doing in the case of an unworn egg-shell fragment of *Struthio camelus*. Without going into further details I may therefore say at once that I have come to the conclusion after a somewhat comprehensive and comparative study of Struthionid egg shells that these fragments of eggs from "Locality 34" originally belonged to an ostrich which laid "non-pitted" smooth eggs similar to those laid to-day by *Struthio camelus* and *S. syriacus*.

Compared with other struthious eggs we may note the following facts:—

In *Struthio camelus*, the North African ostrich, as also in *S. syriacus*, the Syrian ostrich, the external ivory-like "skin" of the egg has a very high polish but it is not pitted with pores obvious to the naked eye. Examined with a strong lens the external openings of the air-pores are visible and take the form of irregularly distributed and small round openings generally coupled together *but unconnected by grooves.*

In *S. australis,* the Southern African ostrich, as also in *S. molybdophanes,* the Somaliland form, the external openings of the air-pores are quite conspicuous and easily visible to the naked eye, taking the form of "rosetted" depressions, scattered regularly over the surface. Microscopically the details of these "rosettes" are very distinct, the air-pores having a very definite cribriform arrangement, so that the two species can be easily distinguished.

The eggs of *Aepyornis, Dinornis, Rhea, Casuarius* and *Dromaeus* similarly have their distinctive features.

I might add here that innumerable fine linear incision-like markings with a tendency to a parallel arrangement are to be noted on the surface of a complete egg of *Aepyornis maximus* kindly lent me by Lord ROTHSCHILD. I should imagine that these fine linear grooves have been rendered more conspicuous by the weathering of the superficial "skin" of the egg.

In a complete specimen of the egg of *S. anderssoni* from the Loess of China, now preserved in the British Museum, as also in two from the Tring Museum very kindly lent me by Lord ROTHSCHILD, the amount of erosion, as I have said before, is much greater than that observable in the fragmentary specimens from Locality 34; and any original struthionid colouring of the surface or polish has entirely disappeared. In fragments from Locality 34 the colour of the outer surface has a pale ochraceous yellow tint. This difference may, of course, indicate that the Locality 34 fragments have only recently been weathered out of their original bed, where erosion due to chemical or other agents may have been slight. It seems conceivable that such fragments, weathered from their original Pontian or Post-Pontian beds and re-deposited in loess may have suffered less erosion than egg-shell remains of later date.

A very good plate illustrating the amount of erosion which is normally present in eggs from the Loess is given in EASTMAN's paper already quoted. The contrast between the corroded and the uncorroded areas on the two aspects of the egg described from Kalgan is well shown.

Among the fragments from Locality 34 are a few which show greater evidence of weathering. I at first thought that these might represent fragments of eggs of another and smaller species. After examining microscopical sections I am inclined to think that they represent fragments which have through accidental exposure undergone more erosion on their outer surface than the rest.

Comparing fragments of these "Locality 34" egg-shell fragments with those of the superficial loess *(S. anderssoni)* one can hardly escape the conclusion that the former must be referred to *Struthio wimani* of the Lower Pliocene (Pontian or Hipparion beds of North China). ANDERSSON (loc. cit. pp. 72, 76) alludes to PERE LICENT's discovery in Kansu (Hsin-Chia-Kon) of struthionid egg-shell remains "entre les ossements" or "au milieu des ossements" of what seemed beyond doubt to be an Hipparion fauna. These fragments we understand were sent to Prof. BOULE of Paris for examination. It would be of immense interest to compare them with eggs from the loess.

### C. Egg-Shell Fragments from Ertemte, Olan Chorea, Tjel-gol-Tabool, and Doshen, Mongolia. *Struthio mongolicus.*

The macroscopical appearance of these fragments will be described *en bloc* as it seems practically impossible to differentiate between them. The fragments are much smaller than in the case of those from Locality 34 (Shansi), while in section they are all very obviously thinner, since 43 fragments averaged 1.9 mm. as against an average of 2.6 mm. for 17 fragments from Locality 34. Fragments from the Chinese loess, as so far measured, average 2.2 mm.

Egg fragments from Mongolia are worn and smooth, especially on the outer surface, and of a pale drab colour, somewhat like broken and worn pieces of earthenware. Mineralization has proceeded to its limits. The inner surface as a rule seems much less eroded than the outer and in some cases there is an obvious contrast in colour between the two sides. Some fragments present quite rounded edges, in others they are comparatively sharp.

I was at first inclined to think that these shell fragments dug up in various localities in Mongolia, the geological nature of which has been so clearly and interestingly discussed by ANDERSSON (loc. cit. pp. 36—52) were simply worn fragments of the eggs of a similar species to that whose eggs were found in Locality 34 or in the loess of Northern China. Microscopical sections reveal that there has not been as much weathering as one supposed, especially of the inner mammillary layer. In fact one vertical section from Olan Chorea reveals very little wearing at all even from the outer surface, so that it seems practically certain that the Mongolian ostrich which laid these eggs was smaller than the ostrich which laid the "Loc. 34" eggs. Its eggs also appear to have been thinner in section than the eggs of the Chinese loess *(S. anderssoni)*. A table of measurements is given below. The average measurement 1.9 mm. there shewn is nearly, if not quite, the average for the modern ostrich *Struthio camelus* but it is obvious that abrasion in the case of the Mongolian fragments has to be allowed for.

*Vertical Measurements of Egg-shell-fragments from Mongolia.*

| *Locality and Description.* | Average Thickness of Vertical Section in Millimetres. |
|---|---|
| Fifteen fragments from Ertemte (No. 3) Mongolia | 1.90 |
| Ten fragments from Olan Chorea (No. 2) „ | 1.90 |
| Two fragments from Doshen „ | 1.85 |
| One fragment from Tjel-gol-Tabool „ | 1.90 |
| Fifteen fragments from Olan Chorea (No. 4) „ | 1.90 |

Micro-photographs of vertical sections of egg fragments from Mongolia and other ocalities are shewn in Pl. IV.

It may be stated that ANDERSSON (loc. cit. p. 45) has called attention to the fact that "loess is just as rare or entirely absent" in the Mongolian plateau as it is a "dominating feature all over Northern China". The superficial deposits in which the egg-shell fragments were found were clays, especially red clays, coarse sand, fine gravel, clayey sand, etc., and with them were also discovered remains of beaver, large masses of frogs' bones, an immense abundance of fresh water shells and certain biconcave vertebrae apparently belonging to fish.

This is of course a very general statement and does not descriminate between the individual localities from which egg fragments have been recovered. ANDERSSON (loc. lit. p. 47) provisionally dates these localities as follows:—

*Vertebrate deposits of the Hallong Osso region.*

PLEISTOCENE (Olan and Diske, sand with *Elephas* and *Rhinoceros*).

PLIOCENE AND LATE MIOCENE:
- Ertemte — Olan Chorea, sand and gravel with a microfauna: *Castor* and other *rodents, Cervavus, Struthiolithus,* etc. In Ertemte also *Amphibians, Fishes* and *freshwater mollusks.*
- Harr Obo. (also Tjel in Gol, Bonk Tjaggan, Tjaggan ör Ich, Anguli Nor.): Red clay with *Aceratherium, Hipparion* and *Artiodactyla* the whole closely resembling the Hipparion fauna of China proper.

## MICROSCOPICAL FEATURES OF SECTIONS OF EGG FRAGMENTS.

NATHUSIUS and ANDREWS did much to enlighten us on the subject of the microscopical structure of the eggs of the Struthiones; and in making our comparative study of the egg-shell fragments from North China and Mongolia we have been indebted to the work of these two authors.

Sections, both vertical and tangential, have been cut in the Palæontological Department of the British Museum of shell fragments from Locality 34, Ertemte and Olan Chorea in Mongolia, and other localities, and have been compared with sections already cut of *Struthio anderssoni* from the loess (see 7c in list of material used, p. 25) as well as with sections of the Recent *Struthio, Cassowary, Rhea, Aepyornis, Dinornis* and *Psammornis.* In addition to this some fine sections from Locality 34 had already been ground at Upsala and proved of great assistance. Micro-photographs of some of these are here shown, and will probably prove of more assistance to the reader than long technical descriptions. For this reason and in view of the fact that the microscopic structure of the mammillary and other layers of the Struthionid egg-shell has already been described by NATHUSIUS and ANDREWS, I shall restrict myself here to the following summary remarks:—

(a) The structure of the sections of egg fragments taken from (1) the Loess, (2) Locality 34, and (3) the Mongolian localities mentioned above presents characters which are purely struthious, using that word in the narrow sense. Sections, vertical and tangential to the surface, present features so similar to those which can be observed in the details of structure of the air channels, the primary and secondary mammillary columns, and other minor features in the case of *Struthio camelus* that there can hardly be a doubt in my mind that the eggs of the Chinese and Mongolian ostriches belonged to the unpitted type of that genus.

(b) Microscopical comparison between thick and thin exemples of egg fragments from Locality 34 indicates no difference in histological detail but merely demonstrates that there has been more erosion of the outer surface in the one case than in the other.

(c) I am unable to appreciate any essential differences of detail or proportion in the microscopic characters exhibited in sections of egg fragments taken either from Locality 34, localities in Mongolia, or in sections from the Rev. H. M. CLARKE's complete egg from the Loess. (Brit. Mus. A. 1308), but the egg fragments from Mongolia seem plainly to indicate an egg which was smaller than that from Locality 34.

(d) I have very carefully compared sections of egg fragments from Locality 34 with sections of the egg-shell of the Recent *Struthio* and it may be briefly said that the only differences that I can appreciate relate simply to size.

## SOME CONCLUDING OBSERVATIONS.

As far as the study of the egg-shell fragments submitted by Dr. WIMAN has been able to carry us there seems to be evidence which justifies the assumption that we have been dealing with three species of ostriches which may be said to be represented in space and time in an area now known as Northern China and Inner Mongolia, viz:—

(1) The ostrich whose eggs have been so frequently found in the Chinese loess for which I have suggested the name *Struthio anderssoni*.

(2) The ostrich whose egg-shell fragments have been found in Locality 34 (Shansi) and which I have referred to the Pontian ostrich — *Struthio wimani* (see Part I p. 18).

(3) The smaller Mongolian ostrich for which, for purposes of reference, I have suggested the name of *Struthio mongolicus*.

*Table to Show Some Measurements of Struthious Eggs.*

| | Long diameter in mm. | Short diameter in mm. |
|---|---|---|
| 1) *Struthio anderssoni.* Syn. *Struthiolithus chersonensis* EASTMAN (1898). | | |
| a) Brit. Mus. Coll. A. 1308. Borders of Honan and Chihli, China | 185 | 154 |
| b) Lord Rothschild's Collection, Tring. River Bank, Wuan, Honan province, China | 173 | 151 |
| Lord Rothschild's Collection, Tring. Honan, China | 175 | 148 |
| c) Upsala, Sweden. (From measurements provided by Prof. WIMAN.) | | |
| 1. Probably from Shansi, P'ing-Lu-Hsien | 188.5 | 158 |
| 2 Either from (a) Shansi, P'ing-Lu-Hsien or (b) Chihli | 186 | 156.5 |
| 3. Honan — Ho Yin Hsien | 183 | 147 |
| 4. Honan — Hsin-An-Hsien | 179 | 143 |
| 5. Honan — Hsin-An-Hsien | 175 | 151 |
| 6. Honan — Mien Chih Hsien | 168 | 137.5 |
| 7. Shansi — P'ing-Lu-Hsien | 166 | 144 |
| (2) *Struthio molybdophanes.* | | |
| a) Brit. Mus. Coll. 1901—10—28—3. Somaliland | 167 | 126 |
| b) Brit. Mus. Coll. 1901—10—28—4. Darimo, Somaliland | 160 | 132 |
| c) Brit. Mus. Coll. 1921—12—21—228 (DRAKE BROCKMAN). Somaliland | 160 | 136 |
| (3) *Struthio masaicus.* | | |
| 1. Brit. Mus. Coll. 91. 6. 31. 3. Kilymanjaro | 158 | 133 |
| 2. Brit. Mus. Coll. Masai-land | 150 | 127 |
| 3. Brit. Mus. Coll. 90. 1. 30. 2. Masai-land. F. I. JACKSON | 151 | 126 |
| 4. Brit. Mus. Coll. 90. 1. 30. 1. Masai-land. F. I. JACKSON | 145 | 124 |
| 5. Brit. Mus. Coll. | 152 | |
| 6. Tring Museum. Masai-land 1893 | 155 | 126 |
| (4) *Struthio camelus.* | | |
| 1. Brit. Mus. Coll. 99. 7. 23. 1. Tebba, Upper Niger | 153 | 130 |
| 2. Brit. Mus. Coll. 99. 7. 23. 2. Tebba, Upper Niger | 152 | 127 |
| 3. Brit. Mus. Coll. 1901. 10. 28. 7. Wed Rhin, Algeria | 150 | 126 |
| (5) *Struthio australis.* | | |
| 1. Brit. Mus. Coll. 91. 6. 21. 4. Worcester, Cape Colony | 145 | 121 |
| 2. Brit. Mus. Coll. (Salvin Godman Coll.). Cape of Good Hope | 144 | 128 |
| 3. Brit. Mus. Coll. S. Africa (I. Sarel) early 19th cent. | 154 | 122 |
| 4. Lord Rothschild's Collection, Tring ex Roedenn Collection (Coll. before 1885) | 152 | 129.5 |
| 5. Ditto ditto | 170 | 126 |
| 6. Ditto ditto | 158 | 127 |

| (6) *Struthio syriacus.* | Long diameter in mm. | Short diameter in mm. |
|---|---|---|
| 1. Brit. Mus. Coll. 1922. 12. 20. 206. Wadi-Abiabh (Cox-Cheezman Coll.) | 146 | 115 |
| 2. Brit. Mus. Coll. 1922. 12. 20. 207. Jauf.-Arabia (Cox-Cheezman Coll.) | 141 | |
| 3. Brit. Mus. Coll. 1927. 8. 4. 1. Maan, Arabia | 152 | 123 |
| 4. Brit. Mus. Coll. 1927. 8. 4. 2. | 147 | 119 |
| 5. Brit. Mus. Coll. 1922. 9. 5. 1. Central Arabia — Halfway between Baghdad and Jerusalem | 148 | 120 |
| 6. Brit. Mus. Coll. 1922. 9. 5. 2. Ditto ditto | 137 | 112 |
| 7. Rothschild Museum, Tring. Taken from clutch by CHARLES DOUGHTY at Beseiba, Lat. 30 N Long 38 E | 138 | 112 |
| 8. Rothschild Museum, Tring. | | |
| (a) Syrian Desert (Aharoni Coll.) | 143.5 | 112 |
| (b) " " " | 144 | 112 |

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# REMAINS OF CARINATE BIRDS FROM CHINA AND MONGOLIA.

The miscellaneous carinate bird remains described in this note form part of a collection of fossil birds from China and Mongolia sent by Professor WIMAN to the British Museum. This collection is quite small, but it includes both bones and egg shell from different geological horizons and from various localities. Some of the specimens are fragmentary and difficult to determine specifically, but most of them are thought to be of sufficient interest to place on record, if only because so little is as yet known of the earlier avi-fauna of China and Mongolia.

So far little has been published on this subject, the two chief accounts are those of SCHLOSSER (1924) and BOULE and TEILHARD (1928), and the present note will add a few records to theirs. Professor SCHLOSSER's paper dealt entirely with material from Mongolia and the bird remains were from two localities only: Ertemte and Olan Chorea. Ten forms were differentiated, but the specimens were too fragmentary to admit of specific or in most cases of even generic identification. (SCHLOSSER, 1924, p. 101.) In their volume on the Palæolithic of China (1928) Professor BOULE and M. TEILHARD DE CHARDIN record a number of bird remains from the Palæolithic floors of Sjara-Osso-Gol in Ordos. Among these they were able to identify at least ten species of carinate birds representing various groups. These are as follows:—

| | |
|---|---|
| *Buteo* cf. *ferox* GMELIN | *Syrrhaptes paradoxus* ILLIG. |
| *Vultur monachus* LINN. | Waders, 2 spp. |
| Small Passerines. | *Podiceps auritus* LINN. |
| *Perdix* cf. *perdix* LINN. | *Anas boschas* LINN. |
| *Coturnix* sp. | *Tadorna tadorna* LINN. |

The following is a list of the localities and birds represented in the present collection:—

*Inner Mongolia.*

| | | |
|---|---|---|
| *Anser* sp. A. | Ertemte. | Pliocene (Post-Pontian). |
| *Anser* sp. B. | " | " |
| Anatine smaller species. | " | " |

*China.*

| | | |
|---|---|---|
| Fragmentary egg shell. | Loc. 45, Shansi. | Pontian. |
| A complete egg. | Honan. | Pleistocene. |

| | | |
|---|---|---|
| *Falco tinnunculus.* | Cave No. 1, Chen Chihli. | Pleistocene. |
| *Pyrrhocorax* sp. | Loc. 61, Chihli. | " |
| *Columba* cf. *livia.* | " " | " |
| *Phasianus* sp. A. | " " | " |
| *Phasianus* sp. B. | " " | " |

## THE AVIAN REMAINS FROM ERTEMTE, MONGOLIA.

This locality which is situated in the Hallong-Osso region of Inner Mongolia and lies about 130 km. N.N.W. of Kalgan has been very fully described by Dr. J. G. ANDERSSON (1923) who was the first to make scientific excavations for vertebrate remains in this area. The bird remains from Ertemte, both those in the present collection and those described by Dr. SCHLOSSER are not sufficiently numerous or well preserved to afford definite evidence of a climate or country very different to that of the present day which is a typical steppe region. The anserine birds indicate the presence of water, but not necessarily permanent lakes or water courses. At the same time the fauna as a whole does seem to point to a considerable change having taken place. From his field observations Dr. ANDERSSON was of opinion that the Ertemte deposit which is chiefly composed of fine sand is of fluviatile or lacustrine origin, and he tentatively suggested (loc. cit., map ii.) the extent of a former Ertemte lake on the shore of which the bone bed was deposited. The vertebrate remains were almost entirely those of small mammals, but these were accompanied by great numbers of frog bones and immense quantities of fresh water shells.

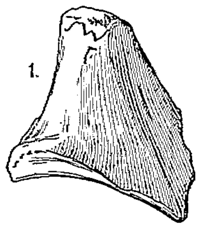
SCHLOSSER who studied Dr. ANDERSSON's Mongolian collections recognised ten species of carinate birds, though some of these could not be more than tentatively named. Eight forms were represented from Ertemte (p. 101) and were given as follows:—

"Waterbird
Anas, Anser
Limicole bird
Galline bird
" "
" "
Passeriformis
Accipiter"

The present collection includes four bird bones each of which is in such an imperfect state of preservation that only approximate identifications of three of them can be made. These specimens are highly mineralised, are olive brown in colour shading into chestnut, and have a hard, polished surface. Some of the bones have an infilling of matrix composed of very fine clayey sand containing fragments of shells; this seems to correspond with the descriptions already given by ANDERSSON and SCHLOSSER.

### Anser sp. A. Text-figs. 1 & 2.

Two imperfect left coracoids have been compared with the corresponding bone in a number of Recent genera and it is found that they undoubtedly represent birds belonging to the Anatidæ, probably species of *Anser*, or possibly *Cygnus*. In one of the coracoids only the lower (sternal) portion is preserved and this shows great similarity to this bone in a Recent *Anser anser*, except that the Mongolian is larger and the shaft of the bone is comparatively wider which may be partly due to pressure and consequent flattening of the bone, perhaps while its cellular structure was being replaced by an infilling of matrix. The side (median internal border) of these two bones is very similar, and each has a small facet at their point of contact behind the spina externa of the sternum, though this is small in the Mongolian bone. The fine inter-muscular ridge running upwards from this facet (text-fig. 2) is similar in length and position in both these bones. It should, however, be mentioned here that when a series of coracoids was studied it was found that considerable variation in these small points may occur even within a single species.

1.

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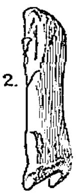
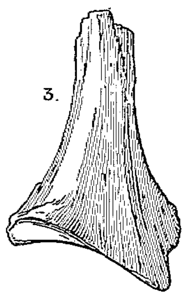


Text fig. 1. *Anser* sp. A, left coracoid, ventral view.
Text-fig. 2. Internal view of the same specimen.
Both natural size.

### Anser sp. B. Text-figs. 3 & 4.

Only the distal portion of the second coracoid is preserved, but this includes most of the shaft which is broken off at the base of the subclavicular process. This bone is smaller and the shaft more slender than in the specimen described above and in size is almost identical with that of a Recent example of *Anser anser*. The side (internal border) of the bone just above its meeting with the sternum differs somewhat from that of the other Mongolian coracoid (text-figs. 1 & 2). It seems probable that these two coracoids represent extinct Anserine

3.

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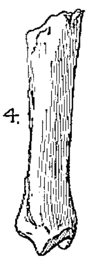

Text-fig. 3. *Anser* sp. B, left coracoid, ventral view.
Text-fig. 4. Internal view of the same specimen.
Both natural size.

species but with so little material available it appears wiser to await the discovery of more complete specimens before attempting to distinguish them nominally.

Besides the two coracoids described above the collection includes the much abraded proximal end of a tibiotarsus which probably belonged to an anatine bird for it is not very different from the corresponding part in the Recent *Branta leucopsis*.

## THE AVIAN REMAINS FROM CHINA.

### Eggs.

The collection from China includes some remains of eggs, among which are several small blocks of what appears to be typical red Hipparion clay. These are from Loc. 45, Shansi and contain a number of fragments of thin egg shell, probably representing more than one egg. That these were broken either before or soon after becoming enveloped in the matrix is indicated by the position of several fragments which are lying one above the other. The most complete specimen has a maximum length of 51.7 mm. and indicates an egg somewhat rounded in shape as in those of many of the ducks.

Text-fig. 5. Egg of an Anserine bird, from Honan. Natural size.

Text-fig. 5 shows a complete egg from Honan which has evidently been preserved in the Loess, for some of the pale brown matrix still adheres to the specimen. The surface of the shell is eroded by the tracks of some organism which lived in small tubes, sections of which remain attached to the surface of the egg. Portions of similar tubes can also be seen on some of the eggs of *Struthio anderssoni* from the Loess.

The Honan egg weighs only $1/2$ oz. averdupois, it has a long diameter of 74 mm. and a short diameter of 53.7 mm. In outline it is an almost perfect ellipse, and it is this shape, together with its size, that seems to make it probable that it belonged to an Anserine bird. It has been compared with a clutch of eggs of *Cygnopsis cygnoides* from China and it resembles very closely in shape two of the six specimens and is only slightly inferior to them in size. These two eggs of *C. cygnoides* have a long diameter of 78.4 and 79.4 mm. respectively, and a short diameter of 54.3 and 55.3 mm.

### *Cave No. I, Chen Chihli.*

**Falco cf. tinnunculus** Linn.

From this cave there are only a few bones which have a rather Recent appearance, they are white in colour except where covered with a thin film of pale brown sandy matrix, four specimens — humerus, pelvis, tibio-tarsus, and tarso-metatarsus — are in a good state of preservation and seem to belong to a single species if not to a single individual. Compared with the corresponding bones of a Recent example of *Falco tinnunculus* the fossils are found to be almost identical, with the exception of the tibio-tarsus which is shorter in the Chinese specimen. The bones from Cave No. I must have belonged to an allied species if they do not actually represent *F. tinnunculus* which ranges right across Northern Asia at the present day.

### *Loc. 61, Chihli.*

In her work on the Fossil Suidæ of China Dr. Helga Pearson (1928, p. 66) speaks of some remains from this locality as being of "undoubted Pleistocene age" and the appearance of the bird material in the present collection seems to endorse this statement. There are only six bones, but these represent at least three species.

**Pyrrhocorax** sp.

Among the remains from Loc. 61 are a right tarso-metatarsus and the proximal end of a right ulna which resemble the corresponding bones of *Pyrrhocorax* and are considerably larger than those of *Corvus monedula*. There are two, instead of the usual single, inferior foramina in the tarso-metatarsus and Dr. Lambrecht (1916, p. 501) has pointed out that this is the number obtaining in the genera *Pyrrhocorax* and *Colaeas (Corvus monedula* Auct.*)*. I have found this character to be constant in a very considerable number of Pleistocene examples of *P. graculus* and *P. alpinus*, but apparently this is less constant in the Recent *C. monedula* for in six skeletons lately examined I found only two tarso-metatarsi (belonging to two individuals) which were pierced by two inferior foramina. The Chinese tarso-metatarsus has a total length of 50.5 mm; this measurement was originally slightly greater, for the median tubercle separating the tibial cups is missing. This maximum length is rather less than in examples of the corresponding bone in *P. graculus*, but considerably greater than in that of *P. alpinus*.

As only the proximal portion of the Chinese ulna is preserved it cannot be decided whether it is most like that of *P. graculus* or *P. alpinus* for this bone in the two Recent species is very similar in bulk, but differs considerably in length; for instance a specimen of *P. graculus* has a maximum length of 70 mm. and one of *P. alpinus* 59.5 mm. At the present day *P. graculus* has a very wide range which includes Europe, North-East Africa, and most of Northern Asia to China. *P. alpinus* was thought to be restricted to the mountainous areas of Northern Spain, the Alps and the Mediterranean countries, Asia Minor to the Caucasus and the Himalayas. Recently Dr. OUTRAM BANGS has told me[1] that it occurs at elevations over 14,000 feet in Western Szechuan.

**Columba** cf. **livia** GMELIN.

A right humerus with the extremities somewhat abraded resembles Pleistocene and Recent examples of this bone in *C. livia* with which it has been compared. This species is found living in China at the present day.

**Phasianus** sp. A.

The collection includes the imperfect proximal portion with the greater part of the shaft of a right humerus of a gallinaceous bird. The proximal articular end has a maximum width of 16 mm. and the shaft has a width of 6 mm. I have compared the Chihli fossil with the available Recent material and believe it to represent either a small species of Pheasant or a *Gallus*, and it must have belonged to a slightly smaller bird than the tibio-tarsus mentioned below. It has to be remembered that among gallinaceous birds the humerus, especially an incomplete example, has no special characteristic points, apart from size and any corroberative evidence, by which to distinguish species or even widely separated genera one from the other.

**Phasianus** sp. B.

After comparison with a number of Recent skeletons the distal end and about a third of the shaft of a right tibio-tarsus is considered to be that of a true Pheasant, and using the name *Phasianus* in a broad sense, though not to include such allied birds as, for instance, the Blood Pheasants, *Ithagenes*, which also occur in China. Except that it is a little larger the fossil very closely resembles the corresponding bone in the skeleton of a male *Chrysolophus pictus* in the British Museum (No. 69. 10. 19. 28). Even at the present day the avi-fauna of China is very rich in number and species of Gallinaceous birds, and Pheasants in particular, and these may have been still more widespread in earlier times.

[1] In lit. 18, 4, 1930; see also, STEVENS 1930, p. 52.

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# EXPLANATION OF PLATES.

## PLATE I.

## PLATE I.

Fig. 1. *Struthio wimani.* Pre-axial section of pelvis shewing truncated ends of pre-acetabular iliac plates and neural spine of first lumbar vertebra. Five-eighths natural size.

*n. sp.* = neural spine of first lumbar vertebra.
*ext. il. pl.* = external iliac plate.
*diap.* = diapophysis of first lumbar vertebra.
+ = transverse process of second lumbar vertebra.

Fig. 2. *Struthio camelus.* (Immature male from Gambia). Pre-axial section of pelvis shewing truncated ends of pre-acetabular iliac plates and neural spine of first lumbar vertebra. Five-eighths natural size.

Fig. 3. *Struthio wimani* pelvis (part). Right side. Three-fifths natural size.

P. R. LOWE, Struthious remains from China and Mongolia. Plate I.

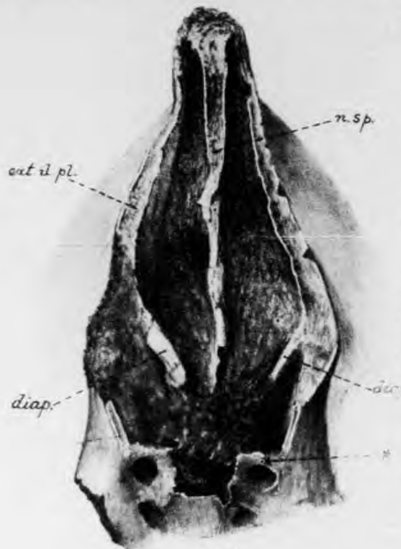


Fig. 1.

Fig. 2.

Fig. 3.

PLATE II.

## PLATE II.

Fig. 1. *Struthio camelus.* (Immature male from Gambia) shewing partial view of left side of pelvis. Three-fifths natural size.

Fig. 2. *Struthio wimani.* Slightly less than three-fifths natural size.

*para* = parapophysis of 5th lumbar vertebra.


Fig. 1.


Fig. 2.

PLATE III.

## PLATE III.

*Struthio wimani.* Ventral view of synsacrum. Seven tenths natural size.

*Lumb.* 2—7 = Transverse Processes of 2nd to 7th lumbar vertebra.
*Ridge* = osseous ridges as in *Struthio.*

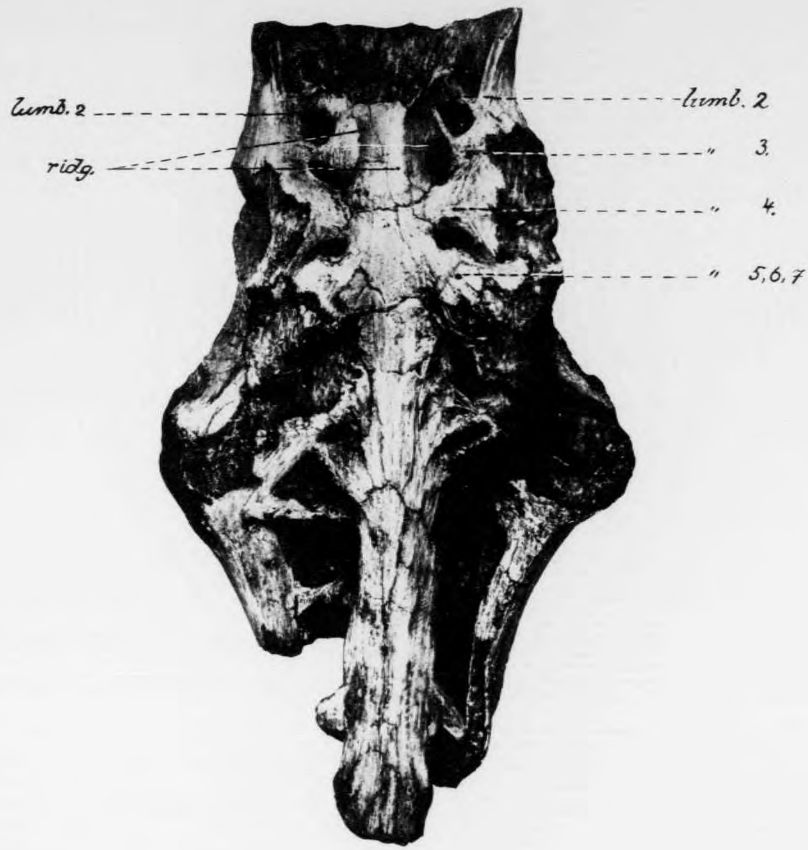
lumb. 2
ridg.
lumb. 2
" 3.
" 4.
" 5,6,7

PLATE IV.

## PLATE IV.

VERTICAL SECTIONS OF EGG-SHELL FRAGMENTS.

*Magnification* $^{18}/_{1}$.

Fig. 1. *Struthio wimani*. Lok. 34, Shansi.

Fig. 2. *Struthio australis*. South Africa.

Fig. 3. *Psammornis rothschildi*. Touggourt, Algeria.

Fig. 4. *Struthio wimani*. Lok. 34, Shansi.

Fig. 5. *Struthio mongolicus*. Olan Chorea, Mongolia.

Fig. 1.

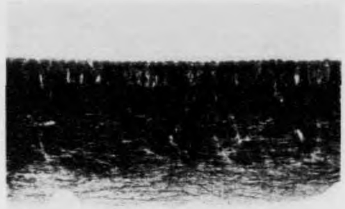

Fig. 2.

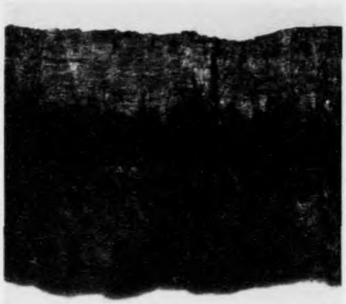

Fig. 3.

Fig. 4.

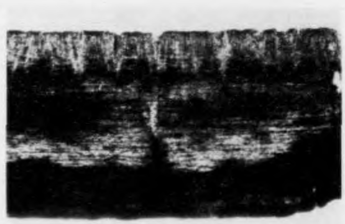

Fig. 5.

附錄：中國之突胸類鳥類化石　　貝杜柔 (Dorothea M. B. Bate)

此外尚有若干鳥類化石茲簡述于下：

(1) 在蒙古發現者為：

雁種一 (*Anser* sp. A) 為一鎖骨，比普通雁者大。

雁種二 (*Anser* sp. B) 亦為一鎖骨，比上者小。

(2) 在中國本部發現者：

A. 蛋一可歸於雁類之蛋，採自河南，種名不易定，為洪新統。又山西亦有此等蛋類發見，或可屬于三趾馬紅土層。

B. 其他鳥類均採自河北，年代為洪積統，共有下列數種：

a. 茶隼 (*Falco* cf. *tinnunculus* L.) 採自河北境之一洞（或為周口店之鷄骨山）。

b. 在河北省第六十一地點者：

甲 紅嘴鴉 (*Pyrrhocorax* sp.)

乙 鴿 (*Columba* cf. *livia*)

丙 雉鷄一 (*Phasianus* sp. A)

丁 雉鷄二 (*Phasianus* sp. B)

按近年在中國採集之鴕鳥蛋化石，曾由譯者研究。魯氏之三種，似均有之。但安氏鴕鳥之分布，不限於黃土期，而紅土層 B C 均有。詳看： On the new finds of fossil eggs of *Struthio anderssoni* Lowe in China with remarks on the egg remains in Shansi, Shensi, and in Choukoutien 中國地質學會誌第十二卷第二期。

# 中國鴕鳥化石

魯維 著
楊鍾健 節要



第一部分 鴕鳥坐骨（參看附圖第一版至第三版）

在山西保德縣境戴家溝，曾發見巨鴕鳥之坐骨。保存之處，為兩邊之中央部分。經研究之結果，知為一新種，名曰維氏鴕鳥 (*Struthio wimani*)。若與在歐洲東南部 (Samos) 所發見之鴕鳥 (*Struthio karatheodoris*) 相比，雖相差甚多，幾可視為兩屬。但因現在之鴕鳥則表示介於二者之間，故兩者均可視為化石鴕鳥，而不必另立新屬。保德之鴕鳥坐骨，與現代者相似，故當為新種而非新屬。

當蓬蒂紀時，歐亞大陸之鴕鳥分佈甚廣，種類亦多。就所知者，已有六種。當時東西之交通，似經由新疆之盆地，而未經喜馬拉亞以南。

第二部分 鴕鳥蛋（參看附圖第四版）

鴕鳥蛋有整者，有破碎者，均採自中國各地。除桑志華所採者外，餘均由作者研究過者，計可分為三種：

A. 黃土期之鴕鳥蛋 (*Struthio anderssoni*) 在中國各地發見極多（參看安特生中國之新生代）。起先以為屬於 *Struthiolithus chersonensis*，經作者詳細研究，知為一新種，名曰安氏鴕鳥。其皮之厚度介於二・一公厘與二・三公厘之間。

B. 蓬蒂紀之鴕鳥蛋 (*Struthio wimani*)，皆採自山西南部，皮特厚，平均二・六公厘。雖故肉眼亦可分別。據作者研究，可歸於上述之維氏鴕鳥一種。

C. 蒙古鴕鳥 (*Struthio mongolicus*) 採自內蒙古，年代當為上新統，其殼皮特薄，僅一・九公厘。

中國古生物誌丙種第六號

第四册

魯維 著

# 中國鴕鳥化石

中華民國二十年十月

實業部地質調查所
國立北平研究院地質學研究所印行
（學術研究與國立中央研究院國立北京大學兩廣地質調查所湖南地質調查所合作）

中國古生物誌丙種第六號

第四册

魯維著

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