Original Article

# Preliminary note on the Miocene flightless swan from the Haraichi Formation, Tomioka Group of Annaka, Gunma, Japan.

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## Abstract

Nearly complete skeleton of a flightless swan, named the "Annaka Short-winged Swan", was found from the upper Middle Miocene Haraichi Formation (11-12 Ma), Tomioka Group in Annaka City, Gunma Prefecture, Japan. The wing elements are reduced distally ; on the contrary the hind leg changed little from the volant ancestor. The skeleton and living posture of "Annaka Short-winged Swan" are proposed in this report through the preliminary investigation.

Key Words : Gunma Prefecture, Annaka, Tomioka Group, Miocene, Flightless bird, Cygnini

## INTRODUCTION

On January 1, 2000, the first day of the new millennium, junior author Hajime Nakajima discovered a fossil vertebrate skeleton exposed on the Middle Miocene river floor of the Usui River near Haraichi, Annaka City, Gunma Prefecture (Fig. 1). For reinforcement a flat resin coating was applied for removal. After that, the slab was prepared from the bottom side very carefully into a relief-like specimen by HN. Subsequently, it was found to be an almost complete skeleton of a large bird, one of the most complete avian fossils ever found in Japan.

The finding of this fossil had very good timing, because 149th Regular Meeting of the Palaeontological Society of Japan (June 24-25 2000) organized by the Gunma Museum of Natural History directed by Y. Hasegawa was about ready to open. The authors decided to present a talk on this fossil at this meeting. We investigated in a hurry, and the perspective was read. This is a note on the specimen that was read in the meeting.

Startlingly, the fossil bird is a flightless species belonging to Tribe Cygnini, especially swans. As well as the plotopterids which prospered in the Eocene and Oligocene (eg. Olson and Hasegawa, 1979, 1996), the occurrence of such an obviously flightless coastal bird from the Miocene signifies the transition of marine zoogeography. Also, the fact that the skeleton is nearly complete is significant for studying avian flightlessness, a frequent pattern of evolution.

A detailed osteological description and taxonomical conclusions will be presented in future publications, as the specimen needs farther preparation. Here we provide a preliminary report on the fossil flightless swan.

## SYSTEMATICS

Class Aves
Order Anseriformes
Family Anatidae
Subfamily Anserinae
Tribe Cygnini
aff. *Megalodytes* sp.

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*Specimen.* --- Skeletal elements in rough articulation, scattered horizontally across a slab of 70 cm × maximum 40 cm (Fig. 2, Pl. 1). Clearly representing one animal. The elements preserved are: cranium, mandible, incomplete sternum, 9 ribs, 16 cervical and thoracic vertebrae, pelvis lacking only pubis branches, 2 caudal vertebrae, left scapula, right and left humeri, right and left ulnae, right (?) radius, left carpometacarpus, right and left femora, right and left tibiotarsi, right and left fibulae, left tarsometatarsus, and some minor bones.

Because it is difficult to assign each vertebra to the cervical or thoracic in the present condition of specimen, we have not reached a final assignment. At least, no distal cervical vertebrae are included. Possibly, more than seven thoracic vertebrae are preserved in the fossil. That is, however, contrary to the fact that Cygnini members have seven thoracic vertebrae anterior to the synsacrum. The right tibiotarsus is broken in the middle of the shaft, and is missing the distal half.

*Locality.* --- Near Haraichi, Annaka City, Gunma Prefecture, Japan; river floor of the Usui River, about 600 m down the river from the Nakahasi Bridge.

*Discovery.* --- By H. Nakajima on January 1, 2000.

*Horizon and the age.* --- Massive siltstone of the Haraichi Formation, Tomioka Group. The late Middle Miocene (approximately 11-12 Ma). Benthic foraminifera (Kaneko and Nomura, 1998) and lithofacies indicate the pelagic depositional environment for Haraichi Formation. Age determination followed Nomura and Ohira (1998).

*Measurements.* --- Because half of bones are covered by matrix, it is impossible to give final measurements of many bones. As a first approximation, we recorded the

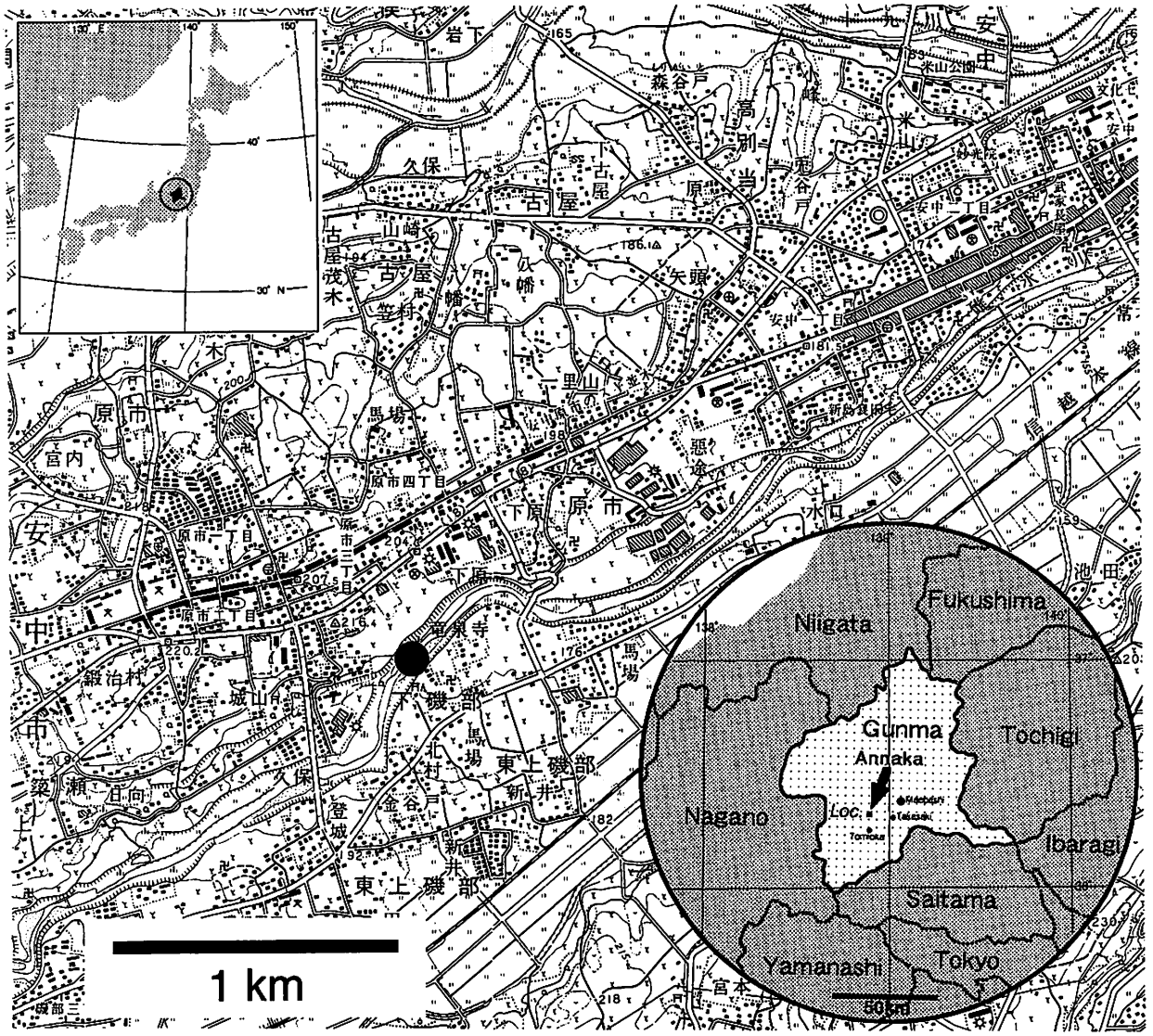


Figure 1. Locality maps for the Miocene fossil bird from Annaka, Gunma, based on the 1 : 25,000 scale topographic map of the Geographical Survey Institute of Japan, "Tomioka" and "Matsuida".

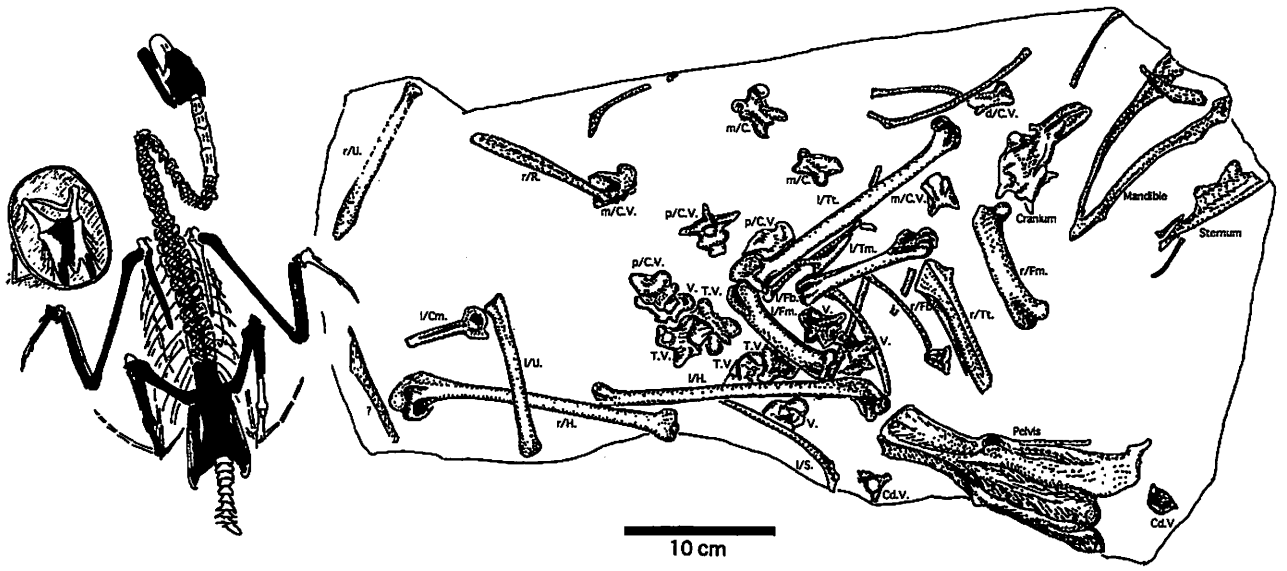


Figure 2. Identifications of each skeletal element of the fossil (on the right slab), and the position in the bird skeleton (in the left bird, blacked bones). Abbreviations are ; d, distal ; l, left ; m, middle ; p, proximal ; r, right / CdV, caudal vertebra ; Cm, carpometacarpus ; CV, vervical vertebra ; Fb, fibula ; Fm, femur ; H, humerus ; R, radius ; Tm, tarsometatarsus ; Tt, tibitarsus ; TV, thoracic vertebra ; U, ulna ; V, vertebra ; cervical or thoracic unknown.

maximum length of the main elements. The measurements are as follows.

Cranium, maximum length of the preserved part : 95 mm.
Mandible, greatest length : 105 mm.
Pelvis, greatest length (without pubis) : 200 mm.
Pelvis, length along the center : 170 mm.
Sternum, maximum length of the preserved part : 105 mm.
Scapula (left), Greatest length : 108 mm.
Humerus (right), greatest length : 220 mm.
Humerus (left), greatest length : 218 mm.
Ulna (right), greatest length : 125 mm.
Ulna (left), greatest length : 124 mm.
Radius (right?), greatest length : 115 mm.
Carpometacarpus (left), greatest length : 66 mm.
Femur (right), greatest length : 97 mm.
Femur (left), greatest length : 94 mm.
Tibiotarsus (left), greatest length : 200 mm.
Tibiotarsus (left), axial length : 190 mm.
Tarsometatarsus (left), greatest length : 110 mm.

## Striking feature for the ecology of fossil bird

The most conspicuous feature on this fossil bird is the evidence of flightlessness, showing extreme adaptation for aquatic mode of life, with no long distance migration. For example, length of ulna is only 55 % of humerus length (Pl. 2-3). Volant birds, in general, have ulnae which are almost equivalent to or longer than the humeri, and shortened distal elements are a remarkable character in flightless species. The other characters such as ; in humerus, much smaller distal end than the proximal end, flattened proximal end, and straight and slender shaft (Pl. 2-2,3) ; low carina of sternum (Pl. 2-6) ; shortened and slender carpometacarpus (Pl. 2-3) ; narrow and small scapula with reduced acromion (Pl. 2-7) , etc. also indicate the flightlessness in this fossil bird.

The pelvis (Pl. 2-8) may also shows a neotenic state as well as the well-known examples in upper half of the body. First of all, the morphology of the pelvis of this bird is atypical. Judging from the size of the femur, which indicates the trunk size reasonably well, we would expect a much longer pelvis for this bird. The other point we find puzzling is the number of proximal cervical/thoracic identification of vertebrae. It seems the fossil includes more than seven thoracic vertebrae, but the result is contrary to the seven thoracic vertebrae found in Cygnini birds.

To explain the two enigmas clear, we hypothesized the fossil pelvis as a "matured but unfused" one, i.e., the short pelvis was perhaps primitive than the longer pelvis which consists of more vertebrae, thoracic vertebrae anterior and caudal vertebrae posterior, but is in our fossil lacking some unfused ones on both ends, being a

neotenic condition. This hypothesis explains the notched caudal margin of fossil pelvis with short synsacral caudal vertebrae. For further investigations, we must prepare the ventral surface of fossil pelvis. Also farther preparation of the vertebrae is needed.

### Identification and Systematics

This fossil is that of a large anseriform. Furthermore, in addition to the characteristic proportions of wide wings (even though it is reduced, the long humerus suggests increased wing span), skeletal elements have characteristics which allow us to identify the fossil bird as a swan. Wing elements and pelvis show unusual morphologies as have been mentioned above, but such modifications are probably neotenic and functional differences reflecting a flightless mode of life.

Here we would like to name this fossil swan the "Annaka Short-winged Swan".

We know *Megalodytes morejohni* Howard 1988 was a flightless Cygnini, reported from the Middle Miocene of California. The holotype is an almost complete tibiotarsus, and a femur and proximal parts of humerus have been referred to this species. However, according to Howard (1988), the holotypic tibiotarsus is 151.9 mm long in axial length. The "Annaka Short-winged Swan", which has 190 mm axial length of tibiotarsus, is much larger than *M. morejohni*, and belonging to a different category. Our investigation is too preliminary to assign the "Annaka Short-winged Swan" to particular genus. We have not examined the specimens of *Megalodytes morejohni* at any rate, and still need to examine other flightless anseriformes.

## RECONSTRUCTION OF THE "ANNAKA SHORT-WINGED SWAN"

### Osteology

The nearly complete skeleton in the fossil allows a reconstruction of the body (Fig. 3).

Consulting *Chendytes* (Mergini), an exemplum of flightless anseriform, in which femur changed little, in

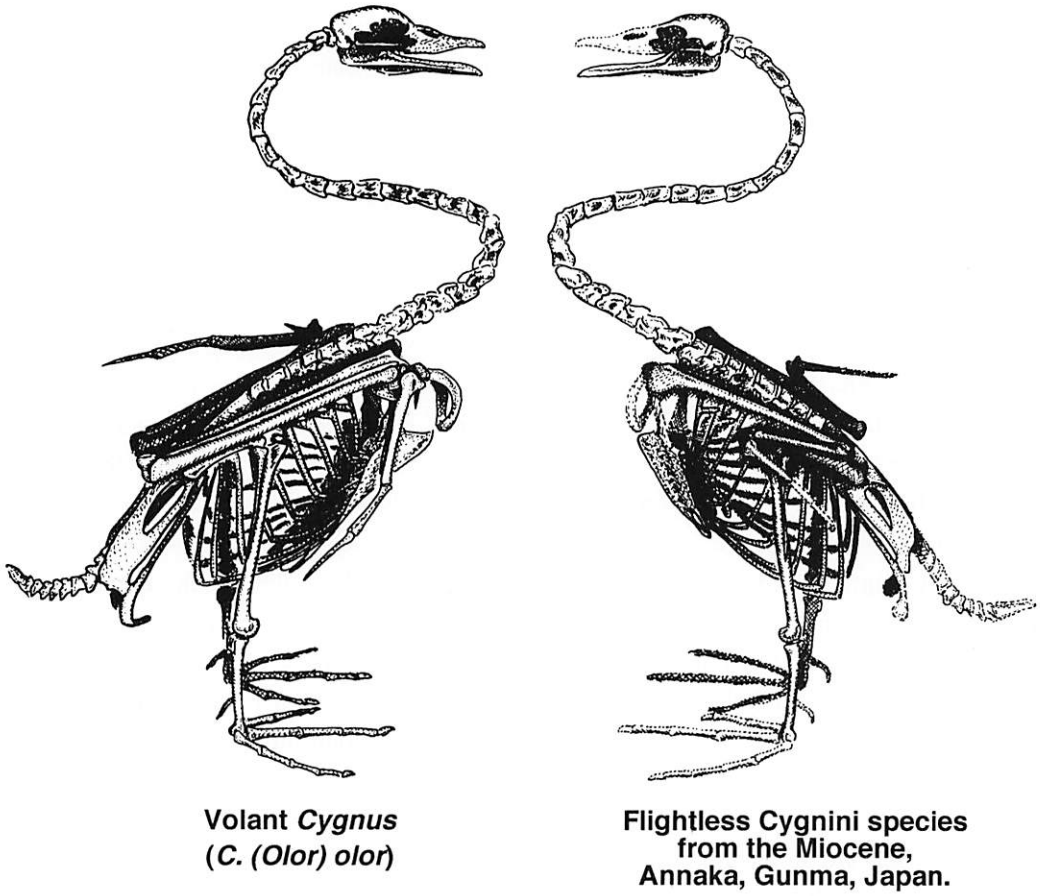


Figure 3. Skeletal reconstruction of "Annaka Short-winged Swan" (right), compared with the skeleton of volant swan, *Cygnus olor* (left).

spite of the extreme reduction of wing elements (Livezey, 1993), the "Annaka Short-winged Swan" may have evolved from a species that was the size of *Cygnus columbianus*. Thus, overall proportions, except for the pectoral and wing regions, resemble those of *Cygnus columbianus*.

However, the wings, especially the distal elements, are remarkably reduced in both size and bulk. The ulna is 55 % the length of the humerus. Elbow joint of the "Annaka Short-winged Swan" might not reach the coxa when furled ; on the contrary volant swans settle it in the back of coxa.

The incomplete sternum is the only remains of the pectoral girdle, but it still shows flightless adaptation in the small size and low carina. No coracoids or furcula are present.

The short pelvis relative to the body size is also a remarkable character of the "Annaka Short-winged Swan". However, the total length of the vertebral column including pelvis might not be changed from its ancestor because the enigmatic pelvis can be understood as a neotenic condition as discussed above.

The trunk might have had a slightly higher angled posture than its ancestor when standing, like the general trend of flightless birds.

The hind leg changed little from the volant ancestor. But phalanges are not well preserved.

The face is impossible to know because the cranium shows only the basal view and the rostrum is missing. The mandible is bent and has narrow symphysial area. This looks strange because anseriformes usually have strait bill and an extensive symphysis in the mandible. Further preparation is needed to find the state of the bill of "Annaka Short-winged Swan", whether the fossil indicates a special adaptation for its dietary habitat or merely diagenetic deformation.

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## REFERENCES

Feduccia, A. and Tordoff, H. B. (1979) : Feathers of *Archaeopteryx* : asymmetric vanes indicate aerodynamic function. *Science,* **203** : 1021-1022.

Howard, H. (1988) : New records of Middle Miocene anseriform birds from Kern County, California. In, K. E. Campbell Jr. ed., *Papers in Avian Paleontology,* 230-236, Natural History Museum of Los Angeles County.

Kaneko, M. and Nomura, M. (1998) : Fossil foraminifera and Paleoenvironment of Haraichi formation and lowest part of Itahana formation in Tomioka and Annaka area, Gunma prefecture, Japan. *Bulletin of Gunma Museum of Natural History,* **2** : 57-66.

Livezey, B. C. (1993) : Morphology of flightlessness in *Chendytes,* fossil seaducks (Anatidae : Mergini) of coastal California. *Journal of Vertebrate Paleontology,* **13** (2) : 185-199.

Nomura, M., and Ohira, H. (1998) : Fission track ages of Miocene tuffs in Tomioka Group, Tomioka area, Gunma Prefecture. *Bulletin of Gunma Museum of Natural History,* **2** : 35-42.

Olson, S. L. (1973) : Evolution of the rails of the South Atlantic islands (Aves : Rallidae). *Smithsonian Contributions to Zoology,* **152** : 1-53.

Olson, S. L. and Hasegawa, Y. (1979) : Fossil counterparts of giant penguins from the North Pacific. *Science,* **206** : 633-635.

Olson, S. L. and Hasegawa, Y. (1996) : A new genus and two new species of gigantic Plotopteridae from Japan (Aves : Pelecaniformes). *Journal of Vertebrate Paleontology,* **16** (4) : 742-751.

## 和文要旨

# 群馬県安中市の富岡層群原市層から発見された中新世無飛翔性ハクチョウについて

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## 要　　旨

群馬県安中市の碓井川河床に分布する中部中新統上部の富岡層群原市層から発見された，全身の骨格要素がほぼ完全に保存された鳥類化石は，ハクチョウ族に含められるが著しい無飛翔性の特徴を示す種であることが判明したので，ここに初期的に報告する．

化石は，尺骨の全長が上腕骨の55%にすぎないなど，翼の要素は遠位ほど退縮している．一方下肢の要素は飛翔性のハクチョウ類と大きな違いはない．翼の退化した本化石をここでは，“Annaka Short-winged Swan” アンナカコバネハクチョウと呼称することとした詳細な分類学的検討はさらに剖出作業を進めてあらためて行うこととし，本報告では，骨格を中心に，飛翔性ハクチョウ類とアンナカコバネハクチョウとの相違を示す．

キーワード：群馬県，安中市，富岡層群，中新世，無飛翔性鳥類，ハクチョウ族

Plate 1. The slab including skeletal elements of one fossil bird, collected from the Middle Miocene, of Annaka, Gunma, Japan.

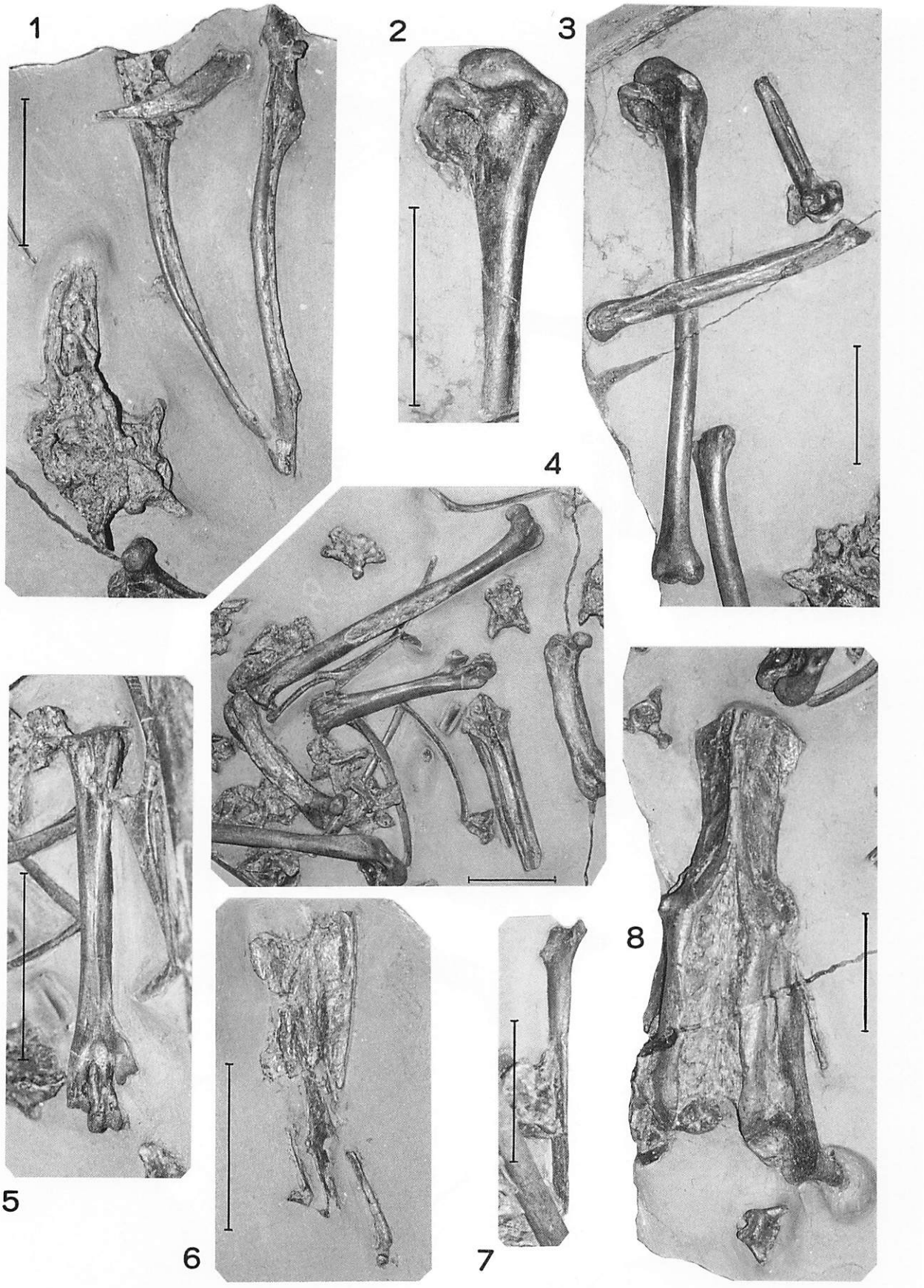


Plate 2. Close up figures of distribution of bones on the slab. 1. basal view of cranium (left bottom) and mandible (right); 2. anconal view of proximal part of left humerus; 3. wing elememts; 4. leg elements; 5, posterior view of left tarsometatarsus; 6, right lateral view of incomplete sternum; 7. dorsal view of left scapula; 8. dorsal view of pelvis and twu caudal vertebrae. All scale bars are 5 cm long.