SUPPLEMENTARY INFORMATION

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1. Provenance and authenticity of the *Yutyrannus* specimens

The three specimens of *Yutyrannus huali* (ZCDM V5000 and V5001 and ELDM V1001) were acquired by the Zhucheng Dinosaur Museum and the Erlianhaote Dinosaur Museum from a fossil dealer who stated that the specimens were collected from a single quarry in Batuyingzi, Beipiao, western Liaoning Province, China. However, the dealer could not provide accurate information as to the exact quarry in which the specimens were collected. Most sedimentary exposures in the Batuyingzi area are of the Upper Jurassic-Lower Cretaceous Tuchengzi Formation, but there are also sporadic exposures of the Lower Cretaceous Yixian Formation. Like most other Liaoning specimens preserving soft tissue, the *Yutyrannus* specimens are preserved in shale slabs that possess sedimentary features typically associated with Liaoning feathered dinosaur specimens from the Jehol Group (of which the Yixian Formation is a part). This strongly suggests that the specimens were collected from the Yixian Formation.

Preparation of the specimens was completed by professionals at the IVPP under the supervision of the senior author (X.X.), though all three specimens had been prepared to some degree before they were transported to the IVPP. ZCDM V5000 and V5001 were originally preserved on one slab, although this is now broken into multiple blocks. Most of the blocks fit together well, allowing a large part of the slab to be reconstructed, but others cannot be directly integrated into the slab. ELDM V1001 is also preserved on a number of separate blocks, most of which can be connected to each other. However, all of the blocks belonging to each slab are lithologically identical, and the blocks are composed of multiple thin layers of shale. The bones in the reconstructed slabs are articulated in a natural way and we did not find any evidence of forgery. Furthermore, the bones belonging to each specimen are size-proportionate and consistent in colour and texture, strongly supporting the interpretation that each specimen genuinely represents one individual. Finally, the morphological information from the different blocks is not discordant with our current understanding of theropod anatomy. Based on our close examination of the blocks, and our previously accumulated rich experience with Liaoning fossils, we can guarantee the authenticity of the specimens.

2. **Selected measurements of the *Yutyrannus* specimens**

Elements:	ZCDM V5000	ZCDM V5001	ELDM V1001
Skull length	905*	800*	630
Scapula length	600	510	
Radius length	273	220	
Metacarpal III length	150	130	
Ilium length	710*	620	530*
Femur length	850	650	613
Tibia length	725	655	623
Metatarsal III length	350	350	312

Measurements are in mm; * indicates an estimated value

3. Size comparisons between *Yutyrannus* and other tyrannosauroids

Yutyrannus huali is a gigantic species, with the largest of the three known specimens (ZCDM V5000) having an estimated body mass of 1414 kg. The body length of this individual is estimated to be about 9 metres. As a living animal, ZCDM V5000 was probably about 60 times as heavy as *Sinocalliopteryx*[1] and 40 times as heavy as *Beipiaosaurus*[2]. Both of these taxa rank among the largest previously known feathered non-avian dinosaurs from the Jehol Group. Some gigantic non-avian maniraptorans are known, and it can be inferred on phylogenetic grounds that these animals were probably feathered[3]. In all cases, however, direct fossil evidence of feathers is lacking and it is not certain whether the plumage formed an extensive covering or was limited to small patches of feathers.

The three known specimens of *Y. huali* have femoral lengths ranging from 61 to 85 cm, much larger than in the vast majority of known Jurassic and Early Cretaceous tyrannosauroids. For example, the femur measures 35 cm in the larger of the two known specimens of *Guanlong wucaii*, 19 cm in the holotype of *Dilong*, and 51 cm in the holotype of *Xiongguanlong baimoensis*. For comparison, femoral lengths of known specimens (including juveniles) range from 25-134 cm in *Tyrannosaurus rex*, 44-104 cm in *Gorgosaurus libratus*, 31-102 cm in *Albertosaurus sarcophagus*, 63-96 cm in *Daspletosaurus torosus*, 77 cm in *Dryptosaurus* and 79 cm in *Appalachiosaurus* (based on data provided by Erickson et al. (2004) and Holtz (1994)[4]. *Sinotyrannus* is a gigantic tyrannosauroid from the Early Cretaceous Jiufotang Formation of Liaoning Province, known only from a single fragmentary specimen that includes hardly any complete elements. However, based on the estimated length of the right ilium (77 cm), the holotype of *Sinotyrannus* is probably slightly larger than the largest known specimen of *Yutyrannus huali*.

4. Additional illustrations of *Yutyrannus*

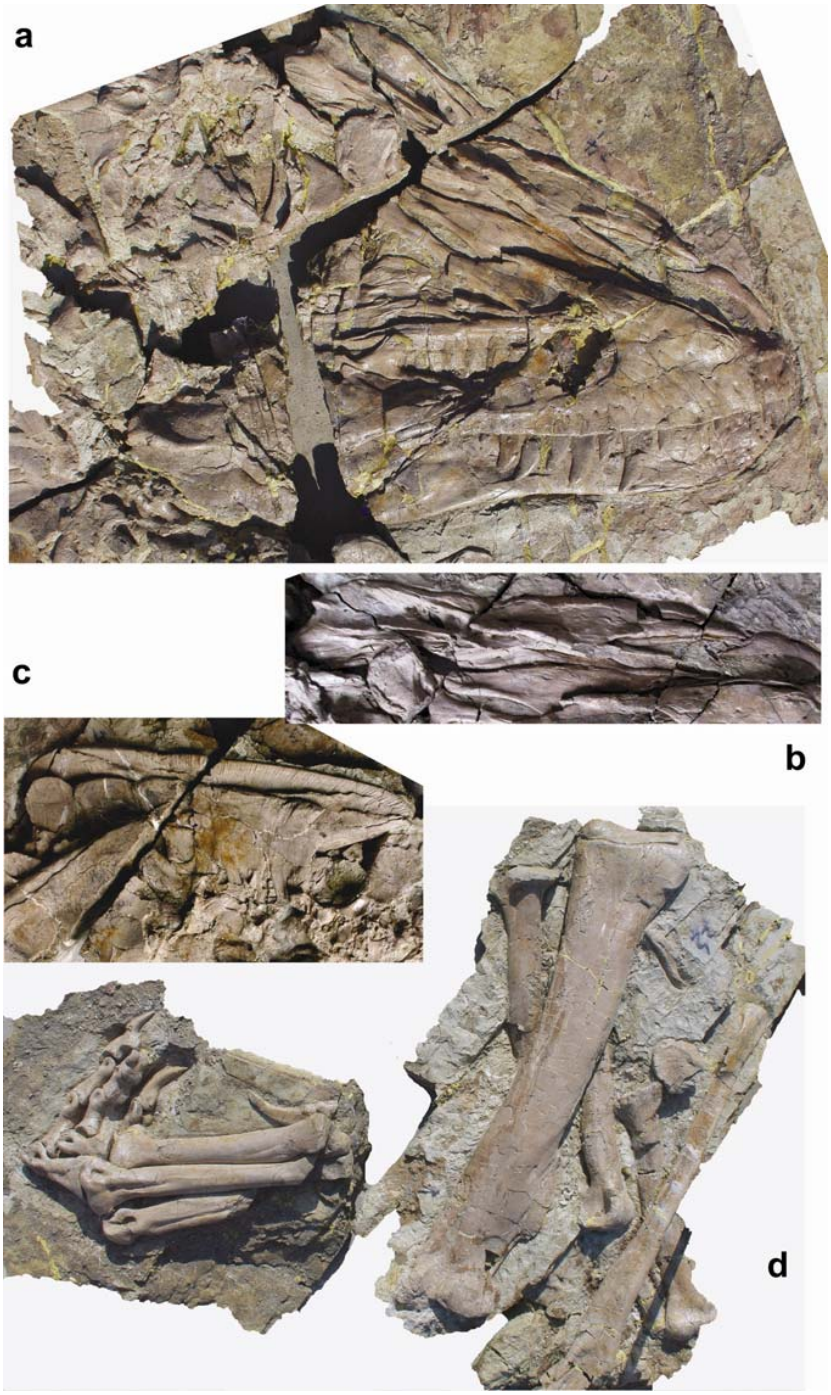

Figure S1. Photographs of *Y. huali* holotype (ZCDM V5000). **a**, skull; **b**, close-up of the nasals; **c,** left ilium; **d,** right hind limb.

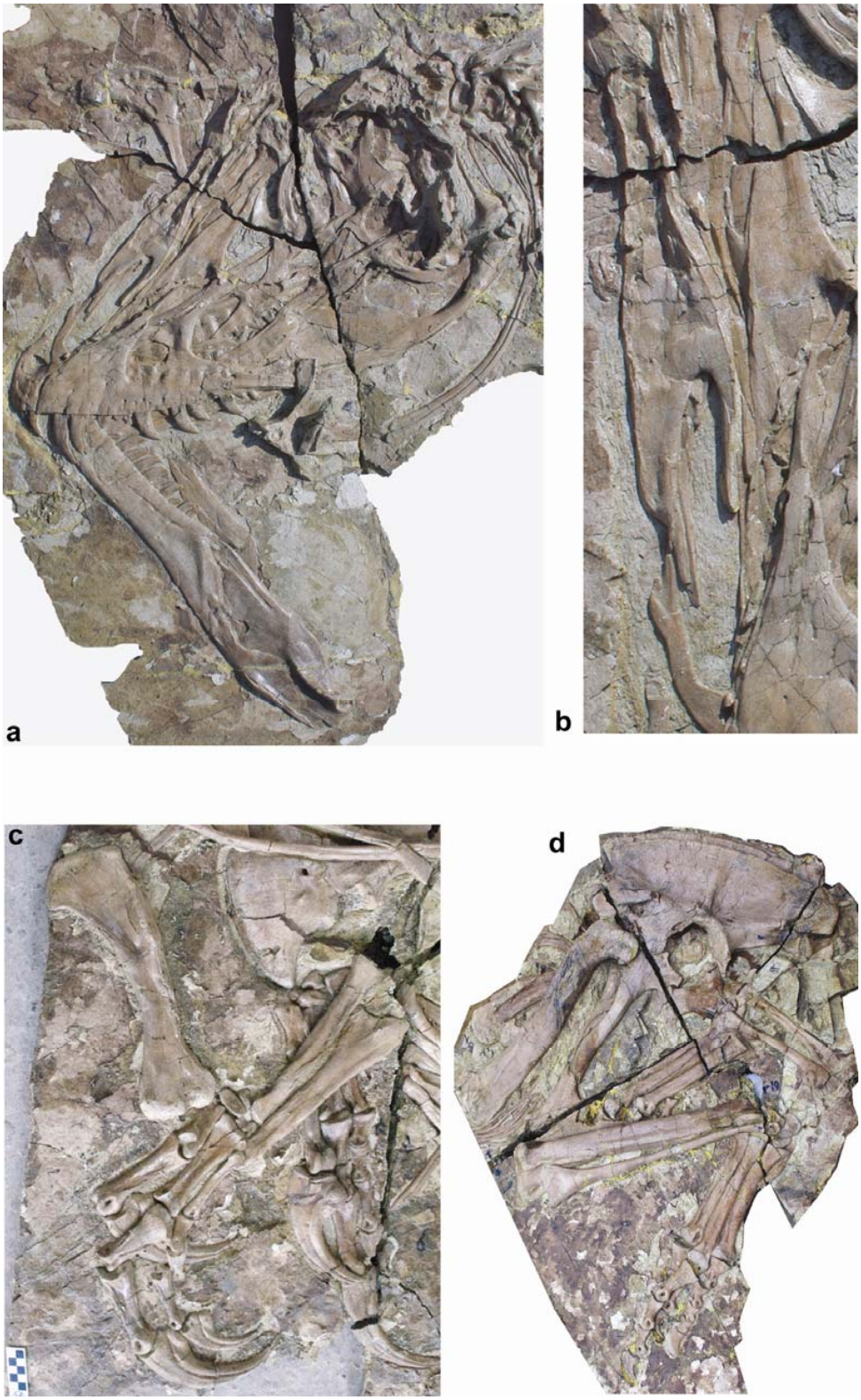

Figure S2. Photographs of *Y. huali* (ZCDM V5001). **a**, skull; **b**, close-up of nasals; **c**, forelimb; **d**, pelvis and hind limb.

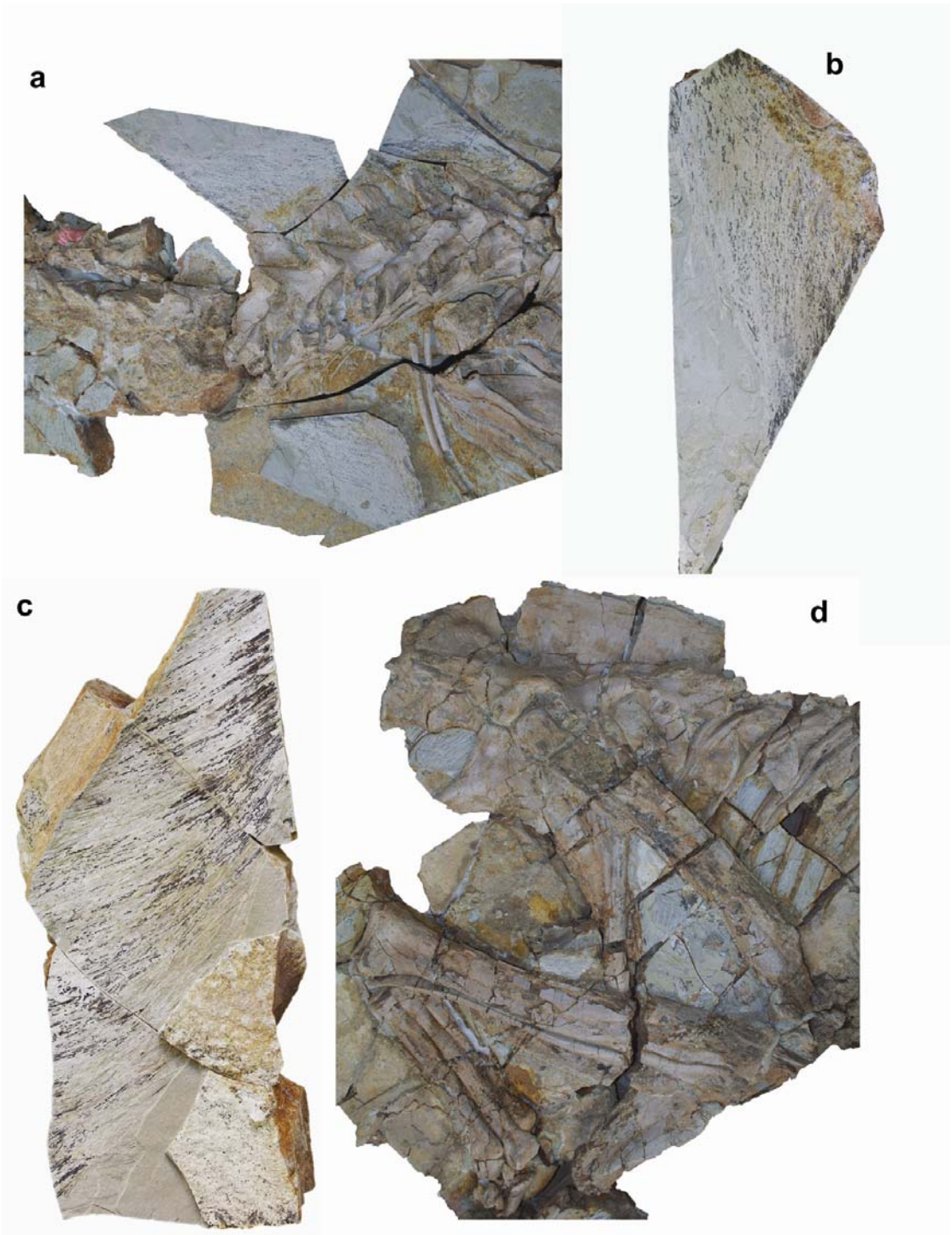

Figure S3. Photographs of *Y. huali* (ELDM V1001). **a**, neck; **b**, close-up of feathers above neck; **c**, long filamentous integumentary structures along a limb bone (which is badly broken and difficult to identify, but is more likely on the basis of relative size to be a humerus than any other element); **d**, pelvis and hind limb.

5. Morphometric analysis of the *Yutyrannus* specimens

We conducted a morphometric analysis in order to understand the growth strategy of *Y. huali.* However, this analysis was limited to the five skeletal elements that could be measured in all three specimens. Furthermore, ZCDM V5001 is only slightly larger than ELDM V1001, which further limits the reliability of the results.

Femur length was used as a standard proxy for overall size, and the lengths of the other four elements were compared to that of the femur (Table S1). The results show that the skull grows nearly isometrically in *Y. huali*, whereas the ilium, tibia, and metatarsus display negative allometry. In tyrannosaurids, the skull and ilium grow isometrically, and the tibia and metatarsus display negative allometry[5]. However, the tibia and metatarsus display much stronger negative allometry in *Y. huali* than in tyrannosaurids[5]. For the two ZCDM specimens of *Y. huali*, the lengths of the scapula, the radius, and metacarpal III could also be compared to that of the femur (Table S2). All three elements are negatively allometric. In tyrannosaurids, the scapula displays positive allometry, the radius displays similar negative allometry, and the metacarpus displays much weaker negative allometry[5].

Table S1

y	x	n	R^2	k	b
Skull length	Femur length	3	0.73846	1.0566	-0.11797
Ilium length	Femur length	3	0.85072	0.83958	0.40217
Tibia length	Femur length	3	0.97424	0.44327	1.5634
Metatarsal III length	Femur length	3	0.40768	0.38073	1.4449

Table S2

Length ratio	ZCDM V5000	ZCDM V5001
Scapula/femur	0.70	0.78
Radius/femur	0.32	0.34
Metacarpal III/femur	0.18	0.20

6. Phylogenetic analysis

In order to investigate the systematic position of *Y. huali*, we conducted two separate analyses on different datasets. First, we investigated the systematic position of *Yutyrannus huali* by adding this species to a recently published comprehensive dataset on theropod phylogeny[6] to confirm its tyrannosauroid affinities. Scorings for *Y. huali* were based on all three known specimens. In cases of polymorphism, we scored *Y. huali* based on the most ontogenetically advanced specimen preserving information about the character in question. The data matrix was analysed using the TNT software package[7]. The analysis was run using a traditional search strategy, with default settings apart from the following: 10000 maximum trees in memory and 1000 replications. The analysis resulted in 13244 equally parsimonious trees, each having a length of 1922 steps, a CI of 0.27, and a RI of 0.64. Figure S4 shows the strict consensus of the 13244 trees, which groups *Y. huali* with other tyrannosauroids.

In order to more accurately determine the systematic position of *Y. huali* among the tyrannosauroids, we added this species to a second dataset specifically designed to illuminate tyrannosauroid interrelationships[8]. The analysis resulted in six equally parsimonious trees, each having a length of 623 steps, a CI of 0.57 and a RI of 0.81. Figure S5 shows the strict consensus of the six trees. For the second dataset, we repeated the analysis with the three *Y. huali* specimens scored as separate operational taxonomic units. This modified analysis resulted in three equally parsimonious trees, each having a length of 629 steps, a CI of 0.56 and an RI of 0.81. Figure S6 shows the strict consensus of the three trees. The three specimens form a monophyletic group, supporting the interpretation that they are indeed conspecific.

Both versions of the analysis of the tyrannosauroid dataset place *Y. huali* as a tyrannosauroid more basal than *Eotyrannus*. The absence of a monophyletic Proceratosauridae in the consensus tree results from the unstable position of one taxon, namely *Stokesosaurus*. Our analysis consistently recovered a clade that always contained *Proceratosaurus*, *Sinotyrannus*, and *Guanlong*, and these three taxa are more basal than *Y. huali* in all shortest trees.

Scorings for *Y. huali* for the first dataset:

10?10010011010?1????0000?0?10011100??00?22100001 1?1?1?0?1??1???0????11???01?1
?01001???0?????000?????????????????????????????????????00000100101 1???1?0??1???11010
01100102000?00000102 12??00?00111??0?????000100?000??1???????10000???0010?01110
0000???????0001000000000 1?1000?00?00?00001?100?00?10?0111??20021??00000000 1?1
10000???0?1?1??100?00??010?0??0?00?0??0?????0?0?????01000???0??0?0?01?120?0??01?
0??0?1?1000020000000010000

Scorings for *Y. huali* specimens for the second dataset:

ZCDM_V5000 ?101?01121100?1?00????1013?1?0?000110?11??0?0?11210??0
00????????101???

????????????????????????????????????10??????011202?????????????1?00?????????????????0110
0??????1??00000100???0?11?000?010000????????1?????????????????????????111010???00?0
?????

ZCDM_V5001 ?001?01111100?1100???01013?1?0?000110?1???0?0?11210?00
00?0??????1???????0?02??11???002?01?????????????????1?????01?111011??01001??????????
????????????????????????????????????010?0?0?11?0112?20110???000?11?000000?????1010???
?00000?1????000000001000?0011?000?01000111?---01001011?0?111?01001-1--1---0---0--
00-00--00

EDM_V5000
00011?1110100?11002?000013?1?0?000110211??000?11210?0000??1???1?1010?10?0102?0
11210?02100??1?????2???1????????1????????2???0111??????0010000?0?0??????????????
????????01010??????0112020???0??????01?000000???101??0????0?0?????????????????????
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Yutyrannus_huali
0101101121100?11002?001013?1?0?000110211??000?11210?0000?01???1?1010?10?0102?
01121000210 1??1?????2???1?1?????01?111011?20100111?????0010000?0?0?????????????
??????????01010?0?11?01120201100??000?11?000000???101010????01100?1????10000000
10000?0011?000?01000011?1110110101110111100100101??1?111010???00?00??00

Scorings for *Teratophoneus* for the second dataset[9]:

????????????????000?????0?01?????????????????2?021?100010?10??????????0???21?1????
??0????01???0?13??21?111?10011112101211?????????????????????????????011?????020?1?1
???11??1100?011??????????11?????????10????????1????1?????????????????????1?0211????
1?????????????????????????????????????010?11?1?????????????????

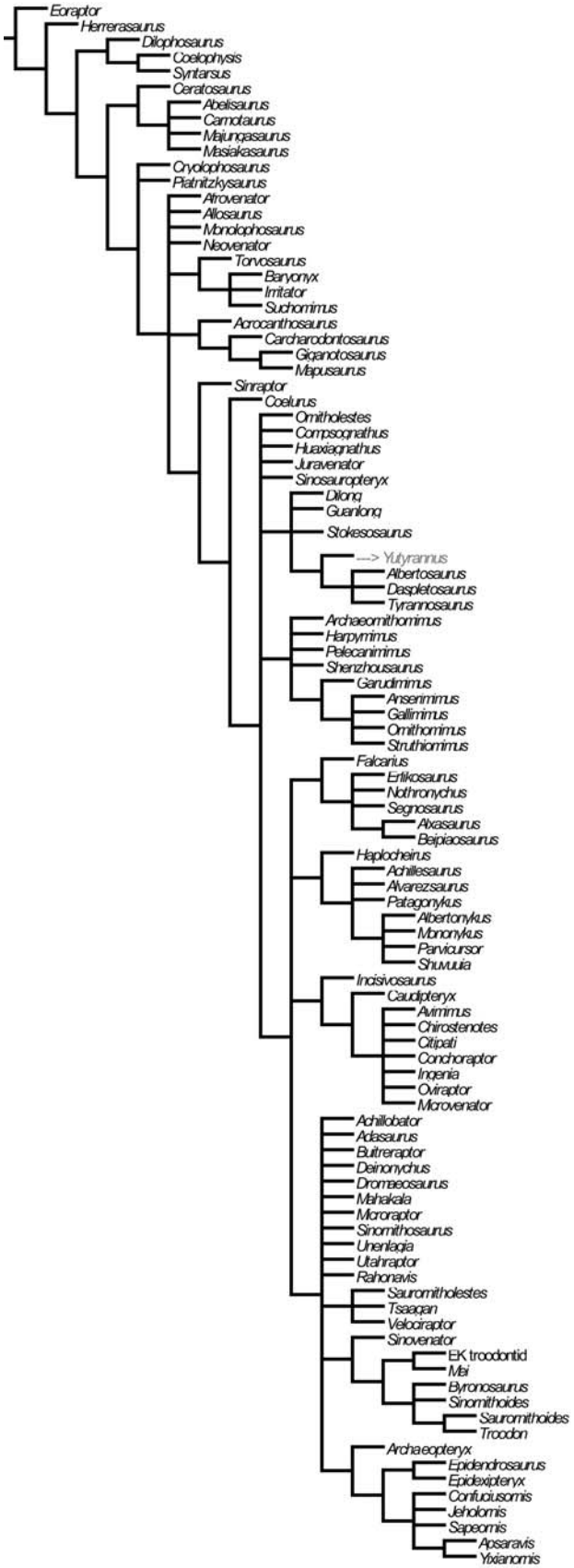

Figure S4. The systematic position of *Y. huali* based on an analysis of a theropod dataset。

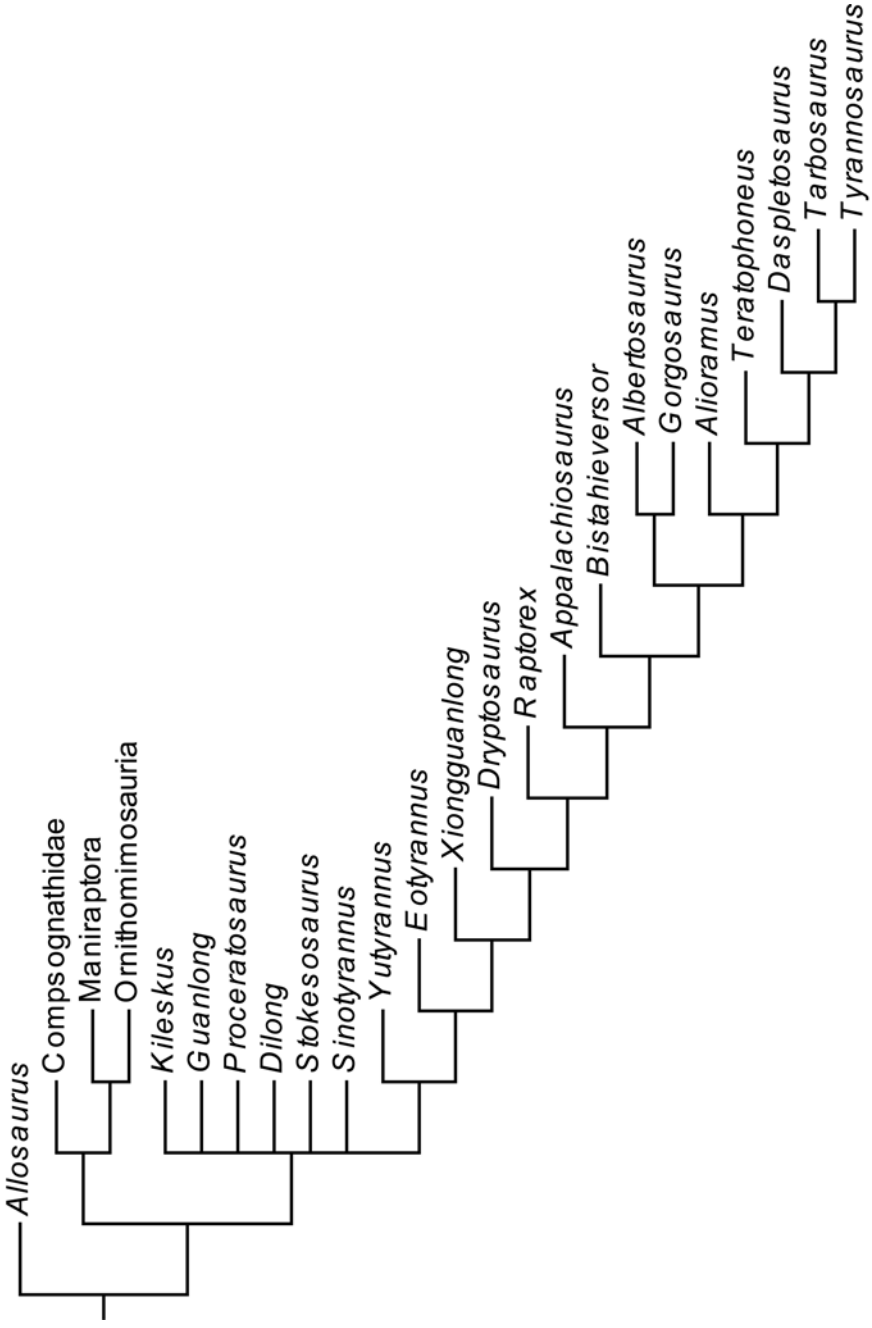

Figure S5. Strict consensus of the six shortest trees (tree length: 623 steps, CI: 0.57 and RI: 0.81) produced by an analysis of a tyrannosauroid dataset with *Y. huali* scored as a single OTU.

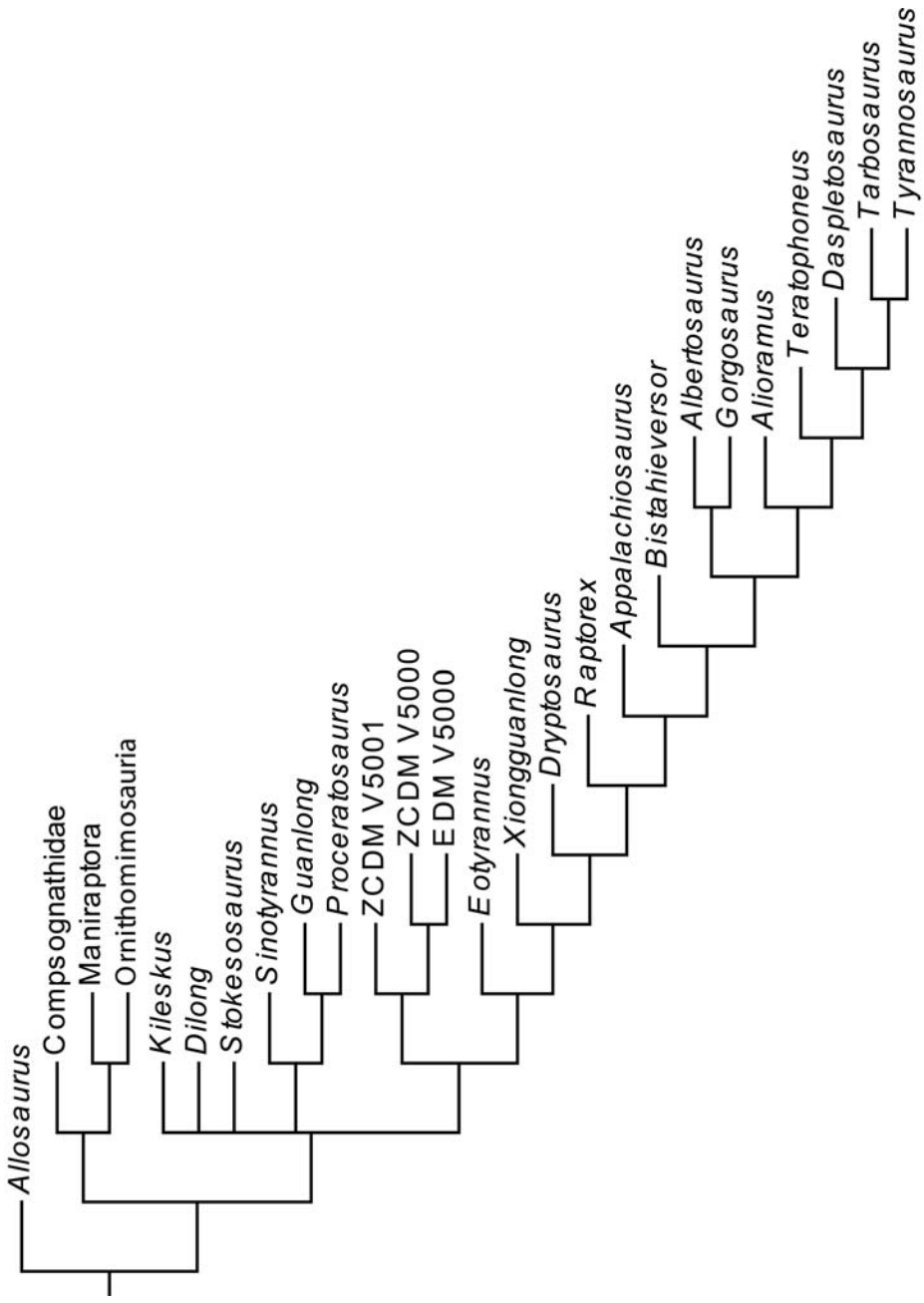

Figure S6. Strict consensus of the three shortest trees (tree length: 629 steps, CI: 0.56 and RI: 0.81) produced by an analysis of a tyrannosauroid dataset with the three known specimens of *Y. huali* scored as separate OTUs.

7. References

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