DIS-Fossil-***Confuciusornis***

## Discovery and naming



|  |  |
| --- | --- |
| ***Confuciusornis* Temporal range:** [**Early Cretaceous**](https://en.wikipedia.org/wiki/Early_Cretaceous)**, 125–120**[**Ma**](https://en.wikipedia.org/wiki/Megaannum)  [**PreЄ**](https://en.wikipedia.org/wiki/Precambrian)  [**Є**](https://en.wikipedia.org/wiki/Cambrian)  [**O**](https://en.wikipedia.org/wiki/Ordovician)  [**S**](https://en.wikipedia.org/wiki/Silurian)  [**D**](https://en.wikipedia.org/wiki/Devonian)  [**C**](https://en.wikipedia.org/wiki/Carboniferous)  [**P**](https://en.wikipedia.org/wiki/Permian)  [**T**](https://en.wikipedia.org/wiki/Triassic)  [**J**](https://en.wikipedia.org/wiki/Jurassic)  [**K**](https://en.wikipedia.org/wiki/Cretaceous)  [**Pg**](https://en.wikipedia.org/wiki/Paleogene)  [**N**](https://en.wikipedia.org/wiki/Neogene)  **↓** | |
|  | |
| *C. sanctus* fossil preserving long wing and tail feathers. | |
| [**Scientific classification**](https://en.wikipedia.org/wiki/Taxonomy_(biology)) | |
| Kingdom: | [Animalia](https://en.wikipedia.org/wiki/Animal) |
| Phylum: | [Chordata](https://en.wikipedia.org/wiki/Chordate) |
| Class: | [Sauropsida](https://en.wikipedia.org/wiki/Sauropsida) |
| *Clade*: | [Dinosauria](https://en.wikipedia.org/wiki/Dinosaur) |
| Order: | [Saurischia](https://en.wikipedia.org/wiki/Saurischia) |
| Suborder: | [Theropoda](https://en.wikipedia.org/wiki/Theropoda) |
| Family: | [†Confuciusornithidae](https://en.wikipedia.org/wiki/Confuciusornithidae) |
| Genus: | †***Confuciusornis*** Hou *et al.*, 1995 |
| [**Type species**](https://en.wikipedia.org/wiki/Type_species) | |
| *Confuciusornis sanctus* Hou *et al.*, 1995 | |
| **Species** | |
| * †***C. sanctus*** Hou *et al.*, 1995 * †***C. dui*** Hou *et al.*, 1999 * †***C. feducciai*** Zhang *et al.*, 2009 * †***C. jianchangensis*** Li, Wang & Hou, 2010 | |
| [**Synonyms**](https://en.wikipedia.org/wiki/Synonym_(taxonomy)) | |
| * [*Jinzhouornis*](https://en.wikipedia.org/wiki/Jinzhouornis)? Hou *et al.*, 2002 | |

Two short tailed *C. sanctus* specimens preserved on a single slab

In November 1993 Chinese paleontologists [Zhou Zhonge](https://en.wikipedia.org/w/index.php?title=Zhou_Zhonge&action=edit&redlink=1), [Hu Yoaming](https://en.wikipedia.org/w/index.php?title=Hu_Yoaming&action=edit&redlink=1) and [Hou Lianhai](https://en.wikipedia.org/w/index.php?title=Hou_Lianhai&action=edit&redlink=1), of the [Institute of Vertebrate Paleontology and Paleoanthropology](https://en.wikipedia.org/wiki/Institute_of_Vertebrate_Paleontology_and_Paleoanthropology) at [Beijing](https://en.wikipedia.org/wiki/Beijing), were presented a bird fossil bought at a flea market in [Sihetun](https://en.wikipedia.org/w/index.php?title=Sihetun&action=edit&redlink=1) by amateur paleontologist Zhang He. It showed a partial skeleton of a bird new to science of which even some feather remains had been preserved. In December 1993 two further specimens were acquired from a farmer, Yang Yushan. Soon afterwards, it was discovered that local farmers were in the process of collecting hundreds of specimens that were provisionally prepared by them to be illegally sold to commercial fossil dealers.[[3]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-3) Many hundreds have since also been added to the official collections of Chinese institutions. In 2010 the [Shandong Tianyu Museum of Nature](https://en.wikipedia.org/w/index.php?title=Shandong_Tianyu_Museum_of_Nature&action=edit&redlink=1) alone possessed 536 specimens.[[4]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-Zheng2010-4) The fossils are compressed but otherwise typically very complete often showing the entire feathering of the animal.

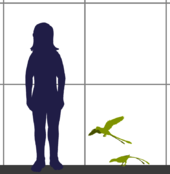
Based on the abundant material, six species have been formally named and described: *C. sanctus* (the [type species](https://en.wikipedia.org/wiki/Type_species)), *C. dui*, *C. feducciai*, *C. jianchangensis*, *C. chuonzhous* and *C. suniae*. The latter two are usually considered synonymous with *C. sanctus*.[[5]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-basalbird2010-5) Most species lived in the early [Aptian](https://en.wikipedia.org/wiki/Aptian) 125 million year old [Jianshangou Beds](https://en.wikipedia.org/w/index.php?title=Jianshangou_Beds&action=edit&redlink=1) of the [Yixian Formation](https://en.wikipedia.org/wiki/Yixian_Formation), though *C. jianchangnsis* is found in the later (120Ma) middle Aptian [Jiufotang Formation](https://en.wikipedia.org/wiki/Jiufotang_Formation). *C. sanctus* is known from the former, and is one of the most common vertebrate species found in the Yixian, often present in dense concentrations. At one time forty were discovered on a surface of about 100 m2. This has been explained as the result of entire flocks of birds being simultaneously killed by ash, heat or poisonous gas following the [volcanic eruptions](https://en.wikipedia.org/wiki/Volcanic_eruption) that caused the [tuff](https://en.wikipedia.org/wiki/Tuff) stone in which the fossils were found to be deposited as lake sediments.[[6]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-6)

In 1995 Zhou, Hou, Zhang and [Gu Youcai](https://en.wikipedia.org/w/index.php?title=Gu_Youcai&action=edit&redlink=1) named *Confuciusornis sanctus*. The generic name combines the philosopher Confucius with a Greek ὄρνις, (*ornis*), "bird". The [specific name](https://en.wikipedia.org/wiki/Specific_name_(zoology)) means "holy one" in [Latin](https://en.wikipedia.org/wiki/Latin) and is a translation of Chinese 圣贤, *shèngxián*, "sage", again in reference to Confucius. The [holotype](https://en.wikipedia.org/wiki/Holotype) specimen is **IVPP V10918**.[[7]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-7) In 1997 Hou named two species. The first was *Confuciusornis chuonzhous*, based on specimen IVPP V10919, originally a [paratype](https://en.wikipedia.org/wiki/Paratype) of *C. sanctus*. The specific name refers to Chuanzhou, an ancient name for [Beipiao](https://en.wikipedia.org/wiki/Beipiao). The second species was *Confuciusornis suniae*, based on specimen IVPP V11308. The specific name honours madam Sun, the wife of Shikuan Liang who donated the fossil to the IVPP.[[8]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-8) In 1999 Hou, Zhou, Zhang, [Larry Martin](https://en.wikipedia.org/wiki/Larry_Martin) and [Alan Feduccia](https://en.wikipedia.org/wiki/Alan_Feduccia) named *Confuciusornis dui*, based on specimen IVPP V11553. The specific name again honours a donating collector: Du Wengya.[[9]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-9) In 2009 [Zhang Fucheng](https://en.wikipedia.org/w/index.php?title=Zhang_Fucheng&action=edit&redlink=1) *et al.* named *Confuciusornis feducciai*, based on specimen D2454, the specific name honouring Feduccia.[[10]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-Zhang2009-10) In 2010 [Li Li](https://en.wikipedia.org/w/index.php?title=Li_Li_(paleontologist)&action=edit&redlink=1), [Wang Jingqi](https://en.wikipedia.org/w/index.php?title=Wang_Jingqi&action=edit&redlink=1) and [Hou Shilin](https://en.wikipedia.org/w/index.php?title=Hou_Shilin&action=edit&redlink=1) named *Confuciusornis jianchangensis*, based on specimen PMOL-AB00114 found at [Toudaoyingzi](https://en.wikipedia.org/w/index.php?title=Toudaoyingzi&action=edit&redlink=1).[[11]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-11)

In 2002 Hou named the genus [*Jinzhouornis*](https://en.wikipedia.org/wiki/Jinzhouornis). [Luis Chiappe](https://en.wikipedia.org/wiki/Luis_Chiappe) later concluded that this is probably a junior synonym of *Confuciusornis*.

***Confuciusornis*** is a genus of primitive crow-sized [birds](https://en.wikipedia.org/wiki/Bird) from the Early [Cretaceous](https://en.wikipedia.org/wiki/Cretaceous) [Yixian](https://en.wikipedia.org/wiki/Yixian_Formation) and [Jiufotang Formations](https://en.wikipedia.org/wiki/Jiufotang_Formation) of [China](https://en.wikipedia.org/wiki/China), dating from 125 to 120 million years ago. Like modern birds, *Confuciusornis* had a toothless beak, but close relatives of modern birds such as [*Hesperornis*](https://en.wikipedia.org/wiki/Hesperornis) and [*Ichthyornis*](https://en.wikipedia.org/wiki/Ichthyornis) were toothed, indicating that the loss of teeth occurred convergently in *Confuciusornis* and living birds. It is the oldest known bird to have a beak.[[1]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-1) It was named after the Chinese moral philosopher [Confucius](https://en.wikipedia.org/wiki/Confucius) (551–479 BC). *Confuciusornis* is one of the most abundant vertebrates found in the Yixian Formation, and several hundred complete, articulated specimens have been found.[[2]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-xu.26norell2006-2)

## Description



Size of *Confuciusornis*, compared to a human.

*Confuciusornis* was about the size of a modern [pigeon](https://en.wikipedia.org/wiki/Pigeon), with a total length of 50 centimetres (1.6 ft)[[12]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-Holtz2008-12) and a wingspan of up to 70 centimetres (2.3 ft). Its body weight has been estimated to have been as much as 1.5 kilograms (3.3 lb),[[13]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-nudds.26dyke2010-13) or less than 0.2 kilograms (0.44 lb).[[14]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-paul2010-14) *C. feducciai* was about a third longer than average specimens of *C. sanctus*.[[10]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-Zhang2009-10)

*Confuciusornis* shows a mix of basal and derived traits. It was more "advanced" or derived than *Archaeopteryx* in possessing a short tail with a [pygostyle](https://en.wikipedia.org/wiki/Pygostyle) (a bone formed from a series of short, fused tail vertebrae) and a bony [sternum](https://en.wikipedia.org/wiki/Sternum), but more basal or "primitive" than modern birds in retaining large claws on the forelimbs, having a primitive skull with a closed eye-socket, and a relatively small breastbone. At first the number of basal characteristics was exaggerated: Hou assumed in 1995 that a long tail was present and mistook grooves in the jaw bones for small degenerated teeth.[[15]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-Martin1998-15)

The skull of *Confuciusornis* was equipped with a pointed toothless beak. It was relatively heavy-built and immobile, incapable of the [kinesis](https://en.wikipedia.org/wiki/Kinesis_(biology)) of modern birds that can raise the snout relative to the back of the skull. This immobility was caused by the presence of a triradiate [postorbital](https://en.wikipedia.org/wiki/Postorbital) separating the eye-socket from the lower temporal opening, as with more basal theropods, and the [premaxillae](https://en.wikipedia.org/wiki/Premaxilla) of the snout reaching all the way to the [frontals](https://en.wikipedia.org/wiki/Frontal_bone), forcing the [nasals](https://en.wikipedia.org/wiki/Nasal_bone) to the sides of the snout.[[16]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-Chiappeetal1999-16)

Fossils of *Confuciusornis* show that it had an exceptionally large [humerus](https://en.wikipedia.org/wiki/Humerus) (upper arm bone). Near its shoulder-end this was equipped with a prominent deltopectoral crest. Characteristically this *crista deltopectoralis* was with *Confuciusornis* pierced by an oval hole which may have reduced the bone's weight or enlarged the attachment area of the flight miscles. The [furcula](https://en.wikipedia.org/wiki/Furcula) or wishbone, like that of [*Archaeopteryx*](https://en.wikipedia.org/wiki/Archaeopteryx), was a simple curved bar lacking a pointed process at the back, a [hypocleidum](https://en.wikipedia.org/w/index.php?title=Hypocleidum&action=edit&redlink=1). The sternum (breastbone) was relatively broad and had a low [keel](https://en.wikipedia.org/wiki/Keel_(bird)) which was raised at the back end. This bony keel may or may not have anchored a larger, cartilaginous, keel for enlarged [pectoral](https://en.wiktionary.org/wiki/pectoral) muscles.[[16]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-Chiappeetal1999-16) The [scapulae](https://en.wikipedia.org/wiki/Scapula) (shoulder blades) were fused to the strut-like [coracoid](https://en.wikipedia.org/wiki/Coracoid) bones and may have formed a solid base for the attachment of wing muscles. The orientation of the shoulder joint was sideways, instead of angled upward as in modern birds; this means that *Confuciusornis* was unable to lift its wings high above its back. According to a study by [Phil Senter](https://en.wikipedia.org/w/index.php?title=Phil_Senter&action=edit&redlink=1) in 2006, the joint was even pointed largely downwards meaning that the humerus could not be lifted above the horizontal. This would make *Confuciusornis* incapable of the upstroke required for [flapping flight](https://en.wikipedia.org/wiki/Bird_flight); the same would have been true for *Archaeopteryx*.[[17]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-senter2006-17)

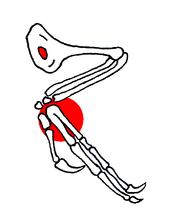


Illustration of *Confuciusornis* wing bones.

The wrist of *Confuciusornis* shows fusion, forming a [carpometacarpus](https://en.wikipedia.org/wiki/Carpometacarpus). The second and third [metacarpals](https://en.wikipedia.org/wiki/Metacarpal) were also partially fused but the first was unfused, however, and also the fingers could freely move relative to each other. The second metacarpal, supporting the flight feathers, was very heavily built; its finger carries a small claw. The claw of the first finger to the contrary was very large and curved, that of the third intermediate in size.[[16]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-Chiappeetal1999-16) The formula of the finger phalanges was 2-3-4-0-0.

The [pelvis](https://en.wikipedia.org/wiki/Pelvis) was connected to a [sacrum](https://en.wikipedia.org/wiki/Sacrum) formed by seven [sacral vertebrae](https://en.wikipedia.org/wiki/Sacral_vertebra). The [pubis](https://en.wikipedia.org/wiki/Pubis_(bone)) was strongly pointing backwards. The left and right ischia were not fused. The [femur](https://en.wikipedia.org/wiki/Femur) was straight; the [tibia](https://en.wikipedia.org/wiki/Tibia) only slightly longer. The [metatarsals](https://en.wikipedia.org/wiki/Metatarsal) of the foot were relatively short and fused to each other and to the lower ankle bones, forming a [tarsometatarsus](https://en.wikipedia.org/wiki/Tarsometatarsus). A rudimentary fifth metatarsal is present. The first metatarsal was attached to the lower shaft of the second and supported a first toe or [hallux](https://en.wikipedia.org/wiki/Hallux), pointing to the back.[[16]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-Chiappeetal1999-16) The formula of the toe phalanges was 2-3-4-5-0. The proportions of the toes suggest that they were used for both walking and perching, while the large claws of the thumb and third finger were probably used for climbing.

### Feathers



Life restoration of *C. sanctus*

The wing feathers of *Confuciusornis* were long and modern in appearance. The primary wing feathers of a 0.5 kilogram individual reached 20.7 centimeters in length. The five longest primary feathers ([*remiges*](https://en.wikipedia.org/wiki/Remiges) *primarii*) were more than 3.5 times the length of the hand and relatively longer than those of any living bird, while the secondary feathers of the lower arm were rather short by comparison. Thus, the wing shape was very unlike that of living birds, being long and narrow.[[13]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-nudds.26dyke2010-13) The primary feathers were asymmetrical to varying degree, and especially so in the outermost primaries.[[16]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-Chiappeetal1999-16) It is unclear whether the upper arm carried tertiaries. Covert feathers are preserved covering the upper part of the wing feathers in some specimens, and some specimens have preserved the contour feathers of the body.[[16]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-Chiappeetal1999-16) Unlike some more advanced birds, *Confuciusornis* lacked an [alula](https://en.wikipedia.org/wiki/Alula), or "bastard wing". In modern birds this is formed by feathers anchored to the first digit of the hand, but this digit appears to have been free of feathers and independent of the body of the wing in *Confuciusornis*.[[16]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-Chiappeetal1999-16) According to [Dieter Stefan Peters](https://en.wikipedia.org/w/index.php?title=Dieter_Stefan_Peters&action=edit&redlink=1) to compensate for the lack of an alula, the third finger might have formed a separate winglet below the main wing, functioning like the flap of an aircraft.[[18]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-Peters1999-18) Despite the relatively advanced and long wing feathers, the forearm bones lacked any indication of quill knobs (*papillae ulnares*), or bony attachment points for the feather ligaments.[[16]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-Chiappeetal1999-16)

Many specimens preserve a pair of long, narrow tail feathers, which grew longer than the entire length of the rest of the body. Unlike the feathers of most modern birds, these feathers were not differentiated into a central quill and barbs for most of their length. Rather, most of the feather formed a ribbon-like sheet, about six millimetres wide. Only at the last one quarter of the feather, towards the rounded tip, does the feather become differentiated into a central shaft with interlocking barbs. Many individuals of *Confuciusornis* lacked even these two tail feathers, possibly due to [sexual dimorphism](https://en.wikipedia.org/wiki/Sexual_dimorphism). The rest of the tail around the pygostyle was covered in short, non-aerodynamic feather tufts similar to the contour feathers of the body, rather than the familiar feather fan of modern bird tails.[[16]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-Chiappeetal1999-16)

### Colouration

In early 2010, a group of scientists led by Zhang Fucheng examined [fossils](https://en.wikipedia.org/wiki/Fossil) with preserved [melanosomes](https://en.wikipedia.org/wiki/Melanosomes) ([organelles](https://en.wikipedia.org/wiki/Organelle) which contain colors). By studying such fossils with an [electron microscope](https://en.wikipedia.org/wiki/Electron_microscope), they found melanosomes preserved in a fossil *Confuciusornis* specimen, [IVPP](https://en.wikipedia.org/wiki/IVPP) V13171.[[19]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-19) The melanosomes were of two types, [eumelanosomes](https://en.wikipedia.org/w/index.php?title=Eumelanosomes&action=edit&redlink=1) and [pheomelanosomes](https://en.wikipedia.org/w/index.php?title=Pheomelanosomes&action=edit&redlink=1). This indicates that *Confuciusornis* had hues of [grey](https://en.wikipedia.org/wiki/Grey), [red](https://en.wikipedia.org/wiki/Red)/[brown](https://en.wikipedia.org/wiki/Brown) and [black](https://en.wikipedia.org/wiki/Black), possibly something like the modern [zebra finch](https://en.wikipedia.org/wiki/Zebra_finch). It was also the first time an early bird fossil has been shown to contain preserved pheomelanosomes.[[20]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-20)[[21]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-21)

## Paleobiology

### Flight

*Confuciusornis* has traditionally been assumed to have been a competent flier based on its extremely long wings with strongly asymmetrical feathers. Other adaptations for improved flight capabilities include: a fused wrist, a short tail, an ossified sternum, a strut-like coracoid, a large deltopectoral crest, a strong [ulna](https://en.wikipedia.org/wiki/Ulna) and an enlarged second metacarpal.[[22]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-22)

However, over the years several claims have been made that the flight of *Confuciusornis* suffered from more or less severe limitations.

The first of these regarded problems to attain a steep flight path due to a limited wing amplitude. In the interpretation of Senter (2006) of the position of the shoulder joint, a normal upstroke would be impossible precluding flapping flight entirely. Less radical is the assessment that due to the lack of a keeled sternum and a high acrocoracoid, the [*Musculus pectoralis minor*](https://en.wikipedia.org/wiki/Pectoralis_minor_muscle) could not serve as a *M. supracoracoideus* lifting the humerus via a tendon running through a [*foramen triosseum*](https://en.wikipedia.org/w/index.php?title=Foramen_triosseum&action=edit&redlink=1). This, coupled with a limited upstroke caused by a lateral position of the shoulder joint, would have made it difficult to gain altitude. Some authors therefore proposed that *Confuciusornis* used its large thumb claws to climb tree trunks. Martin assumed that it could raise its torso almost vertically like a squirrel.[[15]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-Martin1998-15) [Daniel Hembree](https://en.wikipedia.org/w/index.php?title=Daniel_Hembree&action=edit&redlink=1) however, while acknowledging that tree climbing was likely, pointed out that the rump was apparently not lifted more than 25° relative to the femur in vertical position, as shown by the location of the [antitrochanter](https://en.wikipedia.org/w/index.php?title=Antitrochanter&action=edit&redlink=1) in the hip joint.[[23]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-23) Dieter S. Peters considered it very unlikely that *Confuciusornis* climbed trunks as turning the thumb claw inwards would stretch the very long wing forwards, right in the path of obstructing branches. Peters sees *Confuciusornis* as capable of flapping flight but specialised in soaring flight.[[18]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-Peters1999-18)

A second problem is the strength of the feathers. In 2010 [Robert Nudds](https://en.wikipedia.org/w/index.php?title=Robert_Nudds&action=edit&redlink=1) and [Gareth Dyke](https://en.wikipedia.org/wiki/Gareth_Dyke) published a study arguing that in both *Confuciusornis* and [*Archaeopteryx*](https://en.wikipedia.org/wiki/Archaeopteryx), the *raches* (central shafts) of the primary feathers were too thin and weak to have remained rigid during the power stroke required for true flight. They argued that *Confuciusornis* would at most have employed [gliding flight](https://en.wikipedia.org/wiki/Gliding_flight), which is also consistent with the unusual adaptations seen in its upper arm bones, and more likely used its wings for mere parachuting, limiting fall speed if it dropped from a tree.[[13]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-nudds.26dyke2010-13) [Gregory S. Paul](https://en.wikipedia.org/wiki/Gregory_S._Paul), however, disagreed with their study. He argued that Nudds and Dyke had overestimated the weights of these early birds, and that more accurate weight estimates allowed powered flight even with relatively narrow raches. Nudds and Dyke assumed a weight of 1.5 kilograms for *Confuciusornis*, as heavy as the modern [teal](https://en.wikipedia.org/wiki/Common_teal). Paul argued that a more reasonable body weight estimate is about 180 grams, less than that of a [pigeon](https://en.wikipedia.org/wiki/Pigeon). Paul also noted that *Confuciusornis* is commonly found as large assemblages in lake bottom sediments with little to no evidence of extensive postmortem transport, and that it would be highly unusual for gliding animals to be found in such large numbers in deep water. Rather, this evidence suggests that *Confuciusornis* traveled in large flocks over the lake surfaces, a habitat consistent with a flying animal.[[14]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-paul2010-14) A number of Chinese researchers questioned the correctness of the rachis measurements, stating that the specimens they had studied showed a shaft thickness of 2.1 to 2.3 millimetres as compared to the 1.2 millimetre reported by Nudds and Dyke.[[4]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-Zheng2010-4) The latter replied that, apart from the weight aspect, such greater shaft thickness alone would make flapping flight possible; however, they allowed for the possibility of two species being present in the Chinese fossil material with a differing rachis diameter.[[24]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-24)

### Sexual variation



Specimen of *C. sanctus* with paired tail feathers

Many specimens of *Confuciusornis* preserve a single pair of long, streamer-like tail feathers. However, most do not, even specimens which otherwise have exquisitely preserved feathers on the rest of the body; their predominance has been estimated to be as high as 90-95%.[[15]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-Martin1998-15) This difference has been suggested to indicate [sexual dimorphism](https://en.wikipedia.org/wiki/Sexual_dimorphism), with one gender (likely the males) using the streamer-like feathers in courtship displays. However, while sexual variation is the most obvious explanation for the presence or absence of long tail feathers, other factors cannot be ruled out. For example, it is possible that some individuals lack tail feathers because they were fossilized during [molting](https://en.wikipedia.org/wiki/Molt). As in modern birds, molting individuals may have been present alongside non-molting individuals, and males and females may have molted at different times during the year.[[16]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-Chiappeetal1999-16)

Due to the large number of specimens, [statistical analysis](https://en.wikipedia.org/wiki/Statistical_analysis) can be used to investigate this problem. In 2008 Chiappe *et alii* published a [morphometrical](https://en.wikipedia.org/wiki/Morphometrics) study of 106 fossils. The population showed a clear [bimodal distribution](https://en.wikipedia.org/wiki/Bimodal_distribution) of the size of the animals with two [weight classes](https://en.wikipedia.org/wiki/Weight_class). However, there was no [correlation](https://en.wikipedia.org/wiki/Correlation) between size and the possession of the long tail feathers. From this it was concluded that either the sexes did not differ in size or both sexes had the long feathers. The first case was deemed most likely which left the size distribution to be explained. It was hypothesised that the smaller animals consisted of very young individuals, that the large animals were adults and that the rarity of individuals with an intermediate size was caused by *Confuciusornis* experiencing a [growth spurt](https://en.wikipedia.org/wiki/Growth_spurt) just prior to reaching adulthood, the shortness of which would have prevented many becoming fossilised during this phase.[[25]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-25) This interpretation was criticised by Dieter S. Peters who pointed out that, as the smaller animals were not [neonates](https://en.wikipedia.org/wiki/Neonate), the young of *Confuciusornis* had to grow very fast immediately after hatching regardless. This would then imply two growth spurts, which assumption was not very parsimonious. He thought the data would be more simply explained by assuming that both sexes had the long feathers and one of them was the largest. He favoured the possibility that these were the females, having observed such a pattern with the modern [pheasant-tailed jacana](https://en.wikipedia.org/wiki/Pheasant-tailed_jacana) (*Hydrophasianus chirurgus*), a water-bird in which both sexes have long tails and the female sex is the heaviest. He accounted for the fact that most specimens show no tails at all by the possibility that *Confuciusornis* shed the feathers as a defence mechanism, a method used by several extant species, which would have been triggered by the stress induced by the very volcanic explosion that buried the animals.[[26]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-26)



Short tailed *C. sanctus* specimen

The growth speed relevant to this question can be independently measured by researching the bone structure. In 1998 Zhang determined that growth was fast, leading to [fibrolamellar bone](https://en.wikipedia.org/w/index.php?title=Fibrolamellar_bone&action=edit&redlink=1).[[27]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-27) Comparison with the bone structure of an [alligator](https://en.wikipedia.org/wiki/Alligator) indicated that *Confuciusornis* had a high metabolism comparable to that of modern birds.[[28]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-28) The growth speed of *Confuciusornis* would have been similar to that of [*Beipiaosaurus*](https://en.wikipedia.org/wiki/Beipiaosaurus).[[29]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-29) A study by [Armand de Ricqlès](https://en.wikipedia.org/wiki/Armand_de_Ricqlès) in 2003 indicated that growth was essentially modern, *Confuciusornis* reaching its maximum size in at most twenty weeks, perhaps as few as thirteen. Basal birds would have limited their size, not by slowing growth but by limiting the period of growth.[[30]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-30) A 2013 study found [medullary bone](https://en.wikipedia.org/wiki/Medullary_bone) in a short tailed specimen, confirming that it was female.[[31]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-31)

There are immature specimens known, and from the analysis of bone growth patterns of young adults it has been estimated that *Confuciusornis* reached maturity somewhat slower than extant small birds, but faster than advanced dinosaurs (de Ricqlès *et al.*, 2003), which might indicate an omnivorous diet similar to modern [crows](https://en.wikipedia.org/wiki/Crow).

It has been hypothesized that *Confuciusornis* fed on plant materials due to its toothless beak, but no [gastroliths](https://en.wikipedia.org/wiki/Gastrolith) or stomach contents had been reported (Zhou & Zhang, 2003). Dalsätt and colleagues (2006) described a specimen, [IVPP](https://en.wikipedia.org/wiki/Institute_of_Vertebrate_Paleontology_and_Paleoanthropology) V13313 found in the Jiufotang Beds, that preserves seven to nine [vertebrae](https://en.wikipedia.org/wiki/Vertebra) and several ribs of a small fish, probably [*Jinanichthys*](https://en.wikipedia.org/wiki/Jinanichthys). These fish bones are formed into a tight cluster about six millimeters across, and the cluster is in contact with the seventh and eighth [cervical vertebrae](https://en.wikipedia.org/wiki/Cervical_vertebrae) of the bird. In this position it was likely in the crop of the bird, which may have been preparing to regurgitate a [pellet](https://en.wikipedia.org/wiki/Pellet_(ornithology)) when it died. No other fish remains are present in the slab. (Dalsätt *et al.*, 2006). [Andrzej Elzanowski](https://en.wikipedia.org/wiki/Andrzej_Elzanowski) already in 2002 had predicted that *Confuciusornis* was a predator.[[32]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-32) Dieter S. Peters has hypothesized that, although no remains of toe webs have been conserved, it caught its prey swimming using its rather soft bill to search for prey below the waterline.[[18]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-Peters1999-18) [Andrei Zinoviev](https://en.wikipedia.org/w/index.php?title=Andrei_Zinoviev&action=edit&redlink=1) assumed it caught fish on the wing.[[33]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-33)[[34]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-34)

Several extant bird species have been presented as modern analogues of *Confuciusornis* providing insight into its possible lifestyle. Dieter S. Peters thought that it could be best compared with the [white-tailed tropicbird](https://en.wikipedia.org/wiki/White-tailed_tropicbird) (*Phaeton lepturus*), a fisher that too has a long tail and narrow wings — and even often nests in the neighbourhood of volcanoes.[[18]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-Peters1999-18) The [paradise kingfishers](https://en.wikipedia.org/wiki/Paradise_kingfisher) (genus [*Tanysiptera*](https://en.wikipedia.org/wiki/Tanysiptera)) of modern [Australia](https://en.wikipedia.org/wiki/Australia) and [New Guinea](https://en.wikipedia.org/wiki/New_Guinea) have elongated "racket plumes" as their central tail feathers, giving them a superficial resemblance to *Confuciusornis*. These kingfishers also take fish as prey, but they are not specialized fishers. They take many insects and other small prey from their forest habitat.[[35]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-Bleiweiss2005-35)

### Daily activity patterns

Comparisons between the [scleral rings](https://en.wikipedia.org/wiki/Sclerotic_ring) supporting the eyes of *Confuciusornis* and modern birds and other reptiles indicate that it may have been [diurnal](https://en.wikipedia.org/wiki/Diurnality), similar to most modern birds.[[36]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-36)

## Classification

Hou assigned *Confuciusornis* to the [Confuciusornithidae](https://en.wikipedia.org/wiki/Confuciusornithidae) in 1995. At first he assumed it was a member of the [Enantiornithes](https://en.wikipedia.org/wiki/Enantiornithes) and the sister taxon of [*Gobipteryx*](https://en.wikipedia.org/wiki/Gobipteryx). Later he understood that *Confuciusornis* was not an enantiornith but concluded it was the sister taxon of the Enantiornithes, within a larger [Sauriurae](https://en.wikipedia.org/wiki/Sauriurae).[[37]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-37) This was heavily criticised by Chiappe who regarded Sauriurae to be [paraphyletic](https://en.wikipedia.org/wiki/Paraphyletic) as there were insufficient shared traits that indicated that the Confuciusornithidae and the Enantiornithes were closely related.[[38]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-38) In 2001 [Ji Qiang](https://en.wikipedia.org/w/index.php?title=Ji_Qiang&action=edit&redlink=1) suggested an alternative position as the sister taxon of the [Ornithothoraces](https://en.wikipedia.org/wiki/Ornithothoraces).[[39]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-39)

In 2002 Ji's hypothesis was confirmed by a [cladistic analysis](https://en.wikipedia.org/wiki/Cladistic_analysis) by Chiappe, who defined a new group: the [Pygostylia](https://en.wikipedia.org/wiki/Pygostylia) of which *Confuciusornis* is by definition the most basal member.[[40]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-40) Several traits of *Confuciusornis* illustrate its position in the tree of life; it has a more "primitive" skull than [*Archaeopteryx*](https://en.wikipedia.org/wiki/Archaeopteryx), but it is the first known bird to have lost the long tail of *Archaeopteryx* and develop fused tail vertebrae, a [pygostyle](https://en.wikipedia.org/wiki/Pygostyle).[[41]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-Clarke.26Norell2002-41) One controversial study concluded that *Confuciusornis* may be more closely related to [*Microraptor*](https://en.wikipedia.org/wiki/Microraptor) and other [dromaeosaurids](https://en.wikipedia.org/wiki/Dromaeosauridae) than to *Archaeopteryx*, but this study was criticized on methodological grounds (Mayr *et al.*, 2005).

The present standard interpretation of the [phylogenetic](https://en.wikipedia.org/wiki/Phylogenetic) position of *Confuciusornis* can be shown in this [cladogram](https://en.wikipedia.org/wiki/Cladogram):

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| [Aves](https://en.wikipedia.org/wiki/Aves) | |  |  | | --- | --- | |  | [*Archaeopteryx*](https://en.wikipedia.org/wiki/Archaeopteryx) | |  | |  | |  |  | | --- | --- | |  | [*Jeholornis*](https://en.wikipedia.org/wiki/Jeholornis) | |  | |  | |  |  | | --- | --- | |  | [*Sapeornis*](https://en.wikipedia.org/wiki/Sapeornis) | |  | | [Pygostylia](https://en.wikipedia.org/wiki/Pygostylia) | |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | [Confuciusornithidae](https://en.wikipedia.org/wiki/Confuciusornithidae) | |  |  | | --- | --- | |  | ***Confuciusornis*** | |  | |  | [*Changchengornis*](https://en.wikipedia.org/wiki/Changchengornis) | |  | | |  | | [Ornithothoraces](https://en.wikipedia.org/wiki/Ornithothoraces) | |  |  | | --- | --- | |  | [Enantiornithes](https://en.wikipedia.org/wiki/Enantiornithes) | |  | |  | [Ornithuromorpha](https://en.wikipedia.org/wiki/Ornithuromorpha) (including the [Neornithes](https://en.wikipedia.org/wiki/Neornithes)) | |  | | |  | | |  | | |  | | |  | |
|  |

A close relative, the confuciusornithid [*Changchengornis hengdaoziensis*](https://en.wikipedia.org/wiki/Changchengornis_hengdaoziensis), also lived in the Yixian Formation. *Changchengornis* also possessed the paired, long tail feathers, as did several more advanced [enantiornith](https://en.wikipedia.org/wiki/Enantiornithes) birds. True, mobile tail fans only appeared in [ornithuromorph](https://en.wikipedia.org/wiki/Ornithuromorpha) birds, and possibly in the enantiornithine [*Shanweiniao*](https://en.wikipedia.org/wiki/Shanweiniao).[[42]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-Clarkeetal2006-42)[[43]](https://en.wikipedia.org/wiki/Confuciusornis" \l "cite_note-O.27connoretal.2009-43)

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