

World Heritage Sites

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CHENGJIANG FOSSIL SITE CHINA

The exceptionally well preserved soft-bodied chordate fossils of the Chengjiang site in Yunnan, southwest China, are an outstanding record of a major stage in the history of life: the oldest example of the emergence of multicellular forms of metazoan life when the ancestors of almost all the later groups of animals originated. As the earliest evidence of the Cambrian explosion - the rapid diversification of species within a complex marine ecosystem - they have become essential to the understanding of subsequent life on Earth.

COUNTRY

China

NAME

Chengjiang Fossil Site

NATURAL WORLD HERITAGE SITE

2012: Inscribed on the World Heritage List under natural criterion (viii).

STATEMENT OF OUTSTANDING UNIVERSAL VALUE

The UNESCO World Heritage Committee adopted the following Statement of Outstanding Universal Value at the time of inscription:

Brief Synthesis

The Chengjiang Fossil Site, located in the Province of Yunnan, China, conserves fossil remains which are of exceptional significance. The rocks and fossils of the Chengjiang Fossil Site present an outstanding and extraordinarily preserved record that testifies to the rapid diversification of life on Earth during the early Cambrian period, 530 million years before present. In this geologically short interval, almost all major groups of animals had their origins. The diverse geological evidence from the Chengjiang Fossil Site presents fossil remains of the highest quality of preservation and conveys a complete record of an early Cambrian marine community. It is one of the earliest records of a complex marine ecosystem and a unique window of understanding into the structure of early Cambrian communities.

Criterion (viii): The Chengjiang Fossil Site presents an exceptional record of the rapid diversification of life on Earth during the early Cambrian period, 530 million years before present. In this geologically short interval almost all major groups of animals had their origins. The property is a globally outstanding example of a major stage in the history of life, representing a palaeobiological window of great significance.

The exceptional palaeontological evidence of the Chengjiang Fossil Site is unrivalled for its rich species diversity. To date at least 16 phyla, plus a variety of enigmatic groups, and about 196 species have been documented. Taxa recovered range from algae, through sponges and cnidarians to numerous bilaterian phyla, including the earliest known chordates. The earliest known specimens of several phyla such as cnidarians, ctenophores, priapulids, and vertebrates occur here. Many of the taxa represent the stem groups to extant phyla and throw light on characteristics that distinguish major taxonomic groups.

The property displays excellent quality of fossil preservation including the soft and hard tissues of animals with hard skeletons, along with a wide array of organisms that were entirely soft-bodied, and therefore relatively unrepresented in the fossil record. Almost all of the soft-bodied species are unknown elsewhere. Fine-scale detailed preservation includes features as the alimentary systems of animals, for example of the arthropod *Naraoia*, and the delicate gills of the enigmatic *Yunnanzoon*. The sediments of Chengjiang provide what are currently the oldest known fossil chordates, the phylum to which all vertebrates belong. The fossils and rocks of the Chengjiang Fossil Site, together, present a complete record of an early Cambrian marine community. It is one of the earliest records of a complex marine ecosystem, with food webs capped by sophisticated predators.

Moreover, it demonstrates that complex community structures had developed very early in the Cambrian diversification of animal life, and provides evidence of a wide range of ecological niches. The property thus provides a unique window of understanding into the structure of early Cambrian communities.

Integrity

The property has clear boundaries including the most significant rock exposures of the region, and has a buffer zone that provides wider protection to the property. It is noted that fossil evidence is provided in some sites that lie outside the property boundaries and its buffer zone, and these areas need to receive appropriate wider protection and are important to provide context for the property. Prior to 2004, 14 phosphate mining operations occurred in the buffer zone of the property. Since 2008 they have all been closed down. The process of rehabilitating these former mining sites is ongoing and will take some considerable time. No mining activities have actually impacted on the property itself and the ongoing commitment of County and Provincial governments to not open or re-open mines within the property or its buffer zone are critical to protect the values of the property.

Various excavations have occurred within the property in relation to the two key fossil sites. At the key stratigraphic section of Xiaolantian, a deep excavation has been made to create a walkway. Additionally, a museum has been built at Miaotanshan, over the site of the first Chengjiang Fauna fossil discovery. Both the path and museum construction have had impacts on the integrity of the site. The State Party has introduced a process for systematic review and approval for any development which may impact on the site. Moreover, the management authority has completely restricted future infrastructure development in the property.

Protection and Management Requirements

The Chengjiang Fossil Site is state-owned and protected under the Article 9 of the constitution of the People's Republic of China and by various laws including the Environmental Protection Law of the People's Republic of China (2002), the Law of the People's Republic of China on Cultural Relic Protection (2002), the regulations on the management of paleontological specimens (Ministry of Land and Resources, 2002), regulations on the protection and management of geological relics (1995) and the regulation on the protection of Yunnan Chengjiang Fauna Fossil (1997). The property is designated as a protected area ensuring that potentially damaging human activities within the site can be prevented. The area is largely covered with secondary forest and shrub and there is no industrial activity or permanent human habitation within the boundary. The property lies entirely within a Chinese National Geopark.

There is an effective management plan, supported by a dedicated and adequately staffed and resourced management body. The Chengjiang Fossil Site Management Institute is responsible for coordinating on-site management of the protected area. The property protection strategy includes a National Geopark zoning plan which affords adequate protection to key fossil sites, supported by staffing for implementation. The finances of the Chengjiang Fossil Site come largely from national sources and are supplemented by smaller contributions at the City and County levels. Stable and special funding for the ongoing management of the property is adequate to address ongoing protection, promotion and presentation of the property. The property has an established monitoring programme including defined indicators for the conservation of this property, and which needs to be integrated with monitoring of the protection of the wider surroundings of the property. The need for ongoing and effective curation of fossil specimens collected from the property, to the highest international standards, is fully recognised and provided for by the State Party.

Visitor numbers are anticipated to increase from a few thousand (4-5,000) individuals in 2012, most of whom are locals or individuals from neighbouring areas and visiting scientists. Increased visitation to the property requires effective management strategies and the provision of guides, designation of restricted areas, and strict restrictions on fossil collecting. It will be essential to carefully regulate visitor numbers within the capacity of the property. The anticipated maximum numbers at the time of inscription were estimated at c.30-40,000 people. There is a need to assure effective land-use planning in areas surrounding the property in order to secure its long-term conservation, including the conservation of fossil sites in the surrounding area that provide context for understanding the value of the property.

IUCN MANAGEMENT CATEGORY

Unassigned

BIOGEOGRAPHICAL PROVINCE

Sichuan Highlands (2.39.12)

GEOGRAPHICAL LOCATION

The site is in Yunnan, southwestern China, around the hill of Maotianshan 5 km east of the town of Chengjiang and 65 km south of Kunming City. Its central coordinate is 24°40'08" N by 102°58'38" E.

DATES OF ESTABLISHMENT

1984: Soft-bodied fossil biota discovered on Maotianshan by palaeontologist Hou Xianguang;
1997: The fossil site designated the Chengjiang Fauna Provincial Nature Reserve;
2001: Declared the Yunnan Chengjiang Fossil National Geopark; 2008: Master plan updated;
2010: The Chengjiang Fossil Site Management Plan adopted.

LAND TENURE

The site is owned by the State. Under the national Ministries of Land and Resources and of Urban-Rural Development, the site is overseen by the Provincial departments of Land, Resources and Construction and county and municipal governments. On-site management is by the Chengjiang Fossil National Geopark Management Committee.

AREA

The property covers 512 ha. The surrounding buffer zone has a total area of 220 ha.

ALTITUDE

Maotianshan is 2,024m above sea level. The site itself has an elevational range of 156m.

PHYSICAL FEATURES

The Chengjiang fossil *Lagerstätte* site is 3.71 km long by 2.56 km wide on 'Maotianshan', a low hill oriented northeast-southwest containing a comprehensive sequence of exposed and unexposed fossiliferous strata. It is in a pleasant wooded hilly district but its importance lies almost wholly in its abundant paleontological evidence of Early Cambrian life of which it may be called the type locality. Though it covers a limited period of geological time it is of exceptional significance in recording the most completely preserved early Cambrian marine community known: a complete ecosystem with a prolific and exceptionally well preserved biota having complex food webs dominated by sophisticated predators. It displays the anatomy of hard and soft tissues in a very wide variety of organisms, invertebrate and vertebrate in exquisite detail, even the soft tissues of gills, eyes and guts and many entirely soft-bodied animals being preserved. Its beautiful fossils reveal the structure of these earliest animal communities in such fine scale as to make them key for the interpretation of early body plans and the genetic evolution of many major animal groups, providing a context for the understanding of modern marine ecosystems

Fossils of complex micro-organisms suggest that eukaryotes appeared by about 2 billion years ago, after oxygen had begun to form part of the atmosphere. The Jinning orogeny, 860-800 million years ago, generated the basement of the South China Plate on the western Yangtze platform of which the Chengjiang area is situated. Further deformation caused by the Chengjiang orogeny 700-540 million years ago, created repeated crustal upheavals in the area with subsequent erosion until it was flooded by a shallow sea in which abundant small shelly animals were deposited in a now thick layer of carbonate rock. It was in the late Precambrian, 600-570 mya ago, that the first multicellular organisms appeared, in the Ediacaran (upper Sinian) biota. Then, during the early Cambrian period, 543 million years ago, following an increase in atmospheric oxygen and a decrease in carbon dioxide, the remarkable diversification of life known as the Cambrian explosion began.

At that time the Chengjiang area was a shallow gulf in the tropical latitude of 11°S. With plenty of sunlight, sufficient oxygen and organic material, especially abundant algae, the marine conditions were perfect for the proliferation of consumers. The fossils of the Chengjiang fossil sequence occur in the laminated yellowish mudstones and greenish-grey shales of the upper part of the Yu'an-shan member of the Heilinpu Formation dated at 530 million years ago. This member is 200m thick with shale and mudstone interbedded with silty dolomite and calcareous siltstone and repeated beds of fine quartz sandstone in beds from 1cm to 3 cm thick in clear bedding planes, the lower part of each bed being silty and the upper part muddy. The animals were quickly buried within these sediments without disturbance or decay, their soft tissues being preserved through replacement by pyrite, some tissues also being preserved as carbon films. They record in the most completely preserved early Cambrian community known, an exceptional record of a fundamental stage in the history of life - the geologically short period (2-3 Ma) of relatively rapid diversification of metazoan life during which almost all the subsequent major groups of animals originated.

Orogenic activity at the end of the Palaeozoic Era closed off the ancient Tethys Ocean, ending the marine period of the Chengjiang region. From the Cambrian to the late Permian (540-250 Ma), the area experienced several depositional episodes resulting in the accumulation of about 1,500m of sedimentary rocks. The site is located at the southern end of the crustal north-south Xiaojiang fault between the Sichuan and South China tectonic blocks. After the fault became active in the Quaternary period, the fault-bounded asymmetric syncline of Maotianshan took shape, the western limb of which exhibits a continuous succession of the fossil-bearing Lower Cambrian strata and underlying Pre-Cambrian strata trending in a north-northeast to south-southwest direction. Subsequent intermittent uplift and erosion exposed the underlying phosphate-rich Palaeozoic rocks. Much later, the nearby

Fuxian Lake formed in the resulting graben, its northern end reaching the foot of Maotianshan. About 3,000 years ago, human beings first occupied its banks. As a result of deforestation the primary semi-humid evergreen broad-leaved forest gradually disappeared, exposing the lower Cambrian strata.

CLIMATE

The site has a monsoon climate with two seasons: November to April are dry, May to October are wet, with 80% of the annual rainfall of about 964mm. Annual evaporation is 1,757mm; relative humidity is 74%. The annual mean temperature is 15°C with a maximum temperature of 31°C and minimum of -5°C. The dominant winds are southerly and southwesterly with speeds averaging 1-2m per second.

VEGETATION

Before it was protected most of the original forest was lost although there are some remnant indigenous semi-humid evergreen broad-leaved species: *Castanopsis orthacantha*, *C. delavayi*, *Cyclobalanopsis glaucoides*, *Lithocarpus dealbatus*, the conifer *Keteleeria evelyniana* and *Olea yunnanensis*. The present forest, covering about 55% of the site, has been newly replanted with largely warm semi-humid evergreen forest. Yunnan pine *Pinus yunnanensis*, Chinese white pine *P. armandii* are dominant, also with Chinese chestnut *Castanea mollissima* plantations, Nepalese alder *Alnus nepalensis*, Yunnan cypress *Cupressus duclouxiana*, *Eucalyptus* spp. and *Dodonaea viscosa*. The remainder of the site is grassland and farmland.

Currently recorded is a total of 512 vascular plant species belonging to 378 genera and 124 families, of which 341 species and 250 genera are indigenous. The flora comprises 20 pteridophyte species (16 genera, 12 families), 6 gymnosperm species (5 genera, 3 families) and 486 angiosperm species (357 genera, 109 families). Some of these species are nationally protected: *Camellia reticulata* (VU) and *Ranunculus sceleratus*, and some provincially protected such as *Pistacia weinmanniifolia*, *Michelia yunnanensis* and *Taxicodendron griffithii*.

FAUNA

Cambrian fauna:

The Chengjiang fossil sequence dated 530 million years ago, is an outstanding record of a major stage in the history of life - a period of rapid diversification of metazoan life during which almost all the major groups of animals originated, and in the most completely preserved early Cambrian marine community known. The soft and hard tissues of skeletonized animals are preserved with a wide, and elsewhere almost unknown, array of soft-bodied organisms including many vermiform animals normally unrepresented in the fossil record. Recorded as having been found on the site are least 16 animal phyla both living and extinct, with a variety of enigmatic groups, some 30 fossils of uncertain affinity, plus about 152 taxa (mostly new). These range from algae through sponges and cnidarians, ctenophores, sipunculans, priapulids, echinoderms and chordates to numerous bilaterian phyla, including the earliest known vertebrates. The fossil record records two proto-vertebrates of the early Cambrian: *Yunnanozoon lividum* and *Y. magnificissimi* which may be the oldest hemichordates known. Two major types of feeders lived in the benthic shallow-water communities: suspension/micro-particle feeders - mostly epibenthic sedentary taxa - and larger-particle feeders, living in benthic to benthic-pelagic communities. Predation seems to have been a major feeding mode among metazoans such as nemathelminth worms and arthropods. Other forms of feeding are not so evident.

Existing fauna:

The mammals recorded are Chinese pangolin *Manis pentadactyla* (EN), Yunnan bamboo pit viper *Trimeresurus stejnegeri yunnanensis* and Chinese large-toothed snake *Dinodon septentrionalis*; also unspecified reptiles and insects. Birds include black stork *Ciconia nigra*, spoonbill *Platalea leucorodia*, mandarin duck *Aix galericulata*, bar-headed goose *Anser indicus*, sparrowhawk *Accipiter nisus*, Lady Amherst's pheasant *Chrysolophus amherstiae*, crane *Grus grus*, mountain parakeet *Psilopsiagon aurifrons*, rock bunting *Emberiza cia*, tree sparrow *Passer montanus* and *Prinia* spp.

CONSERVATION VALUE

East Yunnan is one of the best regions in the world for showing a continuous, well developed and well distributed sequence of lower Cambrian strata, making it possible to study the Chengjiang soft-bodied fauna in a stratigraphic, sedimentological and palaeo-environmental context. The Chengjiang site presents the most complete record of an early Cambrian marine community and contains a prolific and exceptionally well preserved biota that displays the anatomy of both hard and soft tissues in a very wide variety of organisms, invertebrate and vertebrate in exquisite detail. Its beautiful fossils illuminate

questions about the design of animal bodies and genetic evolution, and record the early establishment of a complex marine ecosystem with food webs dominated by sophisticated predators.

CULTURAL HERITAGE

Around Chengjiang, there is evidence of Palaeolithic activity 30,000-100,000 years ago and there have been Neolithic archaeological discoveries in the area. From about the 12th century B.C.E. people settled the area in large numbers. An administrative regime was set up in the Warring States Period before 221 B.C.E. and in 106 B.C.E. during the West Han dynasty, the area became an administrative county. From the Qin dynasty (300 BC) onward, the Han culture developed; during the Yuan dynasty in 1250 an Islamic culture entered the area and after the 17th century, the Miao tribal people also settled.

LOCAL HUMAN POPULATION

The present county is multicultural, with ethnic groups including Han, Hui, Yi and Miao but the site itself is uninhabited. The buffer zone has patches of farmland in valley bottoms and on gentle slopes and one village of 454 inhabitants in 2010. There are six villages around the bottom of the hill which, with seven others in the surrounding area total about 7,000 inhabitants. Most are Han with a few from the Yi and Miao ethnic minorities. They are mostly farmers and herders. From the 1980s to 2004 the abundant phosphate resources around Maotianshan were mined but the mine sites (4% of the property) are now being restored. The discovery of the fossils has created a local sense of pride and made the people aware of the need to protect this heritage.

VISITORS AND VISITOR FACILITIES

Visitors between 2005 and 2009 numbered some 20,000, with 3,000 in 2005 to 5,000 in 2009, most from local or neighbouring areas and visiting scientists. There is a public-access field station with a museum at Maotianshan and a new museum in Chengjiang town nearby where there are other services. Designation is expected to increase this flow to 30-40,000 which will require guided tours to restricted visiting areas and strict oversight to prevent illegal collecting and damage.

SCIENTIFIC RESEARCH AND FACILITIES

It has long been known that the Lower Cambrian of eastern Yunnan Province is richly fossiliferous. In the early twentieth century the Frenchmen H. Lantenois (1907), J. Deprat (1912), and H. Mansuy (1907, 1912) studied the geology and palaeontology of the region, including Chengjiang, resulting in the publications of new trilobite and arthropod fossils. The area was also extensively studied in the 1930s and 1940s (Hou et al. 2002) and the sequence has long been taken as a standard for the stratigraphic subdivision and correlation of the Cambrian throughout China and beyond. But since the outstanding discovery by Dr. X. Hou of multicellular soft-bodied chordate fossils in 1984 the site has been of the highest international interest and the biota has attracted continuous global coverage and the active interest of many international academic institutions. The Chengjiang Lagerstätte is now known from many localities of the Yu'an-shan member of the Heilinpo Formation over a wide area of eastern Yunnan. The fossils have been studied by many international teams, resulting in numerous publications in the international and scientific press: from the discovery to late 2009, more than 200 papers and 12 monographs have been published on various aspects of the biota and associated sediments. An exhibition of Chengjiang fossils was held at the University of Oxford Museum in 2010 and at the International Palaeontological Congress 3 in London, 2010, nine papers were presented on the fossils.

There is considerable potential for ongoing discoveries. Although many thousands of specimens have been collected, new major discoveries continue to be made every year. This is demonstrated by the continuing publication of papers in high-profile journals. Existing collections contain numerous enigmatic specimens, some in very small numbers, whose true nature will only be determined when additional specimens are recovered. The Chengjiang Fossil Site Management Institute and local government departments work with academic teams from the Laboratory for Palaeobiology at Yunnan University, Kunming University of Science and Technology and the Nanjing Institutes of Geology and Palaeontology and of Palaeontology and Stratigraphy. There is a field station with museum at Maotianshan, a new purpose-built museum in Chengjiang town and museum displays at Yunnan University and at the Nanjing Institutes.

MANAGEMENT

The Chengjiang Fossil Site is state-owned and protected under various laws including the national Law on Cultural Relic Protection of 2002, the national regulations on the management of

palaeontological specimens of the Ministry of Land and Resources, 2002, the provincial Environmental Protection Law of 2002, regulations on the protection and management of geological relics (1995) and the regulations on the protection of Yunnan Chengjiang Fauna Fossils (1997). Maotianshan is a Special Protected Zone of the Geopark. The rest of the property comes within Protected Zones Classes I and II of the Geopark which only scientists and authorised visitors may enter. Limited development is permitted in the buffer zone.

National oversight is provided by the Ministry of Land and Resources, the Ministry of Urban-Rural Development and the Chinese National Commission for UNESCO. Provincial level management is overseen by the Yunnan Administrative Division of Yunnan Provincial Scenic Areas. Locally, management is coordinated between the Yuxi Municipal Government and the Chengjiang County Government. Day-to-day management and monitoring is provided by the Chengjiang Fossil National Geopark Management Committee. The roles of each organisation are clear and this system of management functions well.

There are three management plans: In 2001 the Master Plan for the Yunnan Chengjiang Fossil National Geopark was drafted, and updated in 2008. In 2005 the Plan for the Ecological and Geological Control and Management for the Protection of the Chengjiang Fauna Fossils in Surrounding Areas of Maotianshan was prepared by provincial authorities. In 2010 the Chengjiang Fossil Site Management Plan was adopted for the operational management of the property. Monitoring is done daily of the weather and visitors, monthly of geological conditions and from time to time of vegetation and exotic species, hydrology, land use and village populations.

MANAGEMENT CONSTRAINTS

Profitable phosphate mining occurring all round the site was stopped in 2004 leaving tailings, pollution and waste ground. Fourteen sites within the property are being restored but access tracks, buildings and landscaping with non-native species on the fossiliferous layers have damaged the integrity of the site. Future construction is to be agreed with the Managing Committee to avoid similar disturbance, and reforestation is to be with locally native species. Future increases in the number of visitors will require the definition of restricted areas and strict surveillance to prevent damage and illegal collecting.

COMPARISON WITH SIMILAR SITES

It is very rare to find abundant fossils of soft-bodied organisms at a key point in the evolution of life. Among World Heritage sites the Eocene Messel Pit in Germany and Triassic Monte San Giorgio between Italy and Switzerland include soft-bodied fossils from far later parts of the geological record, and the Lena Pillars Nature Park is noted as a fossil Cambrian reef ecosystem. However, the Burgess Shale site in the Canadian Rocky Mountain Parks is the only strongly comparable site to the Chengjiang site. It is a much earlier and better known discovery, but is more than 10 million years younger in time and with a mostly different fossil fauna. Both sites show short highly diverse periods of Cambrian life in different marine ecosystems: the Chengjiang site a lower shoreface to near offshore environment, the Burgess Shale the seaward edge of a submarine escarpment. Both faunas are from muddy, bottom level communities where the fossils are flattened with some relief and are similarly rich in numbers of phyla, genera and species though these are almost mutually exclusive.

There is a small number of other lower Cambrian sites with soft-tissue fossils not on the World Heritage List, containing some additional taxa which contribute to the total picture of early Cambrian biodiversity such as the exceptionally well preserved Lower Cambrian fossils of Sirius Passet in northern Greenland, the Orsten fossil site in Sweden and the Emu Bay Shale, Australia. However they are all less diverse and so less informative. There are also numerous lower Cambrian sites worldwide that preserve skeletal remains only, but include taxa that are not present in the Chengjiang biota.

STAFF

The Geopark Management Committee employs 14 professional staff in management including 6 in museum studies, two tour guides and 2 specialists each in palaeontology and geology. They are supplemented by geological expertise and comprehensive training in protected area management skills from provincial and national universities. There are 16 local part-time park rangers and a management field station.

BUDGET

Funding comes from national government sources (RMB 27 million in 2009) supplemented by smaller sums from the city and county (RMB 1 million in 2009). Funding increased from RMB 4.9 million in 2008 to RMB 28 million (US\$4,100,000) in 2009.

LOCAL ADDRESSES

The Ministry of Housing and Urban-Rural Development of the People's Republic of China.
Website: www.cin.gov.cn.

The Department of Housing and Urban-Rural Development of Yunnan Province, Chengjiang, Yuxi Municipality, Yunnan Province 652500, People's Republic of China. Website: www.ynjst.gov.cn.

Chengjiang Fossil National Geopark Management Committee, Chengjiang, Yuxi Municipality, Yunnan Province 652500, People's Republic of China.

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DATE

November 2012.