

## World Heritage Sites

### Protected Areas and World Heritage



## PHONG NHA-KE BANG NATIONAL PARK VIETNAM

*The karst formations of Phong Nha-Ke Bang National Park have evolved since the Palaeozoic, over 400 million years ago, and are among the oldest as well as largest tracts of karst in Asia. This vast limestone landscape is extremely complex, with many notable and spectacular geomorphic features, including 126km of caves, including the world's largest cave and longest underground river. Its wildlife has a high level of diversity and endemism.*

### COUNTRY

Vietnam

### NAME

Phong Nha-Ke Bang National Park

### NATURAL WORLD HERITAGE SITE

2003: Inscribed on the World Heritage List under Natural Criterion viii.

2010: Renominated under Natural Criteria viii and x

### STATEMENT OF OUTSTANDING UNIVERSAL VALUE [pending]

The UNESCO World Heritage Committee issued the following statement at the time of inscription:

#### Justification for Inscription

Criterion (viii): Phong Nha is part of a larger dissected plateau, which also encompasses the Ke Bang and Hin Namno karsts. The limestone is not continuous and demonstrates complex interbedding with shales and sandstones. This, together with the capping of schists and apparent granites has led to a particularly distinctive topography.

The caves demonstrate discrete episodic sequences of events, leaving behind various levels of fossil passages, formerly buried and now uncovered palaeokarst (karst from previous, perhaps very ancient, periods of solution); evidence of major changes in the routes of underground rivers; changes in the solutional regime; deposition and later re-solution of giant speleothems and unusual features such as sub-aerial stromatolites. The location and form of the caves suggests that they might owe much of their size and morphology to some as yet undetermined implications of the schists and granites which overlay the limestone. On the surface, there is a striking series of landscapes, ranging from deeply dissected ranges and plateaux to an immense polje. There is evidence of at least one period of hydrothermal activity in the evolution of this ancient mature karst system. The plateau is probably one of the finest and most distinctive examples of a complex karst landform in SE Asia.

In summary, Phong Nha displays an impressive amount of evidence of earth's history. It is a site of very great importance for increasing our understanding of the geologic, geomorphic and geo-chronological history of the region.

### IUCN MANAGEMENT CATEGORY

II National Park

### BIOGEOGRAPHICAL PROVINCE

Indochinese Rainforest (4.5.1)

## **GEOGRAPHICAL LOCATION**

The National Park is located in Quang Binh province in central Vietnam at its narrowest part, about 500 km south of Hanoi and 260 km north of Da Nang. Its western boundary is on the Lao-Vietnamese border, which is here only 42 km from the sea. The Park lies between 17° 20' to 17°48' N and 105° 46' to 106°24' E.

## **DATES AND HISTORY OF ESTABLISHMENT**

The caves have long been appreciated and visited by the people as one of the great landscapes of Vietnam;

1986: Phong Nha Cultural and Historical Site declared (5,000 ha);

1993: Phong Nha declared a Nature Reserve and extended to 41,132 ha;

2001: The Phong Nha-Ke Bang National Park was established by Decision 189/2001, incorporating part of the limestone plateau in the Ke Bang Conservation Area.

2010: Renominated to include Natural Criterion x.

## **LAND TENURE**

Owned by the state. It is managed by the Phong Nha-Ke Bang Management Board under the jurisdiction of the People's Committee and Department of Environmental and Natural Resources of Quang Binh province. The forest is managed by the General Department of Forest Protection of the Ministry of Agriculture and Rural Development.

## **AREA**

The National Park has a core zone of 85,754 ha and a buffer zone of 195,400 ha. Hin Namno National Biodiversity Conservation Area (86,500 ha) adjoins the site in similar terrain across the Laotian border.

## **ALTITUDE**

From 100m to 1,213m (Co Preu).

## **PHYSICAL FEATURES**

Phong Nha-Ke Bang National Park in the Central Annamite Mountains and its bordering lowlands is in one of the largest and most distinctive tracts of karst topography in the world. With the neighboring Ke Bang Conservation Area and karsts it comprises a wide deeply dissected plateau of some 200,000 ha extending into Hin Namno, a similar area in Laos. Its geological history is traced back to the late Ordovician-early Silurian period around 460-400 million years ago. The limestone is discontinuous, being interbedded with shales and sandstones and capped by schists and granites, rising to a number of unexplored peaks over 1,000m high. The extensive transitional landforms derive from an extremely complicated intercalation of limestone massifs and terrigenous terrain which has produced three distinctive types of topography. Two-thirds of the nominated site is Cenozoic karst. A smaller main area is of mainly Mesozoic karst. A third area is a non-karstic landscape of low round-topped mountains of intrusive rock with planation surfaces and abrasion-accumulation terraces along the valleys of the Son, and Chay rivers and on the margins of the central limestone massif.

As a result of tectonic uplift and sea-level changes over time, some seven successive periods of karst formation have created an underground landscape of great complexity. This includes fossil passages at varying levels, major changes in the routes of underground rivers, once buried and now uncovered palaeokarst, and evidence of changes in the solutinal regime, some by hydrothermal action. This has resulted in a network of 17 major explored caves and some 300 smaller caves and grottoes extending over 126km underground. The active river caves are divided into the ten caves of the Phong Nha system discharging to the Son River, and the eight caves of the Vom system, discharging to the Chay River. The variety of forms is immense: dry caves, terraced caves, suspended caves, dendritic caves, intersecting caves, giant speleothems and unusual forms such as sub-aerial stromatolites. Since 2009 the Son

Doong cave, on the Son river, running underground at least 5km by 150m wide and 200m high is now famous as the world's largest cave, It possesses beautiful sand beaches and spectacular speleothems, but at present is open only to scientists and speleologists. Phong Nha cave, with a surveyed length of 7.73km and 14 grottoes, is the best known. Its entrance is the last stretch of the underground Chay River, a tributary of the Son which itself flows underground for 20km. Two beautiful caves, Thien Duong and Tien Son, are nearby. Other extensive caves include the Vom cave system, 15km long, and the Hang Khe Rhy cave system 18.9km long. Phong Nha-Ke Bang contains the catchment area of many but not all of the streams and rivers that feed the Gianh river. Flooding of the valleys occurs between September and November, but in the dry season from February to August almost all the streams dry up.

## CLIMATE

The climate is tropical, hot and humid. The annual mean temperature ranges between 23° and 25°C, with a summer maximum of 41°C and a winter minimum of 6°C. The hottest months are from June to August, with a mean of 28°C; the coldest months are from December to February with a mean of 18 °C. The high annual rainfall averages 2,000-2,500mm, 88% falling between July and December, though there is rain in every month and on more than 160 days a year. The mean annual relative humidity is 84%.

## VEGETATION

Remote sensing data in 1995 showed that 96.2% of the Park was forest-covered, 92.2% in primary forest, much of it badly damaged by fire during the American war. The flora is transitional between the northern and southern floristic zones of the country. Initial field surveys have so far recorded 2651 species of vascular plants in 511 genera and 152 families (in 1997). The area is a centre of endemism: 13 species are endemic to Vietnam, and one, *Hopea hongayanensis* (CR) is endemic to the site. There are 38 species listed in the Red Data Book of Vietnam Plants and 25 species were listed in the IUCN Red List of Threatened Plants in 1997. But new species are continually being discovered.

The forest covers 110,500 ha, mainly in the north and centre of the site, covering most of the limestone of the Park. This dominant cover ( $\pm 75\%$  of the whole) is a dense wet tropical evergreen lowland forest on rock, followed by much smaller areas of the same on rock above 800m ( $\pm 8.5\%$ ) and below 800m on soil ( $\pm 8.3\%$ ). The upland forest grows on rough towers of karst along the narrow limestone range on the Vietnam-Laos frontier. The lowland non-karst forest grows on low hills of sandstone, schist and acidic granite with a relatively moist thick soil with surface streams. There is also a notable dense 50 sq.km forest on limestone of about 2,500 *Calocedrus rupestris* (EN) and *Calocedrus macrolepis* (VU) trees. It is the largest such forest in Vietnam, and most of the trees are 500–600 years old. Other vegetation types include relatively small areas of grasses and scrub on both limestone and soil, permanent wetland forest, rattan and bamboo forests. There is also some agricultural land.

The forest contains giant buttressed trees up to 50m high with woody climbers, a canopy layer and understorey. The commonest species are *Hopea hainanensis*, *Sumbaviopsis albicans*, *Garcinia fragraeoides*, *Burretiodendron hsienmu*, *Chukrasia tabularis*, *Photinia aroboreum* and *Dysoxylum saletti*. In the thin well-drained soil seedlings can grow only in crevices and holes in the limestone where soil has accumulated, so growth is stunted and regeneration after disturbance is slow. The evergreen forest on soil has scattered deciduous trees such as *Dipterocarpus kerri*, *Anogeissus acuminata*, *Pometia pinnata* and *Lagerstroemia calyculata*. The dominant plant families are the Lauraceae (48 species), Fagaceae, Theaceae and Rosaceae, with Orchidaceae (24 species) of which the rare *Paphiopedilum dianthum* (EN) is one. There are also scattered gymnosperms such as *Podocarpus imbricatus*, *P. neriifolius*, and *Nageia fleuryi*. The 13 endemic species of tree are: *Burretiodendron hsienmu*, *Cryptocarya lenticellata*, *Deutzianthus tonkinensis*, *Eberhardtia tonkinensis*, *Heritiera macrophylla*, *Hopea hongayanensis* (CR), *Illicium parviflorum*, *Litsea baviensis*, *Madhuca pasquieri* (VU) *Michelia faveolata*, *Pelthophorum tonkinensis*, *Semecarpus annamensis* and *Sindora tonkinensis*.

## FAUNA

The fauna of the Park is typical of the limestone karst forests of the Annamite mountains. 735 vertebrate species were recorded by IUCN in 2011: 132 mammals, 338 birds, 96 reptiles, 45 amphibians and 124 fish. Mammals include Asian elephant *Elephas maximus* (EN), Asiatic wild dog *Cuon alpinus* (EN), Indochinese tiger *Panthera tigris corbetti* (EN), Himalayan black bear *Ursus thibetanus* (VU), Malayan sun bear *Helarctos malayanus* (VU), giant muntjac *Muntiacus vuquangensis*, Sumatran serow *Capricornis sumatraensis* (VU), gaur *Bos gaurus* (VU), and the secretive antelope-like saola *Pseudoryx nghetinhensis* (CR) only discovered in 1992. The site is particularly rich in primates, with ten species and subspecies, forming 45% of the total living in Vietnam. These include three primates endemic to Indochina: the red-shanked douc langur *Pygathrix nemaeus* (EN), red-cheeked gibbon *Nomascus gabriellae* (EN) and Bengal slow loris *Nycticebus bengalensis* (VU). Other primates are the black-crested gibbon *Nomascus concolor* (CR), northern white-cheeked gibbon *N. leucogenys* (CR), pygmy slow loris *Nycticebus pygmaeus* (VU), northern pigtailed, stump-tailed, Assam and rhesus macaques *Macaca leonina* (VU), *M. arctoides* (VU), *M. assamensis* and *M. mulatta*. The area has important endemic populations of Hatinh langur *Trachypithecus hatinhensis* (*ebenus*) (EN) and Francois's langur *T. francoisi* (EN). These are the largest populations in Vietnam and probably the only ones living in a protected area. Other smaller mammals include Sunda pangolin *Manis javanica* (EN), smooth-coated otter *Lutrogale perspicillata* (VU), Owston's civet *Chrotogale owstoni* (VU) and the recently discovered Annamite striped rabbit *Nesolagus timminsi*. Ten species of bat are listed in the IUCN List of Threatened Species.

The area is part of both an Endemic Bird Area and an Important Bird Area. 15 species are listed in the Vietnam Red Data Book and 20 in the IUCN Red List of Threatened Species. They include five species of pheasant: Vietnamese pheasant *Lophura hatinhensis* (EN), Edward's pheasant *L. edwardsi* (EN), Siamese fireback *L. diardi*, imperial pheasant *L. imperialis* and crested argus *Rheinardia ocellata*. There are also four hornbills, including wreathed, rufous-necked, brown and great hornbills *Aceros undulatus*, *A. nipalensis* (VU), *Anorrhinus tickelli* and *Buceros bicornis*. Other uncommon birds are the chestnut-necklaced partridge *Arborophila charltonii*, red-collared woodpecker *Picus rabieri*, green peafowl *Pavo muticus* (EN), the recently rediscovered endemic sooty babbler *Stachyris herberti*, short-tailed scimitar babbler *Jabouilleia danjoui* and the endemic bar-bellied pitta *Pitta ellioti*. Of the 59 recorded reptile and amphibian species, 18 were listed in the Vietnam Red Data Book and 6 listed in the 1997 IUCN Red List of Threatened Species. Among these are the Chinese three-striped box-turtle *Cuora trifasciata* (CR) and keeled box turtle *Cuora mouhotii* (EN). The 72 fish species quoted in the nomination include four locally endemic including *Chela qaungbinhensis*, but 162 further species have subsequently been found (Clarke, 2004). 259 butterfly species in 11 families are recorded. Considerably higher numbers for all animal species may be quoted since undescribed specimens of both flora and fauna are regularly discovered, for instance the geckos *Certodactylus phongnhakebangensis* in 2002 and *Lygosoma boehmei* in 2005.

Phong Nha-Ke Bang National Park, with the neighbouring Him Namno Biodiversity Conservation Area in Laos, is one of the largest remaining areas of intact forest habitat on limestone karst in Indo-China. The site is of basic importance to understanding the geological and geomorphological development of the region. The presence of tall lowland forest, a regionally threatened habitat type, increases the site's conservation value and the accompanying wildlife is very rich. The Park lies within a Conservation International-designated Conservation Hotspot, a WWF Global 200 Eco-region and a BirdLife-designated Endemic Bird Area.

## CONSERVATION VALUE

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## CULTURAL HERITAGE

Neolithic axe heads and artefacts have been found in some of the caves. The Phong Nha Cave has long been a site of religious importance and was a place of muslim worship in the ninth and tenth centuries. An old Champa era Temple was also discovered in the cave. In 1550 Duong Van An was the first author to leave a record of the Cave, and on one of the dynastic urns at Hué, the area was depicted as one of the great landscapes of Vietnam. At Maria Mountain in the north of the Park, there are some relics of Ham Hghi the last king of the Nguyen dynasty before the French colonial period. During the anti-colonial wars, the forest and caves were used as a refuge and a base. Until recently two small groups of indigenous hunter-gatherer people inhabited the caves or the forest living on hunting and forest products of which they have intimate knowledge. They used simple tools and their clothes were made from the bark of a toxic forest tree *Antiaris toxicaria* and lianas. They are familiar with a number of economically valuable species, such as the precious timbers *go mun* ebony *Diospyros mun* (CR), *go hue* *Dalbergia mammosa* (EN), oil-yielding species like *tau* *Hopea hainanensis* (CR) and *Cinnamomum balansae* (EN) and many medicinal plants.

## LOCAL HUMAN POPULATION

People from two indigenous groups, the Ma-Coong of the Van Kieu group and the Ruc of the Chut group currently live in two villages in the core zone, Arem and Yen Hop (59 households of Ruc). They number about 475 people and are the two smallest ethnic groups in Vietnam. In 1992 the Government of Vietnam set up two new settlements for them. Within the buffer zone there was in 2008 a total population of some 52,000, 83% being from the Kinh, the country's majority ethnic group. Population growth in the region is rapid and poverty is widespread, with many people dependent upon the exploitation of forest products as part of their livelihoods. But some 1,000 local people have been employed in the tourist industry around Phong-Nha.

## VISITORS AND VISITOR FACILITIES

The Phong Nha Cave has long been a place of religious and touristic importance to the people and one of the most visited sites in Vietnam. The Trading and Tourism Department of Quang Binh province is responsible for tourism in the site. Visitor numbers have increased each year from 1,000 in 1993, 5,000 in 1995, including 200 foreign tourists, to 28,000 in 1997, including 1,900 foreign tourists. In 1999 there were 80,500 domestic visitors and 900 international visitors. Phong Nha is the principal attraction, with teams of boatmen taking people 1,500m into the cave. The beautiful Thien Duong cave, discovered in 2005, is also partly open to visitors, but many caves are closed because of the danger to tourists. Adventure river tours and ecotours are offered, also mountain climbing and trekking. At the time of nomination there were 8 vehicles of 4 to 15-seat capacity for tourist transportation, a guest house with 20 rooms near the Xuan Son ferry where boats leave for the cave and 280 international standard hotel rooms in the province. The forest guards of Son Trach commune in Bo Trach district provide security. There is a new small plane airport nearby.

## SCIENTIFIC RESEARCH AND FACILITIES

The cave system has long been known to the people and was explored by westerners from the late 19th century on. From 1990 onwards, extensive research and surveys of the system were conducted, originally under the leadership of H. Limbert from the British Cave Research Association in co-operation with the Faculty for Geology and Geography of Vietnam National University. Speleological expeditions by this group were also made in 1992 and 1994. In 1991 the Forest Inventory and Planning Institute (FIPI) surveyed the area's vegetation cover, flora, fauna and socio-economic characteristics in preparation for a management plan for the Reserve. Between 1991 and 1995 a survey of primate species was made by a group of scientists from FIPI and Xuan Mai Forestry College. From 1996 to 1997 research on the biodiversity of Phong Nha led to a symposium on biodiversity conservation along the Laos-Vietnam frontier. Further surveys of the bird and mammal fauna were made by a team of scientists organised by Fauna and Flora International in 1998, to assess the conservation importance and priorities of the National Park. In 1999 scientists from the Vietnam-Russia Tropical Centre also conducted zoological and botanical surveys in the Ke Bang area. As part of a new management

program for the National Park, a research unit was established in 2003. Research on the area's biodiversity and cave systems continues and new caves and new species of both flora and fauna are regularly found. Cave exploration is curtailed by the dangerous conditions but in 2009 it culminated in the discovery of the Son Doong cave, the world's largest, at present open to scientists only; 20 more caves in a system of 56 km were also discovered then.

## MANAGEMENT

At the national level management of the Park is the responsibility of the Forest Protection Department of the Ministry of Agriculture and Rural Development. Direct responsibility for Park management lies with the Phong Nha-Ke Bang Management Board, under the jurisdiction of the People's Committee of Quang Binh Province. This was created in 2000 to implement the management plan of the National Park which superseded that created for the Nature Reserve in 1993. One section of the Board oversees forest resources and biodiversity protection. It also conducts awareness raising and educational programs with the local authorities and people, and implements programs such as rare orchid cultivation to raise the standard of living of people in the buffer zone. The conservation of cave systems, historical relict landscapes and the developments of tourist services are entrusted to the Phong Nha Historical Relict and Landscape Management Board. The local people do not otherwise participate in Park management. In 1998, a Transboundary Biodiversity Protection Plan was initiated between Laos (Hin Namno Reserve) and Vietnam which could eventually preserve a vast 315,000 ha area of forested karst. The neighbouring provincial authorities of both countries have met many times to discuss co-operative management of the two reserves.

The National Park is included in the Master Plan for economic development in Quang Binh Province for 1997-2010. This included an Investment Plan which has elements of a management plan but was not very detailed (People's Committee, 1999). It included maps and classifications of the ten forest types and cultivated land, a geomorphological map, land uses and zoning. The three zones are: the Strictly Protected zone (about 76% of the area), Ecological Recovery zone (20%) for the regeneration of destroyed forest, and Administrative & Service zone (4%) (People's Committee, 1999). Protection of the watershed to prevent floods in the coastal plain is also very important. The Investment Plan for the National Park includes Programs for Protection, Forest and Wildlife Regeneration, Education & Scientific Research, Infrastructure, Tourism & Education and a Socio-economic Program. These Programs cover activities such as the construction of a Park Headquarters and guard stations, equipment for staff, reforestation, research on threatened wildlife, training of staff and guides, and resettlement and provision of health and education services to the Ruc and Ma-Coong peoples.

## MANAGEMENT CONSTRAINTS

Although the human population density of the National Park is low, its natural resources are under great pressure from the expanding population surrounding it. One of the principal threats to its wildlife is the intensive hunting needed to meet the very high local demand for wild meat, with the consequent decline of species such as wild pig, binturong and primates. This threat has been somewhat reduced through the confiscation of guns but low funding for staff has limited the control of poaching for the live wildlife trade. Illegal timber extraction is a widespread problem, particularly for valuable species such as *go mun* ebony, *go hue* woods and trees used in the extraction of essential oils. Exploitation of rattan is reported to have exhausted this product in several areas. Limestone quarrying is not controlled. Forest burning and clearance by cultivators and hunters has affected many areas near villages. Although bat populations are under no immediate threat, caves and roosting areas are frequently disturbed by human activities. Protective procedures and regulations for the buffer zone are lacking.

Regulation by the provincial authorities of opportunistic commercial activities in the buffer zone is not very effective. But economic development projects in the zone are promoted to reduce the pressures on the Park, and some of the Ma-Coong and Ruc ethnic peoples who live in the limestone caves and gather forest products have been encouraged to move into settlements. Another threat to the Park is the rapid expansion in visitor numbers and the attendant infrastructure, which is encouraged by the government as part of the development of the region. However, tourist facilities are scattered, and are not systematically planned. This development is centred on the Phong Nha Cave, where problems of

water pollution, rubbish and damage to biodiversity are increasing. Remedial measures include training for staff and tourist guides, bans on the use of motor boats and fuel lights in the caves, and establishing waste collection sites. A regular dry season threat to the forest is forest fires, which is being met by stronger fire control measures, education of the locals practising shifting cultivation, and a reforestation program. The lack of a completed management plan is emphasised by the omission of indicators for measuring the state of conservation of biodiversity and natural processes such as water quality.

A major threat to Park's integrity and its rare primate populations is a 24 km stretch of road through the core zone, dividing the main cave from the rest of the Park. This links Highway 20 with the Ho Chi Minh National Highway further south. Construction of the road involved blasting, destruction of forest, large-scale erosion causing sedimentation of rivers, and the alteration of river-flows. The work was completed during the evaluation of the site for World Heritage status. The first 12 km section follows the cliff-lined Chay River, which is the habitat of the largest known populations of Hatinh and black langurs which are restricted to this area and a few further spots in Laos. Measures are reported to have been taken to mitigate the negative physical and social effects (UNESCO, 2005).

### **COMPARISON WITH SIMILAR SITES**

Though there are several examples of tropical karst forest cave sites in southeastern Asia such as Gunung Mulu, and Puerto Princesa, their contexts are quite different. For biodiversity, Ujong Kulon and Lorentz National Park are richer. One other similar Natural World Heritage site in the same Indochinese Rainforest biogeographic province is the Thungyai-Huai Kha Khaeng Wildlife Sanctuaries in Thailand. This contains lowland mountain vegetation and fauna and karst formations, but Phong Nha-Ke Bang has far more impressive karst formations and cave systems, and the sites have few species in common. There is one other Natural World Heritage site in Vietnam at Ha Long Bay, a collection of over 1,600 limestone islands in the Gulf of Tonkin to the north.

### **STAFF**

For the period 2000-2005, the Phong Nha-Ke Bang Management Board had a total of 115 people. The Board is headed by a Director with two Deputy Directors, who supervise three sections, each having a Head. The Forest Protection Section had 94 staff with nine units with nine guards in each who provide site security. The Scientific Section has eight staff, comprising 2 zoologists, 2 botanists, 2 silviculturalists, and 2 socio-economists. The General Section with 10 staff provides administrative and logistical functions. The Culture and Tourism Management Team of 15 supports tourist services and manages cultural relics (People's Committee, 1999).

### **BUDGET**

Initial funding was provided mainly by the Government, and concentrated on establishing infrastructure such as offices and salaries. From 1993 to 1999 some 6,000,000,000 Vietnamese Dong ( $\pm$ US\$420,000) was invested. In Phase 2 an investment of 21,000,000,000 Vietnamese Dong ( $\pm$  US\$1,500,000) was planned. US\$100,000 has been allocated for improving the standard of living of local people in the buffer zone and reducing their impact on the National Park. Quang Binh provincial sources provide about US\$600,000 for tourism activities, with the sale of tickets to visitors and other tourist services providing revenues estimated at US\$100,000 per year. International donors provide funds for survey and research programmes, such as the US\$147,000 LINC project from the U.K. government. Between 2005 and 2007 the German government provided €14.2 million (US\$11.8 million) to improve protection, and FFI provided US\$132,000 for training in management and conservation awareness.

### **LOCAL ADDRESSES**

Forest Protection Department, Ministry of Agriculture and Rural Development, 2A - Ngoc Ha Ba Dinh, Hanoi, Vietnam.

Department of Conservation and Museology, Ministry of Culture and Information, 51 -53 Ngo Quyen - Hai Ba Trung, Hanoi.

Quang Binh Forest Protection Department

The People's Committee of Quang Binh Province, Dong Hoi, Vietnam.

Conservation and Museology Department of Quang Binh Province, Dong Hoi, Vietnam.

Department of Science, Technology and Environment of Quang Binh Province. Dong Hoi, Vietnam.

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## **DATE**

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