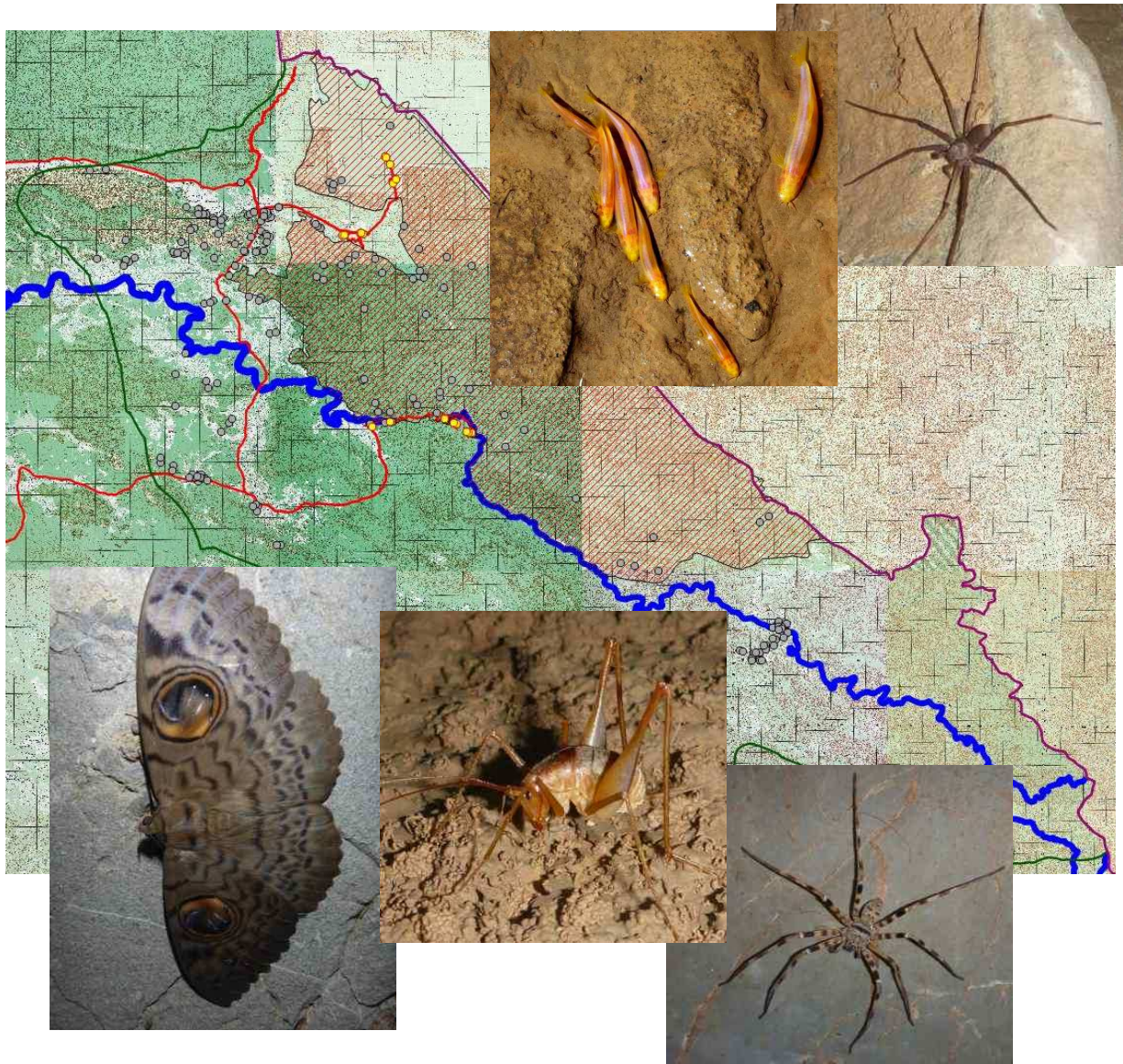


Hin Nam No Cave Biodiversity Study

Draft Report - May 2016



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Integrated nature conservation and sustainable resource management in the Hin Nam No region

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A. **Executive Summary**

Hin Nam No NPA is a 82,000 ha limestone landscape situated at the core of a continuous karst block stretching for more than 250km from the Mekong river plain to the coastal plain of Vietnam. A survey of the cave fauna of Hin Nam No NPA was conducted in February and March 2016, in order to contribute to the assessment of the Outstanding Universal Value (World Heritage Criterion x) of the NPA. A total of 9 caves were sampled manually, in the Tham Xe Bang Fai, the main target, baited traps were set in addition. A total of 1455 specimens were collected, comprising at least 27 orders in 10 classes.

The most important discovery was an eyeless cave fish, which is most probably new to science. It is the second cave fish known in the area, and the fourth cave fish of all Laos. The occurrence of *Bangana musaei*, the first cave fish, could be ascertained, including in one new location.

One of the character species of the caves in the NPA is the Cave Huntsman Spider *Heteropoda steineri*. It is the only *Heteropoda* known to show cave adaptations, and is endemic to the NPA. It co-occurs here with the more widely distributed *Heteropoda maxima*, the largest spider in the world.

Other flagship species of the area are the Giant Harvestman of the genus *Gagrella*, the scorpion *Troglokhammouanus steineri*, a living fossil and only known from the Tham Xe Bang Fai cave, cave crickets of the genus *Diestrammena*, which form the main prey of most predators, the large noctuid moth *Erebus macrops*. Further interesting findings are a pseudoscorpion, a trechine beetle and a schizomida. The specific determination for all of these is still pending.

Generally, the cave fauna of the Hin Nam No NPA is the most diverse in Laos and probably in mainland Southeast Asia as well. As far as identified, it contains a high percentage of endemic species, many charismatic and scientific significant species, constituting an Outstanding Universal Value for the area.

As far as the cave fauna is concerned, the Wholeness, Intactness and the Absence of Threats can be attested for the current state. The Integrity of the Outstanding Universal Value is thus given.

Large tracts of the NPA are uninhabited and inaccessible due to the lack of surface water. In all likelihood, they will remain in this state and thus protected for the foreseeable future. Access to other parts of the NPA is and will be upgraded. Here, development should be monitored closely to guard against detrimental effects. An educational effort as well as law enforcement against hunting of bats will be necessary, collecting for pet trade should be prohibited, and tourist development should be planned and controlled carefully. For the Xe Bang Fai Cave, a simple monitoring system is recommended.

Compared to other karst areas in Laos, Hin Nam No has clearly the most diverse cave fauna. While most elements known from other caves are present, the area also harbours many endemic species. Within the NPA, the Tham Xe Bang Fai system clearly sticks out as a biological hotspot, due to its size, its range of different cave habitats and also the coexistence and interrelation of its cave fauna and stream fauna elements.

Similarities to the cave fauna of Phong Nha-Ke Bang in Vietnam are obvious, since they belong to the same karst block, but the same niches seem to be occupied by different species, and some important endemites, like the cave fishes, are lacking in Vietnam. Overall, the biodiversity of Hin Nam No seems to be considerably higher.

A detailed study of the bat fauna, within and outside of caves, would be highly desirable, as well as further studies of the cave fauna.

B. Introduction

Objective: To survey and sample biodiversity in the caves of Hin Nam No National Protected Area. The information and knowledge obtained from this study will contribute to proving Outstanding Universal Value of Hin Nam No NPA in terms of its biodiversity and biological heritage (World Heritage Criterion x). In addition, the outputs from this project can serve as a basis for management of the caves in terms of conservation of their biodiversity richness, as well as the future use of some of the caves as tourism destinations.

Background: The Hin Nam No National Protected Area covers 82,000 ha of mainly limestone landscape in Boualapha District, Khammouane Province, in central Laos where the Central Indochina Limestone meets the Annamite Mountain Chain. The German Government supported Hin Nam No Project assists the Hin Nam No NPA authorities in developing a co-management system, where local communities share responsibilities for and share benefit from sustainable management of the biodiversity and geological resources in the NPA.

The Department of Forest Resource Management of the Ministry of Natural Resources and Environment is in the process of submitting a proposal to UNESCO to put Hin Nam No National Protected Area on the tentative list as the first Natural World Heritage Site for Lao PDR. The nomination as a World Heritage Site will contribute to the sustainable financing for Hin Nam No NPA which is an important component of the Hin Nam No project.

The proof for Outstanding Universal Value of Hin Nam No NPA is a key requirement to become a natural World Heritage Site. Outstanding Universal Values for Hin Nam No NPA have tentatively been identified for Criteria viii and x, including the caves and the biodiversity they contain. To be able to prove the Outstanding Universal Value of Hin Nam No NPA certain knowledge gaps needed to be addressed. One knowledge gap, to be addressed by this report, concerns the biodiversity in the caves of Hin Nam No NPA, and how the biodiversity of the cave fauna contributes to Outstanding Universal Value under World Heritage Criterion x: *“Contain the most important and significant natural habitats for in situ conservation of biological diversity, including those containing threatened species of Outstanding Universal Value from the point of view of science or conservation”*.

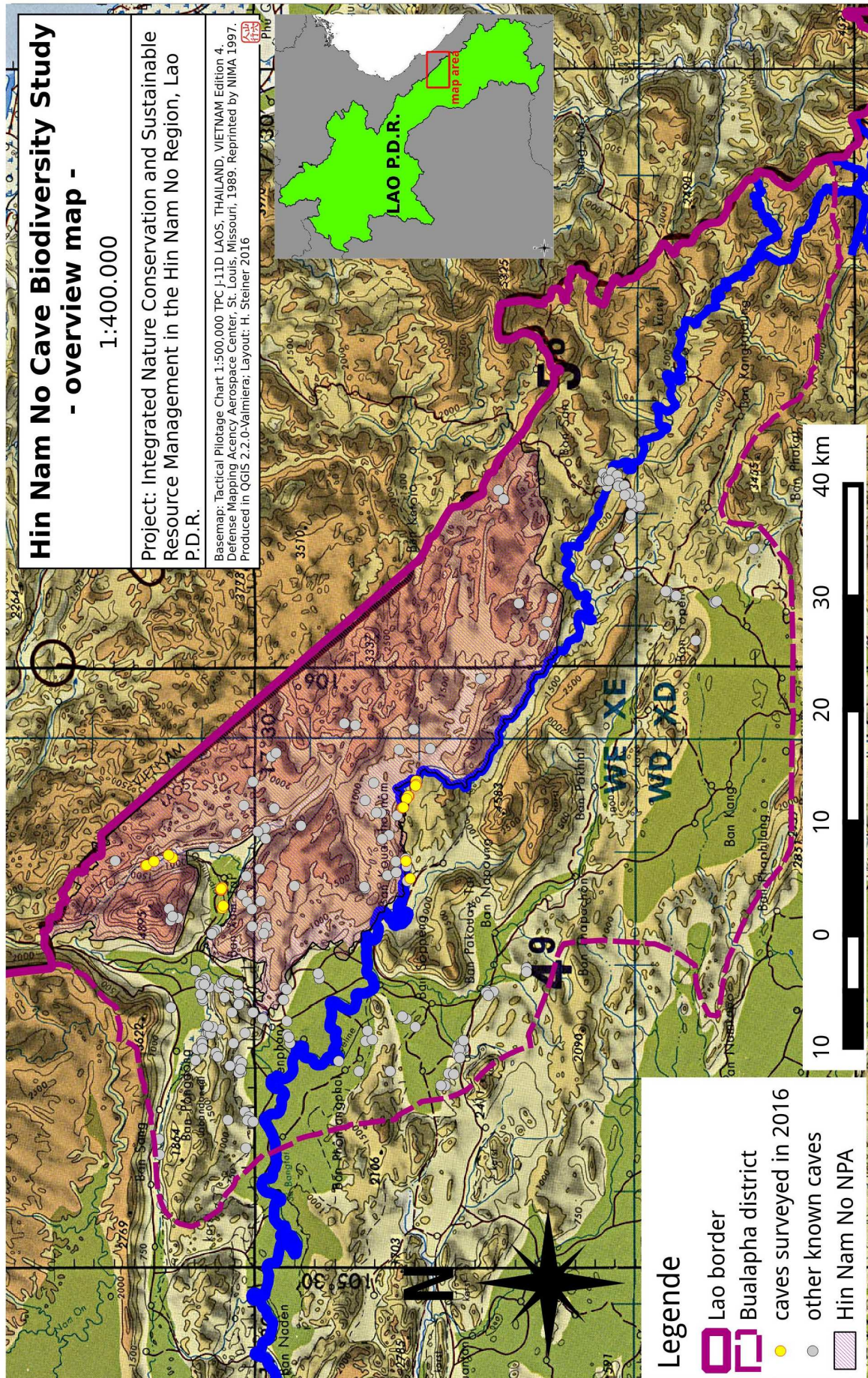


Fig. 1: Location of sampling sites within Bualapha district

C. **Sampling Program and Methods**

The field campaign was conducted during the period 22 February to 4 March, 2016, with the Xe Bang Fai area as main target and the area around Ban Dou in the Northern part of the Hin Nam No NPA as the secondary target. The following list shows the collection dates and surveyed caves.

Ban Nong Ping area:

- 22.02. Tham Xe Bang Fai – setting of traps
- 23.02. Tham Nguen; Tham Nguen Mai
- 24.02. Tham Nguen; Tham Nguen Mai
- 25.02. Tham Pha Pong
- 26.02. Grotte de Nuages, Tham Nguen
- 27.02. Tham Xe Bang Fai – collection of traps
- 28.02. Tham Long

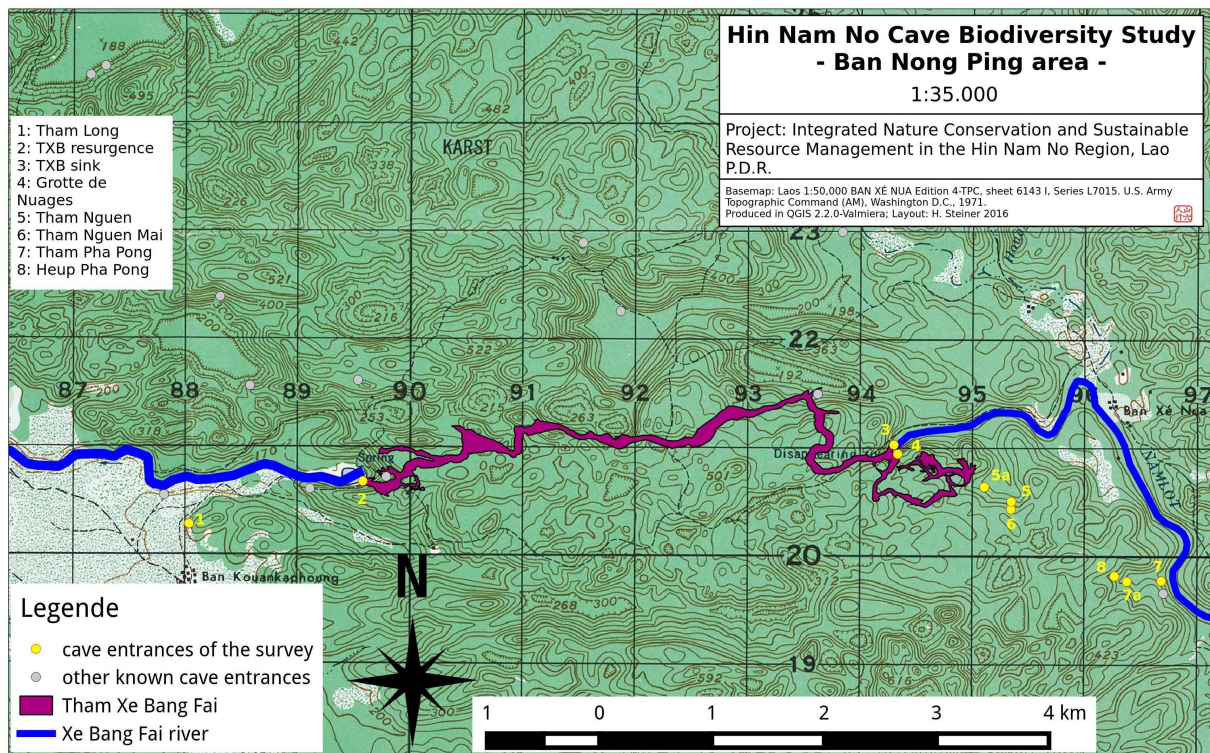


Fig. 2: Sampling sites in the Ban Nong Ping area

Ban Dou area:

- 01.03. Tham Pha Hom
- 02.03. Tham Pak Tham, Tham Nok Aen, Tham Nam Ock, Vietnamese Cave
- 03.03. Tham Nam Ock, karst spring
- 04.03. Tham Pha Kout 1, Tham Pha Kout 2, Tham Pha Hom



Fig. 3: Sampling sites in the Ban Dou area

The sampling was done by the author and Josiane Lips. With two collectors, sampling in all caves was guaranteed, even in cases where two teams mapped different caves simultaneously.

The following sampling techniques were employed:

-- hand collection

Direct search of the different cave habitats and hand collection is still the most efficient method to sample a cross-section of the invertebrate fauna. A certain experience and “search image” is necessary to find the animals, and for some groups (spiders, crickets) some skills to actually catch them. Catching techniques vary from group to group and range from simply picking up by hand via forceps, brushes, catching with a container to the use of nets and shooting with rubber bands.

-- photographic evidence

Vertebrates other than fishes have not be caught, for conservation reasons. Whenever possible, a series of detailed photographs have be made, which will allow a tentative identification.

-- collection of bat skulls

Bats (and other mammals) can be well identified by their skulls. Thus the skulls from skeletons or dead bats found on the ground were collected.

-- setting of traps (Tham Xe Bang Fai only)

A standard method for monitoring of cave fauna is the use of Barber traps. These are simple pitfall traps buried in the ground and filled with a preservative fluid. Their impact on the cave ecosystem is low, since they have hardly any attraction effect and catch only animals which happen to pass over the trap. For the same reason, their selectivity is low.

The use of baited traps requires careful consideration, since they attract animals over some distance, and are thus able to cause a severe loss of cave fauna. However, reasonable catching times for Barber traps are starting around two weeks, up to a year. Within the short time frame of this survey, baited traps were necessary and justifiable. The short trapping time of only 5 days prevented any significant loss of cave fauna, furthermore, the number of traps were low compared to the total size of the cave. Survey times in the other caves were too short to expect meaningful results from traps.

A total of 6 pitfall traps baited with hard cheese and anchovies were set, distributed over the length of the cave. In the same location, a bottle trap baited with hard cheese and anchovies was placed in the water.

On a more experimental scale, a single funnel trap was placed in one of the rapids inside the cave, and two net traps baited with cheese were placed in pools at one location.

Generally, there is no perfect method for monitoring cave fauna. All methods are selective to a larger or lesser degree. Hand collection favours large, conspicuous and active animals, the range of fauna collected depends strongly on the experience of the collector. Pitfall traps favour groundliving animals and animals that move a lot. Baited traps favour scavengers and animals searching for organic matter. Both are more consistent in the range of animals collected, although experience in placing the traps play a role.

The main emphasize has been on the terrestrial cave fauna. Water fauna, however, has been sampled as well, although with a lesser search effort. Since the river is allochthonous, most of the aquatic fauna is expected to be washed-in surface fauna.

Samples have been processed in the following way:

- Fixation and preservation in alcohol in the field, field labelling of the samples.
- Sorting & preliminary identification under a stereomicroscope at home.
- Data input into a computer database
- Computer labelling and separate storage in containers suitable for shipping
- Shipping to known experts for identification, search for additional experts (ongoing)

D. *Outstanding Universal Value*

During the 11 sampling-days, a total of 1459 specimens have been collected by the two collectors. The samples contain approximately 218 different taxa from 16 classes and 34 orders. The preliminary taxa list is given in Appendix 1. 19 taxa are identified to genus level, for most taxa the identification is still pending. The survey covers 11 locations in 9 different caves. Tham Xe Bang Fai, the Grotte de Nuages and Tham Nguen are all part of the Xe Bang Fai cave system, but are considered separately in this report.

Some of these caves, as well as some other caves of the area not covered by this survey, have been sampled by the author in 2007 and 2008. A list of those results is given in Appendix 2. A limited survey was done in 2012 by the Senckenberg Museum Frankfurt (P. JÄGER, pers. comm.), and surveys especially on scorpions by the American Museum of Natural History in 2012 (L. PRENDINI, pers. comm.) and in 2014 by the University of Wisconsin (SHARMA (undat.)). However, as yet no published results are available from these. In total, 83 taxa from 24 orders were recorded from the area. About 43 of these taxa and 1 order have to be added to the numbers of the present survey. Thus, the complete cave fauna of Hin Nam No and adjacent caves known so far amounts to 261 taxa from 37 orders and 16 classes. 37 of the taxa are identified to genus level.

By far the most specimens and taxa were collected in the Tham Xe Bang Fai system. This is not only due to the higher sampling effort in this cave, but reflects the far greater biodiversity of this cave.

A good part of the so far identified species are endemic, the new cave fish, the scorpion, the spiders *Psechrus steineri* and *Pholcus Bang Fai* for a single cave, the cave fish *Bangana musaei* for two caves, the Cave Huntsman Spider *Heteropoda steineri* for Hin Nam No NPA and the Giant Huntsman Spider *H. maxima* for Khammouan Province.

Charismatic species, in the sense that they are able to draw public attention, are the blind cave fishes, the Giant Huntsman Spiders (“largest spider in the world”), the Giant Harvestman and the scorpion (“living fossil”). The noctuid moth *Erebus macrops* belongs in the same category, for its size and beauty.

The largely intact bat fauna deserves a further mention, which is severely threatened elsewhere in Laos.

Flagship species:

Cave Fish *Bangana musaei* (Family Cyprinidae). This white, blind fish of the carp family is only the third known cave fish from Laos. Discovered in 2007, it is known only from 2 caves, thus endemic to the immediate Tham Xe Bang Fai area (KOTTELAT & STEINER 2010). Due to its very restricted distribution, it is listed in the IUCN red list as "vulnerable". During the 2016 survey, a new location within one of these caves was found.



Fig. 4: *Bangana musaei* in Tham Nguen (photo J. Lips)

Cave Fish *Schistura* or *Nemacheilus* n.sp. (Family Balitoridae). An eyeless fish of the loach family was found in a dripwater pool in Tham Nguen Mai. It is almost certainly a new species and will be the fourth known cave fish from Laos (M. KOTTELAT, pers. comm.). Interestingly, its location is in between the caves containing *B. musaei*.



Fig. 5: *Schistura* or *Nemacheilus* sp. in Tham Nguen Mai (photo J.-M. Ostermann)

Cave Huntsman Spider *Heteropoda steineri* (Family Sparassidae). This slender, uniformly brown spider is the only *Heteropoda*-species with clear cave adaptations, among others reduced eyes (Bayer & Jäger 2009). It was so far only known from the immediate surrounding of Tham Xe Bang Fai, but was found during this survey in Tham Nam Ock, in the north of Hin Nam No. Thus it seems to be endemic for the whole of Hin Nam No NPA. It can be regarded as the characteristic species for the caves of Hin Nam No.



Fig. 6: *Heteropoda steineri* in Tham Xe Bang Fai (photo H. Steiner)

Giant Huntsman Spider *Heteropoda maxima* (Family Sparassidae). This impressive spider has been admitted into the Guinness Book of Records as the largest spider in the world. It is endemic for Khammouan Province, but is common in the caves of the province. In contrast to *H. steineri*, it has large eyes, whose blue eyeshine can be seen from a few meters distance, and a dark- and light brown patterned body and legs. Breeding females carry a conspicuous white egg-pad around.



Fig. 7: *Heteropoda maxima* in Tham Pha Hom (photo H. Steiner)

Hin Nam No NPA is the only area in Laos where two *Heteropoda* species occur in caves. *H. steineri* is usually found in larger caves, *H. maxima* favours smaller caves and large rock shelters. In caves where both species coexist, *H. steineri* is usually found deep inside the cave, *H. maxima* is restricted to the entrance area.

Giant Harvestman *Gagrella* n.sp. (Family *Sclerosomatidae*) Longlegged harvestmen are common in dark and damp niches in the entrance areas and small caves, where they often form mass aggregation. Several species were found, the still undescribed species of *Gangrella*, collected by Peter Jäger of the Senckenberg Museum, made it into online Newspapers and Magazines because of its impressive legspan of 30cm (e.g. Miller 2012, Senckenberg 2012).

Scorpion *Troglokhammouanus steineri* (Family *Pseudochactidae*): This scorpion, discovered in 2007, was the second species of an up-to-then monotypic family from Central Asia. It is regarded as a living fossil and so far only known from Tham Xe Bang Fai itself (LOURENÇO 2007). Only a few specimens have been found in 2007 and 2008, and during the present survey it was not encountered.

Cave Crickets of the genus *Diestrammena* or a closely related genus are another characteristic species of Lao caves. They are common, virtually found in any cave, and probably constitute the main prey of all but the smallest predators. The crickets themselves are fungus feeder, an abundant food source on all organic material in the caves.



Fig. 8: Cave Cricket in Tham Nguen Mai (photo H. Steiner)

Bats are the animals foremostly associated with caves by people. At least in the Western World, they have made in recent decades the transition from a hated, demonic animal to a people's favorite. Since the study of bats requires specialized techniques and equipment, they are usually underrepresented in cave fauna surveys. The following species have been recorded from caves of the Hin Nam No NPA: *Rousettus amplexicaudatus*, *Rousettus* sp., *Taphozous theobaldi*, *Megaderma lyra*, *Rhinolophus thomasi*, *R. pearsonii*, *Hipposideros pomona*, *H. diadema*, *H. armiger*, *H. pratti*, *Aselliscus stoliczkanus*, *Myotis siligorensis*, *Kerivoula hardwickii* (Steiner 2010, Thomas et al. 2013).



Fig. 9: *Aselliscus stoliczkanus* in Tham Nguen Mai (photo H. Steiner)

Side by side with the bats, the walls and ceilings of the entrance hall of Tham Xe Bang Fai are populated by Germain's Swiftlet *Aerodramus germani* (Family Apodidae).

Noctuid Moth *Erebus macrops* (Family Noctuidae). This large and showy moth, wing span around 15cm, and two conspicuous eye-spots on the forewings, has often been observed in caves and bunkers of Northern Laos. It is recorded here for Khammouan Province the first time. It doesn't show any morphological adaptations to cave life, but has been found too regularly in the entrance areas of caves to be regarded as a mere accidental visitor.



Fig. 10: *Erebus macrops* in Tham Pha Hom (photo H. Steiner)

Other identified species:

A couple of species have been identified or described from the caves of Hin Nam No NPA, where little else is known.

Spider *Alaria cavernicola* (Family Theridiosomatidae), endemic for Khammouan and Bolikhamsai (Lin et al. 2014)

Spider *Psechrus steineri* (Family Psechridae). Only known from Tham Bing (Xe Bang Fai system) (Bayer & Jäger 2010).

Daddy-long leg spider *Pholcus bangfai* (Family Pholcidae). Only known from Tham Xe Bang Fai (Huber 2011).

Cockroach *Rhabdoblatta memnonia* (Family Blaberidae). Found in Tham Peung, other specimens from epigeal locations in Vietnam (Anisyutkin 2009).

Cockroach *Ergaula* sp. (Family Polyphagidae). Found in Tham Bing, where it is abundant burrowing in the guano.

Longlegged Centipede *Thereuopoda longicornis* (Family Scutigerae), common in caves of SE Asia, eutroglophil (Senckenberg (undat.)).

Shrimp *Macrobrachium dienbienphuense* (Family Palaemonidae), a common freshwater shrimp of Indochina. It is a typical element of the stream fauna entering Tham Xe Bang Fai.

Frog *Kalophrynus interlineatus* (Family Microhylidae) (Stuart 2005). Probably an accidental visitor.

Species expected to be of interest:

Trechine Beetles (Family Carabidae, subfamily Trechinae). One species of the Trechinae was collected, which doesn't have any eyes. Many known trechine beetles are specialized in subterranean habitats and tend to be endemic to their caves or areas.

Pseudoscorpion (Order Pseudoscorpionida). A single pseudoscorpion was found during the survey. This is the first one found in caves of Hin Nam No NPA. Pseudoscorpions are part of the cave fauna in most parts of the world.

Schizomida (Order Schizomida): This is a small order within the class of Arachnids. We haven't found schizomids in caves anywhere before. These here were found in accumulated flood debris.

E. Statement of Integrity

Hin Nam No NPA is at the core of a continuous karst block stretching for roughly 250km from the Mekong river plain at the Thai border to the coastal plain of Vietnam. All types of tropical cave habitats, from rock shelters to large and complex cave systems, from dry, fossil caves to active river caves, as well as all micro-habitats within the caves, are found within the NPA. Thus the cave fauna typical for central Laos is expected to reach its most complete and diverse state in the Hin Nam No NPA. The cave fauna recorded in 2007, 2008 and 2016 - although far from complete - already shows a very high diversity. All typical elements known from other caves in Khammouan are present, plus a wide range

of endemic elements. The *Wholeness* of the cave fauna can thus be attested with a high degree of certainty.

The caves of the NPA are largely undisturbed, due to the remoteness of the area, and, in the case of Tham Xe Bang Fai, the sheer size of the cave. No signs of bat hunting - a rampant problem in the rest of Laos, were seen. In Tham Xe Bang Fai, the height of the cave - 60 to 80m - and the location of the bat colonies above the river prohibits hunting of the bats. Tourism at Tham Xe Bang Fai is still too new for a possible impact on the cave fauna.

No decline in the cave fauna between 2007/2008 and 2016 has been noted. The *Intactness* of the cave fauna can therefore also be attested with a high degree of certainty.

Principally, there are three kinds of threats to cave faunas: 1) direct persecution by hunting, fishing and collecting, 2) impact on the cave habitat by touristic and other uses of the cave, including guano mining, and 3) impact of the surrounding habitat, and watershed.

Due to the remoteness of the NPA until recently, the lack of roads and villages, impact on the surrounding habitat has been minimal, caves have not been used in any way, and hunting of bats has probably been negligible. Tham Xe Bang Fai, the most accessible of the caves, has traditionally been a fish sanctuary, prohibiting fishing in the pool at the entrance, and also within the cave. Hunting of bats is prevented by the sheer height of the cave. In the last years, access to the area has been upgraded, and the touristic use of Tham Xe Bang Fai has steadily increased. However, tourism development has been under the guidance of the Hin Nam No project, a study on possible impacts has been conducted, and development inside the cave has been carefully designed.

The three caves Tham Nam Ock, Nok Aen and Pak Tham in the northern part of Hin Nam No NPA are the subject of low-intensity trekking, other caves within the NPA are currently not used for tourism. Large parts of the NPA are still as good as inaccessible, due to the lack of villages, tracks, and, most of all, surface water. Caves there are naturally well protected. For the current status, *Absence of Threat* can be testified for the Hin Nam No NPA.

F. State of Conservation and Requirements for Protection and Management

As stated above, the cave fauna of the Hin Nam No NPA is currently not under threat. Large tracts of the NPA are devoid of any surface waters and thus unpopulated and unused by man. In all likelihood, they will remain in this state for the foreseeable future. For other parts of the NPA, access is and will be improving, with some forms of development following. Here, future development should be observed closely and, if necessary, corrective measurements taken as early as possible. Especially all development upstream of the Tham Xe Bang Fai which might influence the flood regime, lowers the water quality or affects the ecology of the river has to be seen as critical.

Hunting of bats: Bats are too small a prey to warrant long hunting expeditions, however, with easier access and diminishment of larger prey, the impact will spread further from the villages. On the plus side, development will reduce the

need for bat hunting as a source of protein. Unfortunately, better nourishment doesn't stop hunting. People have a taste for wild meat, and wildlife starts being traded. However, once hunting is no longer driven by hunger, there is a chance for education and enforcement of laws to take effect. Both are urgently needed in the case of bats, since most accessible caves in the rest of Laos have lost most of their bats.

Tourism: Currently, touristic use of the Xe Bang Fai Cave is done in a way compatible with conservation. It should be ascertained, that these standards are kept up in the future, and are extended to other caves entering into touristic use. Tours into the cave should be under the control of a responsible body, the use of own boats and strong car-battery powered lights, as observed during our survey in one Thai group, should be strongly discouraged. We don't know whether the group was accompanied by a local guide, but supervision of the group under these circumstances will be difficult for a guide. Bringing one's own craft is usually motivated by the desire to get away from other groups and reaching places not frequented by ordinary tours. This way, the impact on the cave is also multiplied. More provisions might be brought into the cave, leading to more garbage. The use of an engine increases the reach of a group, furthermore, a direct or indirect impact of the propeller on the aquatic fauna cannot be ruled out. The impact might be small, however, there is no need for it. Using strong searchlights will clearly affect the cave fauna, especially the bats and swiftlets will be sensitive to lighting up the ceiling. All this might be tolerable in a single instance, however, if the example spreads, an unsupervised cave tourism may develop.

If tourist numbers and tours into the cave are greatly increasing, as expected, the setup and conditions of tours and their possible impact should be reviewed.

Further development in the immediate vicinity of the downstream entrance should be discouraged.

Collection of animals for the pet trade should be prevented. *Heteropoda maxima* as the largest spider of the world has already been offered for sale. The cave fishes are other likely targets. The presence of the cave fishes should be publicized as little as possible, their exact location not at all.

In Tham Xe Bang Fai, some form of monitoring should be established, as an early-warning system for detrimental effects of touristic use. Suitable indicator species are the Cave Huntsman Spider *Heteropoda steineri* and the cave crickets. Both are common in the cave, easily seen and identified. The cave crickets are important as the food base of most of the predators, thus their abundance affects the whole cave ecosystem, the Cave Huntsman Spider as top predator is especially sensitive to changed conditions. Monitoring could be done by the tour guides on a regular basis at a fixed location, e.g. the way up to the balcony. It could be well combined with education of the visitors about the cave fauna.

The numbers of bats and swiftlets in the downstream entrance area are another good indicator, although a quantitative monitoring is difficult to achieve. At least a subjective estimate by the guides should be recorded regularly.

G. **Comparative Analysis**

Comparing the biodiversity of the cave fauna between different areas or caves is a difficult task, since little data exist of other areas, and no quantitative data exist at all. All collections have been purely qualitative, and the numbers of specimens and species are biased by sampling effort. The evaluation of the differences in biodiversity within Laos is thus mainly based on experience from collecting cave fauna over 14 years.

Compared to other karst areas in Laos, Hin Nam No has clearly the most diverse cave fauna. Most elements known from other caves are present, although they may be substituted by closely related species endemic for the area. The Huntsman Spiders are a prime example, there are four species found in caves in Laos, *Heteropoda simplex* in northern Laos, also known from Japan, *H. aemulans* in the karst of Vang Vieng (endemic) and *H. maxima* in all Khammouan (also endemic). Hin Nam No is the only area in Laos, where two cave species of *Heteropoda* coexist, with *H. steineri* being endemic to the NPA. This leads already to the second statement, in addition, the caves of the NPA also harbour many endemic species. The cave fishes are an example. Another important factor are the bats, which are seriously depleted in most caves outside of the NPA.

Within the NPA, the Tham Xe Bang Fai system clearly sticks out as a biological hotspot, showing by far the greatest diversity. This is for one due to its large size, for another due to its range of different cave habitats. The main tunnel is a river cave habitat, although in size only comparable to Tham Kong Lor. Tham Nguen and parts of the Grotte de Nuages are regularly flooded habitats, partly covered in clay, while other parts of the Grotte de Nuages and Tham Bing are dry rock habitats. Tham Bing in addition harbours a larger bat colony with its associated guano society. What sets the Xe Bang Fai system apart is that a large allochthonous river enters the cave, carrying with it its typical stream fauna, like fishes, shrimps, but also larvae of may flies, caddy flies and dragon flies. These hatch within the cave and coexistence and interact with the typical cave fauna. The stream fauna not only adds its biodiversity, it probably also allows a greater diversity of the cave fauna element by offering an additional food source and additional niches.

A comparison with the cave fauna of the Phong Nha-Ke Bang National Park, situated in the Quang Binh province of central Vietnam, offers itself. Phong Nha-Ke Bang NP was inscribed on the UNESCO World Heritage list in 2003 for its outstanding geomorphological features. In 2015, an outstanding universal value designation for biodiversity was added, but almost wholly based on the epigean biodiversity.

Two surveys of its cave fauna have been published. Mould et al. (2010) have undertaken a preliminary survey during May 2010, to provide an initial overview of the invertebrate fauna in two cave systems, Phong Nha Cave system and Dark Cave. They collected 248 individual specimens, representing at least 41 species from the three caves examined. The species include five classes, 14 orders, and 29 families. Five species are common across the three caves, three spiders, a raphidophorid cricket and a millipede. Their most significant result was the finding of a blind scorpion in the wild section of Tien Son cave. The main differences in faunal assemblage shown by this survey were the dramatic differences in faunal diversity and abundance between areas used by tourists

and the wild sections of the same caves. However, the authors caution that the results of this preliminary study does not allow a meaningful comparison with other karst areas, either in Vietnam or the remainder of Asia.

Pham (2012) surveyed the invertebrate fauna in caves of Phong Nha Ke Bang NP in August and November 2011. Their survey was done in 16 caves of the core area and 5 caves in the extension area. They collected 730 individuals including 58 species-groups of 7 classes and 22 orders.

The sampling effort of both surveys seem to be comparable to the one of our study. Similarities of the cave fauna of between Hin Nam No NPA and Phong Nha-Ke Bang NP are obvious, since both belong to the same karst block, and are reflected in their findings. However, there is a watershed between these areas, with Hin Nam No NPA draining into the Mekong river, and Phong Nha-Ke Bang into the South China Sea, which should lead to difference in the species composition. As far as can be judged by the limited species identification so far, the same niches seem to be occupied by different species in both areas. Some important endemites, like the cave fishes, are lacking in Vietnam. Overall, the biodiversity of Hin Nam No seems to be considerably higher. A faunal hotspot like the Xe Bang Fai system doesn't seem to exist on the Vietnamese side. Hang Son Doong, much publicised for its sheer size, is mainly a dry cave, Phong Nha Cave is a river cave, but its waters seem to be autochthonous, lacking the influx of stream fauna.

Apart from the fauna diversity, the threat to the biodiversity seems to be a major difference. For Phong Nha-Ke Bang, a clear impact by touristic use on the fauna is stated, including problems with lampen-flora. Problems with tourism development which they are trying to solve have either not yet occurred in Laos or have been addressed beforehand. The setup of structures to steer tourism development from the beginning offer a chance to avoid similar problems.

H. *Conclusions and Recommendations for Further Studies*

Caves are a habitat usually neglected or ignored in the assessment of the biodiversity of an area. This is more due to practical than scientific reasons, since specialized equipment and skills are needed to enter this habitat. However, the cave fauna adds greatly to the biodiversity of an area. Due to its isolated character, caves contain a high amount of endemic species. Especially in tropical caves, where the physical conditions are favourable for life and the input of organic material by bats and flooding can be quite high. Especially in continuous karst landscapes with surface water lacking, conditions outside can be quite harsh in comparison. Here, an important part of the biodiversity will be found underground. Generally, the description or assessment of a karst landscape without its caves and cave fauna is simply incomplete. Hin Nam No, at the core of a very large continuous karst block probably has the most diverse cave fauna in mainland Southeast Asia, and for sure the one in the most pristine condition. It could thus be one of the very few karst sites on the World Heritage List inscribed for the biodiversity of its cave fauna as well as epigeal fauna.

A further survey of the cave fauna of Tham Bing is recommended. Tham Bing is a part of the Tham Xe Bang Fai system, it has a larger bat colony and the

associated guano society, and constitutes thus a different habitat from the rest of the cave. It has only been surveyed superficially in 2007/2008.

A serious gap in our knowledge is the bat fauna of the NPA. Only few data from the caves are available. A more intense survey of the caves for bats and a survey of suitable habitats outside the caves is highly desirable.

Of further interest would be a biological survey of caves in the waterless block in the northeast of the NPA, although this will be logistically challenging.

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Appendix 1

Hin Nam No Cave Fauna Project, Specimens collected 2016

TAX	SPECIES	Ban Nong Ping area					Ban Dou area					total specimens		
		Tham Xe Bangfai *)	Grotte de Nuages *)	Tham Nguen *)	Tham Nguen Mai	Tham Pha Pong	Tham Long	Tham Nam Ock	Tham Nok Aen	Tham Pha Hom	Tham Pha Kout 1		Tham Pha Kout 2	karst spring
Mammalia, Chiroptera, Hipposideridae	<i>Aselliscus stoliczkanus</i>				s									0
Mammalia, Chiroptera, Hipposideridae	<i>Hipposideros diadema?</i>		s											0
Mammalia, Chiroptera, Rhinolophidae	<i>Rhinolophus</i> sp. 1		s											0
Mammalia, Chiroptera, Rhinolophidae	<i>Rhinolophus</i> sp. 2		s											0
Mammalia, Chiroptera, Hipposideridae or Rhinolophidae	(horseshoe bat)					s								0
Mammalia, Chiroptera, Vespertilionidae	<i>Miniopterus</i> sp.	s			s									0
Mammalia, Chiroptera	(bat)	3			s		s		s					3
Aves	(bird skeleton)						s							0
Reptilia, Squamata, Gekkonidae	(gecko eggs)					s			s					0
Amphibia, Anura	(frog)	2			s		s							2
Actinopterygii, Cypriniformes, Balitoridae	<i>Schistura</i> or <i>Nemacheilus</i> sp.				2									2
Actinopterygii, Cypriniformes, Cyprinidae	<i>Bangana musaei</i>		s	2		s								2
Actinopterygii, Cypriniformes, Cyprinidae	<i>Devario</i> cf. <i>fangfangae</i>			1								1		2
Actinopterygii, Cypriniformes, Cyprinidae	<i>Oreochthys parvus</i>	1												1
Actinopterygii, Cypriniformes, Cyprinidae	<i>Poropuntius</i> cf. <i>laensis</i>			1										1
Actinopterygii, Cypriniformes	(fish)						s					s		0
Insecta, Coleoptera, Anobiidae	(anobiid beetle, sp. 1)	1	7											8
Insecta, Coleoptera, Anobiidae?	(anobiid? beetle, sp. 2)	1												1
Insecta, Coleoptera, Anthicidae	(anthicid beetle, sp. 1)	3												3
Insecta, Coleoptera, Anthicidae	(anthicid beetle, sp. 2)			1										1
Insecta, Coleoptera, Bostrichidae	(bostrichid beetle)							1						1
Insecta, Coleoptera, Carabidae, Bembidiini?	(bembidiine? beetle)	7												7
Insecta, Coleoptera, Carabidae, Trechinae	(trechine beetle, sp. 1)				1									1
Insecta, Coleoptera, Carabidae, Trechinae	(trechine beetle, spp.)			s			s							0
Insecta, Coleoptera, Carabidae	(carabid beetle, sp. 1)				20									20
Insecta, Coleoptera, Carabidae	(carabid beetle, sp. 2)	1												1
Insecta, Coleoptera, Carabidae	(carabid beetle, sp. 3)	3												3
Insecta, Coleoptera, Carabidae	(carabid beetle, sp. 4)	1												1
Insecta, Coleoptera, Carabidae	(carabid beetle, sp. 5)					1								1
Insecta, Coleoptera, Carabidae	(carabid beetle, sp. 6)	1												1
Insecta, Coleoptera, Coccinellidae?	(lady bug)	1												1
Insecta, Coleoptera, Corylophidae	(corylophid beetle)	1												1
Insecta, Coleoptera, Elateridae	(elaterid beetle)							2						2
Insecta, Coleoptera, Elmidae?	(elmid? beetle)	1												1
Insecta, Coleoptera, Endomychidae, Merophysiinae	(merophysiin beetle)					3		16						19
Insecta, Coleoptera, Leiodidae	(leiodid beetle)			1										1
Insecta, Coleoptera, Lucanidae?	(lucanid? beetle)	1												1
Insecta, Coleoptera, Meloidae	(meloid beetle)								2					2

TAX	SPECIES	Tham Xe Bangfai *)	Grotte de Nuages *)	Tham Nguen *)	Tham Nguen Mai	Tham Pha Pong	Tham Long	Tham Nam Ock	Tham Nok Aen	Tham Pha Hom	Tham Pha Kout 1	Tham Pha Kout 2	karst spring	total specimens
Insecta, Coleoptera, Mordellidae	(mordellid beetle)	1												1
Insecta, Coleoptera, Pselaphidae	(pselaphid beetle)	s												0
Insecta, Coleoptera, Staphylinidae, Tachyporinae	(tachyporine beetle)									1				1
Insecta, Coleoptera, Staphylinidae	(staphylinid beetle, sp. 1)	3			1									4
Insecta, Coleoptera, Staphylinidae	(staphylinid beetle, sp. 2)	1												1
Insecta, Coleoptera, Staphylinidae	(staphylinid beetle, spp.)	1		10	5									16
Insecta, Coleoptera, Tenebrionidae, Lagriinae	(lagriine beetle)	1						3						4
Insecta, Coleoptera, Tenebrionidae	(tenebrionid beetle)					1			10					11
Insecta, Coleoptera	(beetle, sp. 1)							1						1
Insecta, Coleoptera	(beetle, sp. 2)	1												1
Insecta, Coleoptera	(beetle, sp. 3)	2												2
Insecta, Coleoptera	(beetle, sp. 4)							1						1
Insecta, Coleoptera	(beetle, sp. 5)	5												5
Insecta, Coleoptera	(beetle, sp. 6)	7												7
Insecta, Coleoptera	(beetle, sp. 7)	1												1
Insecta, Coleoptera	(beetle, sp. 8)									1				1
Insecta, Coleoptera	(beetle, sp. 9)	1												1
Insecta, Coleoptera,	(water beetle)							1						1
Insecta, Coleoptera	(beetle, spp)	2			1				1					4
Insecta, Coleoptera,	(beetle larva)	1		2										3
Insecta, Coleoptera?	(beetle? larva)	1												1
Insecta, Collembola	(springtails, sp. 1)				1			1						2
Insecta, Collembola	(springtails, sp. 2)				1									1
Insecta, Collembola	(spring tails, spp.)	20		17	2	1								40
Insecta, Dermaptera, Forficulidae	(forficulid earwig)			1										1
Insecta, Dermaptera	(earwigs, sp. 1)	13												13
Insecta, Dermaptera	(earwigs, sp. 2)	9												9
Insecta, Dermaptera	(earwigs, sp. 3)	18												18
Insecta, Dermaptera	(earwigs, spp.)	7												7
Insecta, Dictyoptera	(cockroach, sp. 1)				1	10			1					12
Insecta, Dictyoptera	(cockroach, sp. 2)				1									1
Insecta, Diplura	(diplura)				1									1
Insecta, Diptera, Brachycera	(fly, sp.1)	1												1
Insecta, Diptera, Brachycera	(fly, sp.2)	1												1
Insecta, Diptera, Brachycera	(fly, sp.3)	3												3
Insecta, Diptera, Brachycera	(fly, sp.4)	1												1
Insecta, Diptera, Brachycera	(fly, sp.5)	6												6
Insecta, Diptera, Brachycera	(fly, sp.6)	2												2
Insecta, Diptera, Brachycera	(fly, spp.)	2		1	2				1	s				6
Insecta, Diptera, Brachycera	(fly larva, sp. 2)	1												1
Insecta, Diptera, Brachycera	(fly larva, sp. 1)	1												1
Insecta, Diptera, Nematocera, Culicidae	(mosquito, spp.)	1								s				1
Insecta, Diptera, Nematocera, Culicidae?	(mosquito?, sp. 1)	4												4
Insecta, Diptera, Nematocera, Culicidae?	(mosquito?, sp. 2)	10												10
Insecta, Diptera, Nematocera, Culicidae?	(mosquito?, sp. 3)	3												3

TAX	SPECIES	Tham Xe Bangfai *)	Grotte de Nuages *)	Tham Nguen *)	Tham Nguen Mai	Tham Pha Pong	Tham Long	Tham Nam Ock	Tham Nok Aen	Tham Pha Hom	Tham Pha Kout 1	Tham Pha Kout 2	karst spring	total specimens
Insecta, Diptera, Nematocera, Culicidae?	(mosquito?, sp. 4)	22												22
Insecta, Diptera, Nematocera, Culicidae?	(mosquito?, sp. 5)	4												4
Insecta, Diptera, Nematocera, Culicidae?	(mosquito?, sp. 6)	3												3
Insecta, Diptera, Nematocera, Culicidae?	(mosquito?, sp. 7)	1												1
Insecta, Diptera, Nematocera, Culicidae?	(mosquito?, sp. 8)	1												1
Insecta, Diptera, Nematocera, Keroplatidae ?	(fungus gnat)	7			2									9
Insecta, Diptera, Nematocera, Keroplatidae ?	(fungus gnat larva)					s		s						0
Insecta, Diptera, Nematocera, Scatopsidae	(minute black scavenger fly)	2												2
Insecta, Diptera, Nematocera, Tipulidae?	(crane fly)							1						1
Insecta, Diptera, Nematocera	(midge, sp. 1)	2												2
Insecta, Diptera, Nematocera	(midge, sp. 2)	1												1
Insecta, Diptera, Nematocera	(midge, sp. 3)	1												1
Insecta, Diptera, Nematocera	(midge, sp. 4)	3												3
Insecta, Diptera, Nematocera	(midge, sp. 5)	2												2
Insecta, Diptera, Nematocera	(midge, sp. 6)	1												1
Insecta, Diptera, Nematocera	(midge, sp. 7)	4												4
Insecta, Diptera, Nematocera	(midge, sp. 8)	2												2
Insecta, Diptera, Nematocera	(midge, sp. 9)	5												5
Insecta, Diptera, Nematocera	(midge, spp.)				2									2
Insecta, Diptera	(dipter, sp. 1)	1												1
Insecta, Diptera	(dipter, sp. 2)	1												1
Insecta, Diptera	(dipter, sp. 3)	6												6
Insecta, Diptera	(dipter, sp. 4)	6												6
Insecta, Diptera,	(dipter, sp. 5)	1												1
Insecta, Diptera,	(dipter, sp. 6)	1												1
Insecta, Diptera	(dipter, sp. 7-sp.22)	15												15
Insecta, Diptera	(dipter, spp.)	37		2		2			4					45
Insecta, Diptera	(dipter larva)			2										2
Insecta, Ephemeroptera	(mayfly, sp.1)	1												1
Insecta, Ephemeroptera	(mayfly, sp.2)	1												1
Insecta, Ephemeroptera	(mayfly, sp.3)	2												2
Insecta, Ephemeroptera	(mayfly, sp.4)	1												1
Insecta, Ephemeroptera	(mayfly, spp.)	6												6
Insecta, Ephemeroptera	(may fly larva, sp. 1)	1												1
Insecta, Ephemeroptera	(may fly larva, sp. 2)	4												4
Insecta, Ephemeroptera	(may fly larva, sp. 3)	5												5
Insecta, Ephemeroptera	(may fly larva, sp. 4)	4												4
Insecta, Ephemeroptera	(may fly larva, sp. 5)	1												1
Insecta, Hemiptera, Heteroptera, Reduviidae, Emesinae	(assassin bug, sp. 1)	5												5
Insecta, Hemiptera, Heteroptera, Reduviidae, Emesinae	(assassin bug, sp. 2)	5												5
Insecta, Hemiptera, Heteroptera, Reduviidae, Emesinae	(assassin bug, spp.)	5								2				7

TAX	SPECIES	Tham Xe Bangfai *)	Grotte de Nuages *)	Tham Nguen *)	Tham Nguen Mai	Tham Pha Pong	Tham Long	Tham Nam Ock	Tham Nok Aen	Tham Pha Hom	Tham Pha Kout 1	Tham Pha Kout 2	karst spring	total specimens
Insecta, Hemiptera, Heteroptera	(water bug, sp. 1)	1												1
Insecta, Hemiptera, Heteroptera	(water bug, sp. 2)	1												1
Insecta, Hemiptera, Heteroptera	(water bug, sp. 3)							1						1
Insecta, Hemiptera, Heteroptera	(water bug, sp. 4)							1						1
Insecta, Hemiptera, Heteroptera	(bug, spp.)	8		1		10								19
Insecta, Hemiptera, Homoptera	(homoptera)	1												1
Insecta, Hemiptera	(hemiptera)				1									1
Insecta, Hymenoptera, Formicidae	(ant, sp.1)							1						1
Insecta, Hymenoptera, Formicidae	(ant, sp.2)	1												1
Insecta, Hymenoptera, Formicidae	(ant, spp.)	1		5	6	1			8					21
Insecta, Hymenoptera	(wasp, sp.1)	1												1
Insecta, Hymenoptera	(wasp, sp.2)	1												1
Insecta, Hymenoptera	(wasp, spp.)									s				0
Insecta, Lepidoptera, Geometridae	(geometrid moth)							s						0
Insecta, Lepidoptera, Noctuidae	Erebus macrops						s	s		1				1
Insecta, Lepidoptera, Pterophoridae?	(plume moth?)	1												1
Insecta, Lepidoptera, Tineidae	(tineid moth, sp. 1)	1												1
Insecta, Lepidoptera, Tineidae	(tineid moth, sp. 2)								3					3
Insecta, Lepidoptera	(moth, spp.)	2								2				4
Insecta, Odonata	(dragonfly larva)	1												1
Insecta, Orthoptera, Gryllidae	(cricket)									1				1
Insecta, Orthoptera, Rhaphidophoridae	(cave cricket)	17	1	5	8	3	s	3	1	4	s	1		43
Insecta, Psocoptera	(psocoptera)								2					2
Insecta, Trichoptera	(caddy fly, sp. 1)	3												3
Insecta, Trichoptera	(caddy fly, sp. 2)	2												2
Insecta, Trichoptera	(caddy fly, sp. 3)	1												1
Insecta, Trichoptera	(caddy fly larva)	1												1
Insecta, Trichoptera	(caddy fly, spp.)	9							s					9
Arachnida, Acari, Cunaxidae ?	(cunaxid mite)	12												12
Arachnida, Acari, Oribatidae	Oribates sp.					2								2
Arachnida, Acari	(mites, sp. 1)	6												6
Arachnida, Acari	(mites, sp. 2)	2		6	1	5			3					17
Arachnida, Acari	(mites, sp. 3)	2												2
Arachnida, Araneae, Araneidae	Argiope sp.	1												1
Arachnida, Araneae, Dipluridae?	(Diplurid? spider)									1				1
Arachnida, Araneae, Gnaphosidae	(gnaphosid spider)				1									1
Arachnida, Araneae, Mimetidae	(mimetid spider)	1												1
Arachnida, Araneae, Nephilidae	Nephila pilipes					s								0
Arachnida, Araneae, Nesticidae	(nesticid spider)	1												1
Arachnida, Araneae, Oonopidae	(oonopid spider, sp. 1)	1												1
Arachnida, Araneae, Oonopidae	(oonopid spider, sp. 2)	1												1
Arachnida, Araneae, Oonopidae	(oonopid spider, sp. 3)	1												1
Arachnida, Araneae, Pholcidae	(pholcid spider, sp. 1)						1							1
Arachnida, Araneae, Pholcidae	(pholcid spider, sp. 2)	2												2
Arachnida, Araneae, Pholcidae	(pholcid spider, sp. 3)	3												3
Arachnida, Araneae, Pholcidae	(pholcid spider, sp. 4)	3								1				4
Arachnida, Araneae, Pholcidae	(pholcid spider, sp. 5)									4				4
Arachnida, Araneae, Psechridae?	(psechrid? spider)					3								3
Arachnida, Araneae, Salticidae	(jumping spider)									2				2

TAX	SPECIES	Tham Xe Bangfai *)	Grotte de Nuages *)	Tham Nguen *)	Tham Nguen Mai	Tham Pha Pong	Tham Long	Tham Nam Ock	Tham Nok Aen	Tham Pha Hom	Tham Pha Kout 1	Tham Pha Kout 2	karst spring	total specimens
Arachnida, Araneae, Sparassidae, Heteropodinae	<i>Heteropoda maxima</i>						s	1	s	1		2		4
Arachnida, Araneae, Sparassidae, Heteropodinae	<i>Heteropoda steineri</i>	3	1	s	4	4		4						16
Arachnida, Araneae, Sparassidae, Heteropodinae	<i>Heteropoda? sp.</i>							s		s				0
Arachnida, Araneae, Sparassidae, Heteropodinae	<i>Sinopoda ?</i>					3								3
Arachnida, Araneae, Sparassidae	(sparassid spider)					7					s			7
Arachnida, Araneae, Tetrablemmidae	(tetrablemmid spider)	5												5
Arachnida, Araneae, Tetraguathidae	(tetraguathid spider, sp. 1)	1												1
Arachnida, Araneae, Tetraguathidae	(tetraguathid spider, sp. 2)	1												1
Arachnida, Araneae, Theridiidae	(theridiid spider, sp. 1)	14												14
Arachnida, Araneae, Theridiidae	(theridiid spider, sp. 2)							1						1
Arachnida, Araneae, Theridiidae	(theridiid spider, sp. 3)	1												1
Arachnida, Araneae, Theridiidae or Nesticidae	(theridiid or nesticid spider, sp. 4)	1												1
Arachnida, Araneae, Theridiidae or Nesticidae	(theridiid or nesticid spider, sp. 5)	2												2
Arachnida, Araneae, Theridiosomatidae	(theridiosomatid spider, sp. 1)	1												1
Arachnida, Araneae, Theridiosomatidae	(theridiosomatid spider, sp. 2)							6		5				11
Arachnida, Araneae, Theridiosomatidae	(theridiosomatid spider, sp. 3)	10												10
Arachnida, Araneae, Theridiosomatidae	(theridiosomatid spider, sp. 4)						2							2
Arachnida, Araneae, Theridiosomatidae?	(theridiosomatid? spider, sp. 5)	1												1
Arachnida, Araneae, Uloboridae	(uloborid spider)									1				1
Arachnida, Araneae	(spider)	83		14	s	8	s		12	5		s		122
Arachnida, Opiliones, Laniatores	(harvestman, sp. 1)							1						1
Arachnida, Opiliones, Laniatores	(harvestman, sp. 2)				1									1
Arachnida, Opiliones, Laniatores	(harvestman, sp. 3)							5						5
Arachnida, Opiliones, Laniatores	(harvestman, spp.)	3												3
Arachnida, Opiliones, Phalangioidea	(longlegged harvestman, sp. 1)						1							1
Arachnida, Opiliones, Phalangioidea	(longlegged harvestman, sp. 2)						2							2
Arachnida, Opiliones, Phalangioidea	(longlegged harvestman, sp. 3)									3				3
Arachnida, Opiliones, Phalangioidea	(longlegged harvestman, sp. 4)	8												8
Arachnida, Opiliones, Phalangioidea	(longlegged harvestman, sp. 5)						1							1
Arachnida, Opiliones, Phalangioidea	(longlegged harvestman, sp. 6)						2							2
Arachnida, Opiliones, Phalangioidea	(longlegged harvestman, sp. 7)	1												1
Arachnida, Opiliones, Phalangioidea	(longlegged harvestman, spp.)	1				7	s				3			11
Arachnida, Opiliones	(harvestman)	5		4		1			8	21				39
Arachnida, Pseudoscorpiones	(pseudoscorpion)	1				7								8
Arachnida, Schizomida, Schizomidae	(ant spider)			6	3	1								10
Crustacea, Copepoda	(copepods)	6												6

TAX	SPECIES	Tham Xe Bangfai *)	Grotte de Nuages *)	Tham Nguen *)	Tham Nguen Mai	Tham Pha Pong	Tham Long	Tham Nam Ock	Tham Nok Aen	Tham Pha Hom	Tham Pha Kout 1	Tham Pha Kout 2	karst spring	total specimens
Crustacea, Malacostraca, Decapoda	Macrobrachium dienbienphuense	5												5
Crustacea, Malacostraca, Decapoda	(tiny white shrimp)	1												1
Crustacea, Malacostraca, Decapoda	(crab or shrimp)	1												1
Crustacea, Malacostraca, Decapoda	(crab)							s						0
Crustacea, Malacostraca, Isopoda	(woodlouse, sp.1)	1												1
Crustacea, Malacostraca, Isopoda	(woodlouse, sp.2)	8				1								9
Crustacea, Malacostraca, Isopoda	(woodlouse, sp.3)	3												3
Crustacea, Malacostraca, Isopoda	(woodlouse, sp.4)				3									3
Crustacea, Malacostraca, Isopoda	(woodlouse, sp.5)	2				1		8						11
Crustacea, Malacostraca, Isopoda	(woodlouse, sp.6)	4												4
Crustacea, Malacostraca, Isopoda	(woodlouse, sp.7)	2												2
Crustacea, Malacostraca, Isopoda	(woodlouse, spp.)	8				6			1					15
Crustacea, Ostracoda	(seed shrimps)	4												4
Myriapoda, Chilopoda, Scutigermorpha, Scutigerae	Thereuopoda longicornis							s		1		1		2
Myriapoda, Chilopoda	(shortlegged centipede)							1						1
Myriapoda, Chilopoda	(centipedes)			7	1				1					9
Myriapoda, Diplopoda	(millipedes, sp. 1)							1						1
Myriapoda, Diplopoda	(millipedes, sp. 2)							1						1
Myriapoda, Diplopoda	(millipedes, sp. 3)				4			13		3				20
Myriapoda, Diplopoda,	(millipedes, sp. 4)	2			30			4		s				36
Myriapoda, Diplopoda	(millipedes, sp. 5)				21	11		1						33
Myriapoda, Diplopoda,	(millipedes, sp. 6)				1									1
Myriapoda, Diplopoda	(millipedes, spp.)			96	22	30				1				149
Mollusca, Bivalvia	(mussel)	1							s	s				1
Mollusca, Gastropoda	(snail)	17		15	10	17	1			5		3		68
Mollusca, Gastropoda	(tiny spring snails)	25												25
Nematoda?	(nematods)				13									13
Annelida, Oligochaeta, Lumbricidae	(earthworms)	9		2		1								12
??	(larva)					30			4					34
??	(worms??)				4									4
??	(??)	4							1	1				6
*) parts of the Xe Bang Fai system		s = sightings or photographic proof only												
Classes: 16; Order: 34; Taxa: 218 (19 identified to genus)													Total specimens	1459

Appendix 2

Specimens collected in the Tham Xe Bangfai area 2007/2008 or recorded in the literature												
TAX	SPECIES	Tham Xe Bang Fai *)	Grotte de Nuages *)	Tham Bing *)	Tham Ene	Tham Koy	Tham Ko Kou Phou	Tham Peung	Tham Pha Pong	unnamed footcave cave in Hin Nam No NBCA	total specimens	Remark
Mammalia, Chiroptera, Megachiroptera, Pteropodidae	<i>Rousettus amplexicaudatus</i>	1		2							3	
Mammalia, Chiroptera, Megachiroptera, Pteropodidae	<i>Rousettus sp.</i>			3							3	
Mammalia, Chiroptera, Microchiroptera, Emballonuridae	<i>Taphozous theobaldi</i>	1									1	
Mammalia, Chiroptera, Microchiroptera, Hipposideridae	<i>Hipposideros armiger</i>	3									3	
Mammalia, Chiroptera, Microchiroptera, Hipposideridae	<i>Hipposideros diadema</i>	37		8							45	
Mammalia, Chiroptera, Microchiroptera, Hipposideridae	<i>Hipposideros pratti</i>			1							1	
Mammalia, Chiroptera, Microchiroptera, Hipposideridae	<i>Hipposideros pomona</i>	x										1)
Mammalia, Chiroptera, Microchiroptera, Hipposideridae	<i>Aselliscus stoliczkanus</i>	x										1)
Mammalia, Chiroptera, Microchiroptera, Megadermatidae	<i>Megaderma lyra</i>	x										1)
Mammalia, Chiroptera, Microchiroptera, Rhinolophidae	<i>Rhinolophus thomasi</i>	x										1)
Mammalia, Chiroptera, Microchiroptera, Rhinolophidae	<i>Rhinolophus pearsonii</i>	x										1)
Mammalia, Chiroptera, Microchiroptera, Vespertilionidae	<i>Myotis siligorensis</i>	x										1)
Mammalia, Chiroptera, Microchiroptera, Vespertilionidae	<i>Kerivoula hardwickii</i>	x										1)
Mammalia, Chiroptera, Microchiroptera	(bat skulls)	12			8						20	
Mammalia, Chiroptera, Microchiroptera	(bat, small, insectivorous)	1									1	
Mammalia, Chiroptera	(small bat skeleton)			0							0	
Aves, Apodiformes, Apodidae	<i>Aerodramus germani</i>	2									2	
Amphibia, Microhylidae	<i>Kalophrynus interlineatus</i>									x		2)
Amphibia, Rhacophoridae	cf. <i>Rhacophorus orlovi-complex</i>		1				1				2	
Actinopterygii, Cypriniformes, Cyprinidae	<i>Bangana musaei</i>		4						2		6	
Insecta, Coleoptera	(beetle, red thorax, black wings 2 creme bands)			1							1	
Insecta, Coleoptera	(beetle? larvae)			2							2	
Insecta, Coleoptera	(beetles)	3									3	
Insecta, Coleoptera	(small black beetles)	3									3	
Insecta, Coleoptera	(small brown beetle)	1									1	
Insecta, Coleoptera	(small dark beetles)	2									2	
Insecta, Coleoptera	(small black beetle)				1						1	
Insecta, Coleoptera, Staphylinidae??	(tiny Staphylinidae??)	19									19	
Insecta, Dermaptera,	(earwig)	1									1	
Insecta, Dictyoptera	(cockroach)			1					1		2	
Insecta, Dictyoptera	(small cockroach)								3		3	
Insecta, Dictyoptera, Blaberidae, Epilamprinae	<i>Rhabdoblatta memnonia</i>							1			1	
Insecta, Dictyoptera, Polyphagidae	<i>Ergaula sp.</i>			29							29	

TAX	SPECIES	Tham Xe Bang Fai *	Grotte de Nuages *	Tham Bing *	Tham Ene	Tham Koy	Tham Ko Kou Phou	Tham Peung	Tham Pha Pong	unnamed footcave	cave in Hin Nam No NBCCA	total specimens	Remark
Insecta, Diptera, Brachycera, Chloropidae	(fly, small)	1										1	
Insecta, Diptera, Brachycera, Dolichopodidae	(redeyed fruit flies)		6									6	
Insecta, Diptera, Brachycera, Milichiidae	(tiny fly & black&white ringed abdomen)			1								1	
Insecta, Diptera, Brachycera, Scenopinidae	(tiny fly & black&white ringed abdomen)			1								1	
Insecta, Diptera, Brachycera, Simuliidae	(small flies, black & brown)	4										4	
Insecta, Diptera, Nematocera	(mosquito)	6										6	
Insecta, Diptera, Nematocera	(mosquitos)	5										5	
Insecta, Diptera, Nematocera	(pale mosquitos)	2										2	
Insecta, Diptera? Ephemoptera	(fly, redeyed)	1										1	
Insecta, Ephemeroptera	(may fly)	1										1	
Insecta, Ephemeroptera	(may fly, yellow)	3										3	
Insecta, Hemiptera, Heteroptera, Reduviidae?	(assassin bug)	5										5	
Insecta, Hemiptera, Heteroptera, Reduviidae?	(assassin bug, small, black, stick)	1										1	
Insecta, Hemiptera, Heteroptera, Reduviidae?	(assassin bugs, roundish)							2				2	
Insecta, Hemiptera, heteroptera, Reduviidae?	(assassin bug, roundish)			3								3	
Insecta, Hemiptera, heteroptera, Reduviidae?	(assassin bug, sticklike)			1								1	
Insecta, Hemiptera, Heteroptera, Reduviidae?	(small assassin bug, stick)	1										1	
Insecta, Hymenoptera, Formicidae	(black ant)			4								4	
Insecta, Hymenoptera, Formicidae	(tiny ant)							1				1	
Insecta, Hymenoptera, Formicidae	(ants)					4						4	
Insecta, Lepidoptera	(small fly-like black moth)	1										1	
Insecta, Lepidoptera, Tineidae	(tineid case)			1								1	
Insecta, Orthoptera, Rhabdophoridae	(cave cricket)	15	4	2	3	1	1	1		5		32	
Insecta, Psocoptera	indet. Psocoptera							2				2	
Arachnida, Acari	(tiny yellow mites)			50								50	
Arachnida, Araneae, Pholcidae	(longlegged spiders, yellow-brown patterned abdomen)				2							2	
Arachnida, Araneae, Pholcidae	(Spider, longlegged)	1										1	
Arachnida, Araneae, Pholcidae	Pholcus bangfai	5										5	
Arachnida, Araneae, Pholcidae?	(pholcid spider)			1						1		2	
Arachnida, Araneae, Pholcidae?	(pholcid? spider, different)	1										1	
Arachnida, Araneae, Pholcidae?	(pholcid spider, lantern-eyes)	6										6	
Arachnida, Araneae, Psecridae	Psechrus steineri			3								3	
Arachnida, Araneae, Segastridae	(spider, depresses abdomen)	1										1	
Arachnida, Araneae, Sparassidae, Heteropodinae	Heteropoda maxima		x			1	1					2	3)
Arachnida, Araneae, Sparassidae, Heteropodinae	Heteropoda steineri	26	4	2	6	2		3	2			45	
Arachnida, Araneae, Sparassidae	Heteropoda sp.								1	1		2	
Arachnida, Araneae, Sparassidae?	(sinopoda-like)	2										2	
Arachnida, Araneae, Theridiosomatidae	Alaria cavernicola	x											4)

TAX	SPECIES	Tham Xe Bang Fai *)	Grotte de Nuages *)	Tham Bing *)	Tham Ene	Tham Koy	Tham Ko Kou Phou	Tham Peung	Tham Pha Pong	unnamed footcave	cave in Hin Nam No NBCC	total specimens	Remark
Arachnida, Araneae, Theridiosomatidae	(small spiders, globular Abdomen)	3										3	
Arachnida, Araneae	(3 tiny ball-spider)	3										3	
Arachnida, Araneae	(bown spider, 4 dots on abdomen)								1			1	
Arachnida, Araneae	(longlegged large spider)	2										2	
Arachnida, Araneae	(small longlegged spiders)	2										2	
Arachnida, Araneae	(spider, shortlegged, tiny)	1										1	
Arachnida, Araneae	(spiders, midsized, brown)	2										2	
Arachnida, Araneae	(tiny spider)		1									1	
Arachnida, Chelicerata, Scorpiones, Pseudochactidae	Troglokhamouanus steineri	3										3	5)
Arachnida, Opiliones, Sclerosomatidae	Gagrella n.sp.												6)
Arachnida, Opiliones	(large opiliones)								2			2	
Arachnida, Opiliones	(longlegged opiliones)					1				1		2	
Arachnida, Opiliones	(Opiliones with pincers)	2										2	
Arachnida, Opiliones	(harvestman)	3	2									5	
Crustacea, Malacostraca, Decapoda	Macrobrachium dienbienphuense	4										4	
Crustacea, Malacostraca, Isopoda	(woodlouse)									1		1	
Crustacea, Malacostraca, Isopoda	(woodlouse, pale)	4										4	
Crustacea, Malacostraca, Isopoda	(woodlice)	3										3	
Crustacea, Malacostraca, Isopoda	(rolling woodlouse)			10								10	
Crustacea, Malacostraca, Isopoda	(whitish isopod)	1										1	
Myriapoda, Chilopoda, Scutigermorpha, Scutigerae	Thereuopoda longicornis	1		2								3	
Myriapoda, Chilopoda, Scutigermorpha, Scutigerae	(scutigerae, small)	1										1	
Myriapoda, Chilopoda, Scutigermorpha, Scutigerae?	(longlegged centipede, tiny)	1										1	
Myriapoda, Diplopoda	(millipede)							18	1			19	
Myriapoda, Diplopoda	(small millipeds)	26										26	
Myriapoda, Diplopoda	(millipe, red, strong sculptured)	1										1	
Myriapoda, Diplopoda	(small white millipeds)	2										2	
Mollusca, Gastropoda	(large snail)							1				1	
Anellida, Lumbricoidea	(earthworm)	1										1	

Classes: 11; Order: 24; Taxa: min. 83 (27 identified to genus level)

total specimens: 473

Remarks:

*) parts of the Tham Xe Bang Fai system

1) Thomas et al. 2013

2) Stuart 2005

3) Steiner 2010

4) Lin, Li, & Jäger 2014

5) reconfirmed 2014: Sharma (undat.)

6) Miller 2012; Senckenberg 2012

all other: records by the author