

BIOSPELEOLOGICAL RESEARCH IN THE LAO P.D.R.

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Laos, together with neighbouring Vietnam, has been recognized as one of the hotspots of biodiversity in the recent years. Many of the new species found are associated with karst, thus a similar high biodiversity is to be expected from the cave fauna. The first cave species from Laos was described in 1920, in the 80 years to follow a mere four further cave species have been described. The discovery of the Giant Huntsman Spider, *Heteropoda maxima*, described from museum material in 2001, constitutes a turning point in the research of the Lao cave fauna, since it triggered a still ongoing survey of the Lao spider fauna, including many cave species. It was also the starting point of the biospeleo-logical research presented here. Within the framework of the Northern Lao-European Cave Project and the French Khammouane Expedition, collection of cave fauna during the annual expeditions yielded to date a total of 24 species new to science. Included are major discoveries like a blind cave fish, an ancient scorpion, a new huntsman spider of the genus *Heteropoda* and several *Sinopoda*. A summary of our research on the Lao cave fauna is presented here.

1. Introduction

The People's Democratic Republic of Laos is a small landlocked country in Southeast Asia, which only recently has been recognized as a hotspot of biodiversity, like its neighbour Vietnam. Both countries are home to extensive karst landscapes, which constitute some of the habitats least accessible to man, and thus offering essential refuges for wildlife. Thus it doesn't come as a surprise that several of the newly discovered species seem to be associated with karst. The most well-known example is the rock rat *Laonastes aenigmamus*, others are the Limestone Leaf Warbler *Phylloscopus calciatilis*, the Bare-faced Bulbul *Pycnonotus hualon*, the Gymnure *Hylomys megalotis*, the two rats *Saxatilomys paulinae* and *Tonkinomys daovan-tieni* and the pit viper *Triceratolepidophis sieversorum* (Steiner 2012). Naturally, these karst landscapes are riddled with caves, ranging from foot caves a few meters long to giant caves like Tham Xe Bangfai with its tunnels up to 80 meters wide and high or the Tham Nam Non system with a length exceeding 30 kilometers. An equally diverse cave fauna is thus to be expected. However, very few researchers have taken up the challenge so far. Biospeleological research in the Lao P.D.R. is thus still in its infancy. The present article will give an review of the cave species known and the research done in Laos so far, and summarize the results of our ten years of surveying cave fauna in Laos.

2. Historic overview

The first description of a species from caves in Laos, was a cave cricket, *Diestrammena vitalis*, published by Chopard (1920). Of the locality, only the province is stated, Xieng Khouang. It was followed by another cave cricket, *Eutachycines cassani* from two caves in Khammouan, published also by Chopard (1954).

In the 1990's, a woodlouse, *Exalloniscus bessoni*, from Tham Rusi, Luang Prabang Province, was described (Dalens 1992), a record of birds reported the swift *Apus pacificus* from caves in Khammouane Limestone NBCA (Duckworth et al. 1998), without naming specific ones, a

report on shrews mentions several species found in caves in Khammouan Province (Smith et al. 1998). Next, WWF published a wildlife report (Duckworth et al. 1999). It includes a section on bats, many stated to roost in caves, but usually without naming specific caves. Finally, a new crab, *Erebusa calobates*, was described from three caves in Khammouan Province (Yeo and Ng 1999), and the first cave fish from Laos, *Troglocyclocheilus khammouanensis* was described from Tham Khoun Don, Khammouan Province (Kottelat and Bréhier 1999).

Thus, for the first 80 years, beginning with the first cave record, a mere five new species from caves in Laos have been described, and only marginally more known species were reported. With the gradual opening of the country to tourism, records of cave species and discoveries of new cave species started to increase.

The year 2000 saw a bat survey of Khammouan Province published (Robinson and Webber 2000), including several cave records, and the description of the first two cave beetles, *Laosaphaenops deharvengi* and *Eustra lao* from caves in Vientiane Province (Deuve 2000). The Dutch AMIS expedition 2000 to the area around Nong Khai, Luang Prabang province included also a thorough bat survey of the surveyed caves (Damen et al. 2003).

The Lao chapter of the Encyclopaedia Biospeologica (Besson et al. 2001) gave the first overview of the state of knowledge regarding the biospeleology of Laos, though many of the records were of specimens not or only tentatively identified.

In 2002, a second cave fish, *Schistura kaysoni* was published from Laos (Vidthayanon and Jaruthanin 2002). The locality stated, Phu Tham Nam Cave in Khammouan Province, is somewhat obscure. The coordinates given are in an unlikely area, a hill of this name is found in Khammouan at a different position, but no cave in this hill is known to any of the speleologists working in Khammouan province.

The following year, *Hipposideros scutinaries*, a new species of bats was described from caves in Bolikhamxai and Khammouan Province (Robinson et al. 2003) as well as *Leptogenys khammouanensis*, probably the first cave-

associated ant worldwide, found in Khammouan Province (Roncin and Deharveng 2003).

A major impact has the description of the huntsman spider *Heteropoda maxima* from museum material in the Natural History Museum in Paris, which was collected in the 1930's (Jäger 2001). It was popularized as the largest spider in the world, based on the legspan of a male specimen, measuring 30 cm. It triggered an ongoing research of the spiders of Laos, which yielded many cave records and new cave species. This research also brought the author to Laos in the first place.

3. Methods

Cave fauna was recorded and collected by the author from 2003 to 2008 within the frame of the French Khammouan Expedition, and from 2003/04 to date as part of the Northern Lao-European Cave Project. Invertebrates and fishes were sampled by hand and preserved in 70–90% alcohol. Vertebrates other than fishes were only photographed. Additionally, skulls or mummies of bats and other mammals, which were found on the ground, were also collected. The specimens were determined by various specialists as far as possible, these remained in their respective collections. All records, own as well as those gleaned from the literature, are stored in a relational data base.

4. Results and discussion

Currently, 273 taxa determined at least to generic level are known from caves of the Lao P.D.R. 134 of these taxa were collected or recorded during our research. A total of 24 new species were described from cave specimens collected during the present surveys or including cave material collected during the present survey (Table 1). Annotations to some of the species or groups are given in the following. Reviews of the cave fauna of Laos are found in Besson et al. (2001), Boonman and Steiner (2005) and Steiner (2008, 2010).

4.1. Bats and other mammals

Large bat colonies are rarely encountered in Laos. The local population is hunting bats for food, and accessible caves are always known to the villagers. Thus usually only few individuals of bats remain. A lot of caves show signs of hunting in the form of scaffolding, entrances closed by branchwork or long bamboo poles found for knocking down bats. The few larger colonies we have seen were hanging in inaccessible places, either above deep shafts or above a river, where they are safe from hunting, since killed animals can't be retrieved. Unfortunately, it's equally impossible to find skulls of dead bats in these locations. In total, we were able to record 16 different species of bats (Steiner 2010).

Rats were regularly encountered in Lao caves. They are probably conspecific with *Leopoldamys sabanus*, identified by skulls found in caves in Luang Namtha Province, and also reported by Smith et al. (2004).

Tracks and quills of porcupines are found sometimes quite deep inside the caves, and tracks and droppings of the serow in entrance areas of caves with large portals.

4.2. Reptiles and amphibia

We found the pit viper *Triceratolepidophis sieversorum* up to several hundred meters inside several caves of Khammouan Province. Other snakes encountered are probably only accidental visitors. Geckos or gecko eggs were regularly seen in the entrance areas but none could be identified with any certainty.

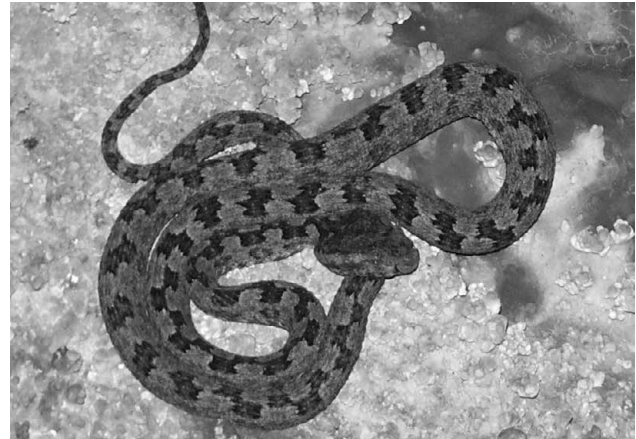


Figure 1. *Triceratolepidophis sieversorum*.

Frogs are frequently found in the entrance areas of damp caves or even deep within in river caves. Species identified from pictures belonged to the *Rana chloronata*- and the *R. nigrovittata*-complex.

4.3. Fish

Laos is a country with abundant rivers and large karst areas. It is thus astonishing that only two species of cave fish have been reported so far. Many caves are crossed by allochthonous rivers, fishes are regularly seen there, the few species who were identified are all surface species.



Figure 2. *Bangana musaei*.

However, in 2007 and 2008, we collected white cave fishes in the Grotte des Nuages and Tham Pong. The fishes have been described as a new species, *Bangana musaei* (Kottelat and Steiner 2010), the third cave fish from Laos. It is without eyes, the smallest known species of the genus and also the first cave species. The fish has been observed only in a single residual pool in each cave. This is probably not their primary habitat but the only one where they are accessible to humans. Nothing else is known of its ecology.

4.4. Spiders

One of the most characteristic species found in the caves of Laos are the large huntsman spiders of the genus *Heteropoda* in the family Sparassidae. They are usually up to a good

hand-size and can be often seen from several meters away by their blueish eye-shine. They are found in almost all caves. Four species are found regularly in caves, *H. aemulans*, *H. maxima*, *H. simplex* and *H. steineri*, show a clear geographical distribution pattern.

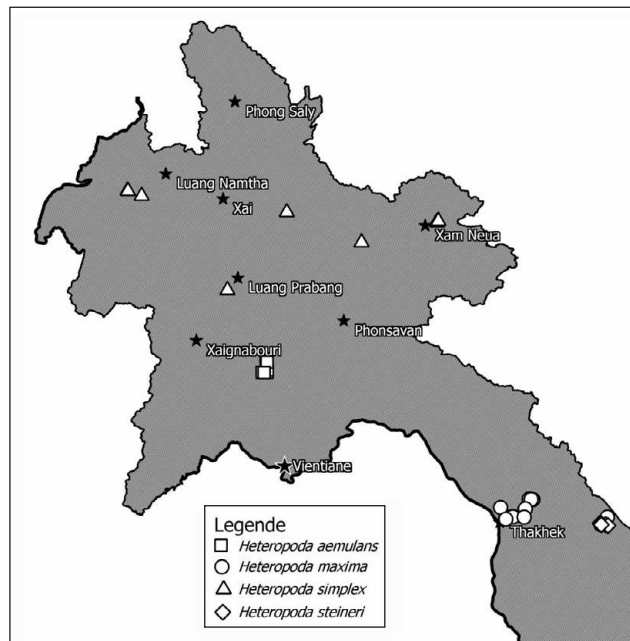


Figure 3. Distribution of cave *Heteropoda* species.

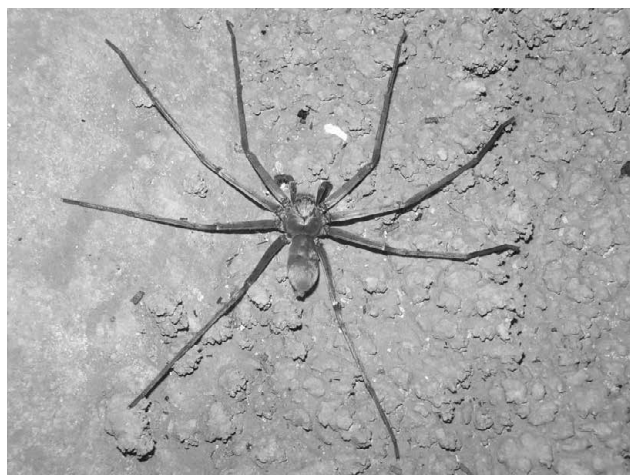


Figure 4. *Heteropoda steineri*.

H. aemulans is restricted to the karst area around Vang Vieng (Vientiane Province), *H. maxima*, as the largest species, also occupies the area of the largest caves, i.e. Khammouan and Bolikhamsai Province, *H. steineri* has so far only been found at the upper reaches of the Xe Bangfai river in Khammouane. Interestingly, *H. maxima* and *H. steineri* share a sympatric distribution, and have both been seen in the same cave (Tham Xe Bangfai and Grotte de Nuages). However, they seem to occupy different ecological niches. *H. maxima* was found in these cave only close to the entrances or daylight openings, while *H. steineri* was always deep within the cave. It is the only *Heteropoda*-species which shows troglomorphic traits like a uniform color and reduced eyes. All 3 species have not been found outside of caves and should be regarded as troglophilic at least. *H. simplex*, originally described from Japan, covers the whole north of Laos from Luang Namtha to Huaphan Province. It is found outside of caves as well,

but mostly in dark and humid places. For literature, see Bayer and Jäger 2009; Jäger 2001, 2007; Jäger and Praxaysombath 2009; Steiner 2010.

The genus *Sinopoda*, closely related to *Heteropoda*, but more strongly cave adapted, was only recently found to be most divers in Lao caves (Jäger 2012). With the exception of *Sinopoda tham*, each species seems to be restricted to a single cave (Fig. 6). *Sinopoda scurion* from the so-called Sinopoda Cave, the only of these species not collected by



Figure 5. *Sinopoda tham*.

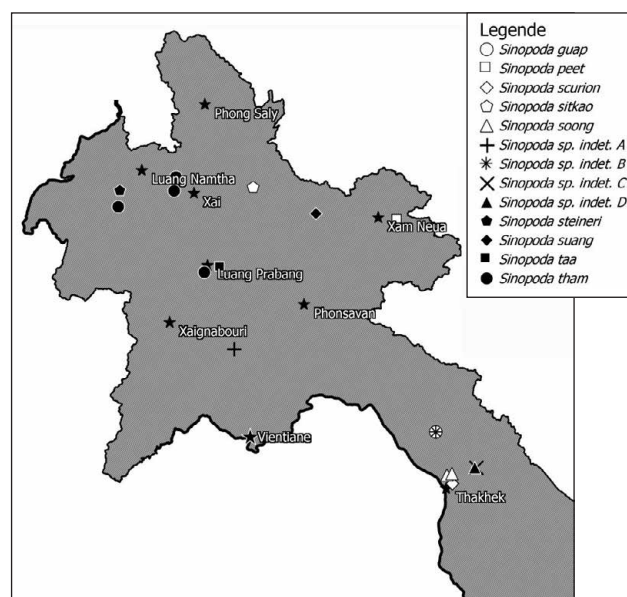


Figure 6. Distribution of *Sinopoda* species.

us, gained fame as the first blind cave spider from Laos.

Two further spider families were shown to be rather divers in Lao caves, with several new species described: The Psechridae (Bayer and Jäger 2010; Bayer 2012) and Pholcidae (Huber 2005, 2011).

Other spiders described from Lao caves are found in Logunov and Azarkina 2007, Jäger (2007), Jäger and Praxaysombath (2009, 2011) and Wang et al. (2008).

4.5. Other arachnids

A very large whip scorpion, *Typopeltis magnificus* has been described from caves in Khammouan Province (Haupt 2004). It is not uncommon, and usually found in assemblies of several individuals, an unusual behaviour for whip scorpions (Jäger, pers. comm.)

Two small scorpions collected at Tham Xe Bangfai during the French Khammouan Expedition proved to be a scientific sensation. They were described as *Troglokhammouanus steineri* and placed in a family thought to be very ancient, which previously consisted of a single member from central Asia (Lourenço 2007). Following this discovery, two further species of this family have been found in caves in neighbouring Vietnam, and a third one, *Vietbocap lao*, is reported from Tham Nam Lot, Khammouan Province (Lourenço 2012). This genus shows stronger troglomorphic features than the first.



Figure 7. *Troglokhammouanus steineri*.

Ophiliones are commonly found in most of the Lao caves, due to a lack of specialists, they remain unidentified so far.

4.6. Insects

Cave crickets, most probably species of the genus *Diestrammena* and related genera, are characteristic of Lao caves. They are usually the most common animal, found virtually in all caves, and probably also the most common prey of all predators in the cave. At least three different species, probably many more, were collected.

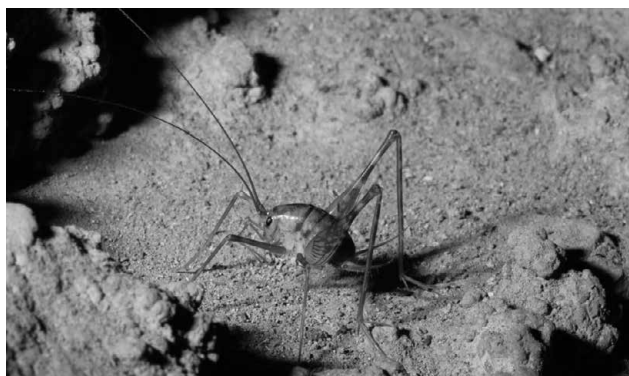


Figure 8. Cave cricket.

The specimens are currently studied at the Russian Academy of Science in St. Petersburg, identifications are still pending.

A rather conspicuous moth, *Erebus macrops* (family Noctuidae) is often seen on cave walls close to the entrance in Northern Laos. Larvae of tineids or the cases they build are regularly found in guano, but none could be raised to the imago and thus identified. The association of tineids with caves respective guano itself is well known. All other moths are probably accidental visitors.

A cockroach found in Tham Peung at the Xe Bangfai, Khammouan, has been described as *Rhabdoblatta memnonia*, together with epigeal material from Vietnam (Anisyutkin 2009).

A wide variety of other insects have been collected during these our expeditions, including beetles, earwigs, cockroaches, flies, fruit flies, mosquitos, fungus gnat and other dipters, assassin bugs, water bugs, cicada and other bugs, ants, termites, ant lions and collembola. None of these has been identified so far.

4.7. Other invertebrates

The long-legged cave centipede, *Thereuopoda longicornis* (fam. Scutigerae) (P. Stoev, pers. comm.), is another character species of Lao caves. It's distribution ranges from all of Southeast Asia to Australia and Papua New Guinea. In the literature, it is often confused with *Scutigera decipiens* (a nomen nudum).

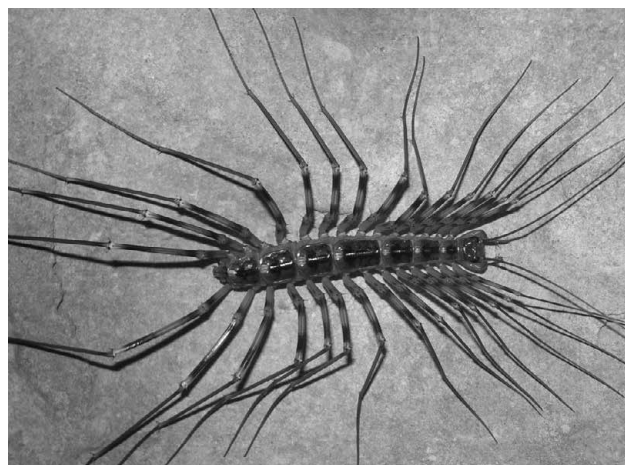


Figure 9. *Thereuopoda longicornis*.

Millipedes were common in all but the very dry of the Lao caves, sometimes assemblies of quite large numbers were found. However, most of the specimens are still awaiting identification. *Phusioglyphiulus steineri* (family Cambalopsidae) from Tham Kamuk, Khammouan Province (Golovatch et al. 2009) and *Sinocallipus steineri* (family Sinocallipodidae) from Tham Gia, Luang Prabang Province (Stoev and Enghoff 2011) have been described as new species.

Shells of snails are commonly found in caves, though it is usually impossible to determine whether they have just been washed in or not. From living specimens, four new species have been described from cave entrance areas of Luang Namtha Province, one named in honour of our expedition member Liz Price, *Sinoennea lizae* (Maassen 2008).

Grey and pink leeches were found in 2006 in Tham Nam Rok, Vieng Phoukha area, and 2007 in Tham Deu (Phou Khoun area) and Tham Thia Thong (Vieng Thong area). They most probably belong to a species which has been described as *Haemadipsa cavatuses* from specimens of a Chinese cave. It is reported to feed on bats (Borda and Sidall 2010) We also found the same species in caves in Myanmar. A new family, Titetrabdellidae, will be created to accommodate the new species and its sister taxon.

Table 1. New species described from or including cave specimens from the present research.

Group	Family	Species	Cave
Fish	Cyprinidae	<i>Bangana musaei</i> Kottelat and Steiner, 2010	Grotte de Nuages, Tham Pong
Cockroach	Blaberidae	<i>Rhabdoblatta memnonia</i> Anisyutkin, 2009	Tham Peung
Spider	Sparassidae	<i>Heteropoda steineri</i> Bayer and Jäger, 2009	Tham Xe Bangfai
		<i>Sinopoda steineri</i> Jäger, 2012	Tham Nam Eng
		<i>Sinopoda tham</i> Jäger, 2012	Tham Chom Ong
		<i>Sinopoda sitkao</i> Jäger, 2012	Tham Doun Mai
		<i>Sinopoda taa</i> Jäger, 2012	Tham Nguen
		<i>Sinopoda suang</i> Jäger, 2012	Tham Ho Neung
		<i>Sinopoda peet</i> Jäger, 2012	Tham Ma Liong
		<i>Sinopoda guap</i> Jäger, 2012	Tham Nam Non
		<i>Sinopoda soong</i> Jäger, 2012	Tham Pha Yot
	Pholcidae	<i>Pholcus steineri</i> Huber, 2011	Tham Chom Ong, Tham Na Thong, Tham Mokfek
		<i>Pholcus namou</i> Huber, 2011	Tham Muay, Tham Roj Ru
		<i>Pholcus thakek</i> Huber, 2011	Tham Kamuk
		<i>Pholcus bangfai</i> Huber, 2011	Tham Xe Bangfai
		<i>Pholcus namkhan</i> Huber, 2011	Tham Pha Man
	Psechridae	<i>Psechrus steineri</i> Bayer and Jäger, 2010	unnamed cave at Ban Tham
		<i>Psechrus ancoralis</i> Bayer and Jäger, 2010	Tham Mue, Tham Na Thong, Tham Seua-Tham Nam Lot
	Salticidae	<i>Spartaeus banthamus</i> Logunov and Azarkina, 2007	Tham Pha Ban Tham
Amaurobiidae	<i>Notiocelotes laosensis</i> Wang, Xu and Li, 2008	Tham Kamuk	
Scorpions	Pseudochactidae	<i>Troglokhammouanus steineri</i> Lourenço, 2007	Tham Xe Bangfai
Millipedes	Cambalopsidae	<i>Plusioglyphiulus steineri</i> Golovatch, Geoffroy, Mauriès, & Van den Spiegel 2009	Tham Kamuk
	Sinocallipodidae	<i>Sinocallipus steineri</i> Stoev and Enghoff, 2011	Tham Gia

5. Discussion and Conclusions

Although a substantial amount of information on the cave fauna has been gathered so far, the biospeleology of Laos is still in the stage of simply compiling an inventory of the cave fauna. We are just beginning to understand the geographic patterns of the first groups. The caves of the Upper Xe Bangfai seem to be a hot spot with several new species. There also seems to be a tendency towards giantism, represented by worlds largest spider *Heteropoda maxima*, the whip spider *Typopeltis magnificus*, the longlegged centipede *Thereuopoda longicornis* and a yet undiscrbed giant harvestman, which made headlines recently for its leg span of more than 30 cm.

However, we are still far away from describing even parts of the cave ecology of Laos – the ultimate goal of biospeleology. Ecological informations, apart from some chance observations, are still completely lacking. Thus there is still abundant work to be done, and a wide untrodden field for the interested researcher. It is to be hoped that more cavers will take up this most exciting research in one of the most exciting countries on earth.

Acknowledgments

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References

- Anisyutkin LN, 2009. New data on Epilamprinae from Vietnam and Laos (Dictyoptera: Blaberidae). – *Zoosystematica Rossica* 18 (1), 48–53.
- Bayer S, 2012. The lace-sheet-weavers – a long story (Araneae: Psechridae: Psechrus). – *Zootaxa* 3379, 1–170.
- Bayer S, Jäger P, 2009. *Heteropoda* species from limestone caves in Laos (Araneae: Sparassidae: Heteropodinae). – *Zootaxa* 2143, 1–23.

- Bayer S, Jäger P, 2010. Expected species richness in the genus *Psechrus* in Laos (Araneae: Psechridae). – *Revue Suisse de Zoologie* 117 (1), 57–75.
- Besson J-P, Bréhier F, Deharveng L, 2001. Laos. – In: C. Juberthie & V. Decu (eds.): *Encyclopaedia biospeologica* 3. Société internationale de Biospéologie, Moulis & Académie Roumaine, Bucarest, 1883–1889.
- Borda E, Sidall ME, 2010. Insights into the evolutionary history of Indo-Pacific bloodfeeding terrestrial leeches (Hirudinida: Arhynchobdellida: Haemadipidae). *Invertebrate Systematics* 24 (5), 456–472.
- Boonman M, Steiner H, 2005. Biospeleological Observations. – Pp. 86–96 in: Dreybrodt, J. & Laumanns, M. (eds): *The unknown North of Laos (Karst and Caves of the Provinces Luang Phrabang and Luang Nam Tha)*. Berliner Höhlenkundliche Berichte 16.
- Chopard L, 1920. Description d'un Orthoptere cavernicole du Laos (Phasgonuridae). *Bull. Soc. ent. France* 1919 No. 18: 338–340.
- Chopard L, 1954. Contribution à l'étude des Orthoptéroïdes cavernicoles. *Notes Biospéol.* 9, 27–36.
- Dalens H, 1992. Sur une nouvelle espèce du genre *Exalloniscus* (Crustacea Isopoda Oniscidae) récoltée au Laos. – *Arthropoda Selecta* 1 (4), 17–22.
- Damen F, Eskes D, Burgers J, Meijer P, Damen F sr., 2003. *Amis Laos Caving Expedition 2000. Expedition Report of the first Dutch caving Expedition in Lao P.D.R.* 104, 4 maps.
- Deuve T, 2000. Un nouveau genre de Trechinae aphaenopsien et une nouvelle *Eustra* microphtalme, cavernicoles dans un karst du Laos (Coleoptera, Trechidae et Paussidae). *Revue française d'Entomologie, nouvelle série*, 22 (1), 37–42.
- Duckworth JW, Tizard RJ, Timmins RJ, Thewlis RCM, Robinchaud WG, Evans TD, 1998. Bird records from Laos, October 1994–August 1995. *Forktail* 13, 33–68.
- Duckworth JW, Salter RE, Khounboline K. (eds.), 1999. *Wildlife in Lao PDR. 1999 Status Report*. IUCN, Vientiane, 275.
- Golovatch SI, Geoffroy J-J, Mauriès J-P, Van den Spiegel D, 2009. Review of the millipede genus *Plusioglyphiulus* Silvestri, 1923, with descriptions of new species from Southeast Asia (Diplopoda, Spirostreptida, Cambalopsidae). *Zoosystema* 31 (1), 71–116.
- Haupt J, 2004. A new species of whipscorpion from Laos (Arachnida: Uropygi: Thelyphonidae). *Senckenbergiana biologica* 83 (2), 151–155.
- Huber BA, 2005. Revision of the genus *Spermophora* Hentz in Southeast Asia and on the Pacific Islands, with descriptions of three new genera (Araneae: Pholcidae). *Zoologische Mededelingen* 79, 61–114.
- Huber BA, 2011. Revision and cladistic analysis of *Pholcus* and closely related taxa (Araneae, Pholcidae). *Bonner Zoologische Monographien* 58, 1–509.
- Jäger P, 2001. A new species of *Heteropoda* (Araneae, Sparassidae, Heteropodinae) from Laos, the largest huntsman spider? *Zoosystema* 23 (3), 461–465.
- Jäger P, 2007. Spiders of Laos with descriptions of new species (Arachnida: Araneae). *Acta Arachnologica* 56 (1), 29–58.
- Jäger P, 2012. Revision of the genus *Sinopoda* Jäger, 1999 in Laos with discovery of the first eyeless huntsman spider species (Sparassidae: Heteropodinae). *Zootaxa* 3415, 37–57.
- Jäger P, Praxaysombath B, 2009. Spiders from Laos: New species and new records (Arachnida, Araneae). *Acta Arachnologica* 58 (1), 27–51.
- Jäger P, Praxaysombath B, 2011. Spiders from Laos with forty-two new records and first results from the provinces Bolikhamsay and Champasak (Arachnida: Araneae). *Acta Arachnologica* 60 (1), 9–31.
- Kottelat M, Bréhier F, 1999. *Troglocyclocheilus khammouanensis*, a new genus and species of cave fish from the Khammouan karst, Laos (Teleostei, Cyprinidae). *Revue suisse de Zoologie* 106 (2), 347–359.
- Kottelat M, Steiner H, 2010. *Bangana musaei*, a new cave fish from central Laos (Teleostei: Cyprinidae). *Ichthyological Exploration of Freshwaters* 21 (4), 289–384.
- Logunov DV, Azarkina GN, 2007. New species of and records for jumping spiders of the subfamily Spartaeinae (Aranei: Salticidae). *Arthropoda Selecta* 16 (2), 97–114.
- Lourenço WR, 2007. First record of the family Pseudochactidae Gromov (Chelicerata, Scorpiones) from Laos and new biogeographic evidence of a Pangaeian palaeodistribution. *C. R. Biologies* 330, 770–777.
- Lourenço WR, 2012. The genus *Vietbocap* Lourenço & Pham, 2010 (Scorpiones: Pseudochactidae); proposition of a new subfamily and description of a new species from Laos. *Comptes Rendues Biologies* 335, 232–237.
- Maassen WJM, 2008. Remarks on a small collection of terrestrial molluscs from north-west Laos, with descriptions of three new species (Mollusca: Pulmonata: Streptaxidae, Vertiginidae). *Basteria* 72, 233–240.
- Robinson MF, Jenkins PD, Francis CM, Fulford AJC, 2003. A new species of the *Hipposideros pratti* group (Chiroptera, Hipposideridae) from Lao PDR and Vietnam. *Acta Chiropterologica* 5 (1), 31–48.
- Robinson MF, Webber M, 2000. Survey of bats (Mammalia: Chiroptera) in the Khammouan Limestone National Biodiversity Conservation Area, Lao P.D.R. *Natural History Bulletin of the Siam Society* 48, 21–45.
- Roncin E, Deharveng L, 2003. *Leptogenys khammouanensis* sp. nov. (Hymenoptera: Formicidae). A possible troglobitic species of Laos, with a discussion on cave ants. *Zoological science* 20 (7), 919–924.
- Smith A, Robinson MF, Webber M, 1998. Notes on a collection of shrews (Insectivora: Soricidae) from Lao P.D.R. *Mammalia* 62 (4), 585–588.
- Smith AL, Robinson MF, Webber M, 2004. Muridae (Rodentia) from the Khammouan Limestone and Xe Pian National Biodiversity Conservation Areas, Lao PDR. *Mammalia* 68 (2–3), 167–173.
- Steiner H, 2008. Biospeleological observations. Pp. 95–105 in: Dreybrodt, J. & Laumanns, M. (eds.): *The Unknown North of Laos (Part 2 – 2006–2008: Karst and Caves of the Provinces Luang Phrabang, Luang Nam Tha, Xieng Khouang, Huaphan and Vientiane)*. Berliner Höhlenkundliche Berichte 32.
- Steiner H, 2010. Biospeleological observations. pp. 71–88 In: Dreybrodt, J. & Laumanns, M. (eds.): *The Unknown North of Laos (Part 3 – 2009–2010: Karst and Caves of the Provinces Houaphan and Oudomxay)*. Berliner Höhlenkundliche Berichte 38. 94 pp + Annex.
- Steiner H, 2012. Biodiversity of caves in Laos The biospeleology of the Xe Bang Fai area. URL: <http://www.explo-laos.com/English/Fauna.html>

- Stoev P, Enghoff H, 2011. A review of the millipede genus *Sinocallipus* Zhang, 1993 (Diplopoda, Callipodida, Sinocallipodidae), with notes on gonopods monotomy vs. peripheral diversity in millipedes. *Zookeys* 90: 1–34, doi: 10.3897/zookeys.90.1291
- Vidhayanon, C., Jaruthanin, K., 2002. *Schistura kaysoni*, (Teleostei: Balitoridae) a new cave fish from the Khammouan karst, Laos PDR. *Aqua* 6 (1): 17–20.
- Wang X-P, Xu X, Li S, 2008. *Notiocoelotes*, a new genus of the spider subfamily Coelotinae from Southeast Asia (Araneae, Amaurobiidae). *Zootaxa* 1853, 1–17.
- Yeo DCJ, Ng PKL, 1999. *Erebusa calobates*, new genus, new species, a troglobitic crab (Brachyura, Potamidae) from Laos. *Journal of Crustacean Biology* 19 (4), 908–916.