

*Cheliferidae (Pseudoscorpiones) from guano, Gua Petruk*



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## **SUMMARY**

The study of cave fauna in Java Karst has been done in February to December 2007 and March 2008 in eleven karst areas. The specimens from March 2008 fieldwork are still under study. About 1028 specimens of cave arthropods from 172 species belong to 68 families are collected. Among them 50 species are known as cave-obligate species. All of these species are members of Arachnida, Chilopoda, Diplopoda, Natantia, Brachyura and Hexapoda. The highest species number of arthropods is found in Gunung Sewu (46 species) followed by Gombong (43 species) and Sukabumi (32 species). About 34 species of bats from eight families are collected. The highest species number is found in Tuban (14 species) followed by Gunung Sewu, Gombong and Banten for each karst is 8 species. Several new species of arthropods are discovered during the fieldwork mostly members of arachnids and crustaceans. The second species of *Stenasellus* (Isopods) is discovered in tourist cave in Gua Buniayu (Sukabumi). About three species of *Stygophrynus* from caves in Grobogan, Tuban and Madura are believed to be a new to science. The biogeography and contribution to conservation of certain cave species are discussed.





## Chapter 1.

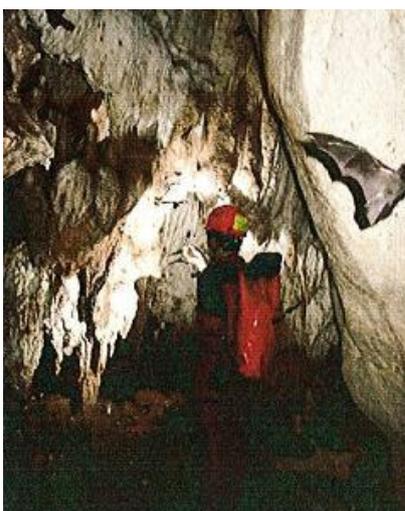
### **INTRODUCTION**

Indonesia has an extensive karst area ranging from Sumatra to Papua. Unfortunately, its biological information in most areas is still poor and uneven.

Caves in Java have an extensive development, but there are very few biological surveys, especially on cave fauna diversity. Caves are home for huge number of species such as arthropods and bats, but only 5 described species have been found in Java. This is very low compared to Maros Karst, which has over 15 species. The most recent cave obligate species from java, *Syenasellus javanicus*, was described in 2006. The species was found in small puddles of small caves near limestone's quarry. The status of the population still remains unknown. Moreover, several species are still waiting to be described and believed to be obligate cave fauna that new to science. Survey on arthropods and a bat in java's karst areas is tremendously needed, as the result will provide baseline data for more critical conservation steps.

Karst areas in Java are densely populated and threatened by limestone quarry, habitat conversion, and many other human activities. Since none of these karst areas have been designated as conservation area, it is very difficult to manage the karst ecosystems to ensure the conservation of cave fauna and its habitats.

The project is focused on cave arthropods and bats that form an important link between subterranean and epigeal world.



The main objectives of the project are:

1. to explore and to study the diversity of cave fauna focussing on cave arthropods and bats;
2. to build a baseline data for further activities and support for conservation and management;
3. to promote the importance of cave fauna in order to increase public awareness to its diversity and roles in karst conservation;
4. to support the declaration of karst protection using cave fauna baseline data.





## Chapter 2.

### **PROJECT ACTIVITIES**

**R**ESearch ACTIVITIES. Research activities are based on several fieldworks in eleven karst areas especially Gunung Sewu, Gombong Selatan, Cibinong Karst and other karst areas. The fieldwork was done started from February-August 2007. (see Chapter 3 and Chapter 4).

**D**ISSEMINATION ACTIVITIES. The dissemination activities are based on several talks, seminars and many medias such as leaflets, posters, news and television. The activities are located in several places Gunung Sewu, Yogyakarta, Jember (East Java) and other areas.





## Chapter 3.

### **PROJECT AREAS**



The project areas are in eleven karst areas with several caves successfully observed.

**Table 1.** The list of karst areas in Java

No.	Karst Areas	Regency	Province	Ages	Km <sup>2</sup>
1	Banten	Lebak	West Java	Miocene	-
2	Sukabumi	Sukabumi	West Java	Oligo-Miocene	342.85
3	Cibinong	Bogor	West Java	Miocene	55
4	Ciamis	Ciamis	West Java	Miocene	290.17
5	Padalarang	Bandung	West Java	Oligo-Miocene	9.91
6	Gombang	Kebumen	Central Java	Miocene	40
7	Grobogan	Grobogan	Central Java	Miocene	-
8	Menoreh	Purworejo	Central Java	Oligo-Miocene	-
9	Gunung-Sewu	Gunung Kidul	Yogyakarta	Miocene	1300
10	Tuban	Tuban	East Java	Pliocene	1500
11	Madura	Sampang	East Java	Miocene	-





Brief overview of each karst area with notes on caves

1. Bayah karst (Banten Province)  
 Bayah karst is situated on the southern coast of Java as part of Southern Mountain Range. No detail study on cave biodiversity on this area.  
 Cave Surveyed:
  - a. Gua Lalay
  - b. Gua Lauk
  - c. Gua Langir
  - d. Gua Sarah
  
2. Sukabumi Selatan Karst (West Java Province)  
 Sukabumi Selatan is situated on Sukabumi Regency about 10km southern Sukabumi city. The geological setting of the area is discussed completely by Anonym (2004). Sukabumi Selatan is a part of Nyalindung formation with the ages of the carbonate deposit about Oligo-Miocene. The length of the karst area is about 12.5km and width 2.5km. The area is the highest karst formation in Java known so far with about 700-800m asl.  
 Caves:
  - a. Gua Lalay near Pelabuhan Ratu
  - b. Gua Bunlayu
  - c. Gua Siluman
  - d. Gua Antik
  - e. Gua Gombong
  
3. Cibinong-Clampea-Leuwiliang Karst (West Java Province)  
 The Cibinong Karst is about 55km<sup>2</sup> with the carbonate deposit about Miocene. Recently, the area has been exploited by cement factory and critically threatened by many human activities.  
 Caves:
  - a. Gua Cikaray
  - b. Gua Cikenceng
  - c. Gua Garunggang
  - d. Gua Sipahang
  - e. Gua Simasigit
  
4. Padalarang Karst (West Java Province)  
 Cave:
  - a. Gua Pawon
  
5. Ciamis-Tasikmalaya Karst (West Java Province)  
 Caves:
  - a. Gua Donan
  - b. Gua Lanang
  - c. Gua Panggung





- d. Gua Rengganis
- e. Gua Karangpani
- f. Gua Cijambe
- g. Gua Pelataran



6. Gombang Selatan Karst (Central Java Province)

Caves:

- a. Gua Petruk
- b. Gua Barat
- c. Gua Liah Atas
- d. Gua Jatijajar
- e. Gua Intan
- f. Gua Simbar
- g. Gua Kali
- h. Gua Darat

7. Menoreh Karst (Central Java Province)

Caves:

- a. Gua Kiskendo
- b. Gua Nguwik
- c. Gua Seplawan
- d. Gua Sekantong

8. Gunung Sewu Karst (Yogyakarta-Central Java-East Java Province)

Caves:

- a. Gua Toto
- b. Gua Sodong Dadapayu
- c. Gua Sodong Mudal
- d. Gua Semulah





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- e. Gua Gilap
  - f. Gua Brihan
  - g. Gua Kalibanjar
  - h. Gua Gong
  - i. Gua Tabuhan
  - j. Gua Kiuut
  - k. Gua Jomblang Lor
  - l. Gua Song Agung
  - m. Gua Braholo
  - n. Gua Tlogo

9. Grobogan Karst (Central Java Province)

Caves:

- a. Gua Urang
- b. Gua Gadjah
- c. Gua Pawon

10. Tuban Karst (East Java Province)

Caves:

- a. Gua Akbar
- b. Gua Nggragas
- c. Gua Lawa Montong
- d. Gua Manuk Montong
- e. Gua Ngerong
- f. Gua Lawa Temandang 1
- g. Gua Lawa Temandang 2
- h. Gua Lawa Jururejo
- i. Gua Srunggo
- j. Gua Putri Asih
- k. Gua Jombangan 1
- l. Gua Jombangan 2
- m. Gua Srunggo Fosfat
- n. Gua Segeru
- o. Gua Landak 1
- p. Gua Lawa Mbelik

11. Madura Karst (East Java Province)

Caves:

- a. Gua Sarang Burung
- b. Gua Pajjang





## Chapter 4.

# **PROJECT RESULTS**

## THE CAVE FAUNA DIVERSITY INVERTEBRATE

About 1028 specimens from 172 species, 71 families belong to groups of Arachnida, Myriapoda, Crustacea and Hexapoda are collected from caves (Table 3). Among them 50 species are indicated as cave obligate species (troglobite and stygobite). One species of interesting Hirudinea (Annelida) is reported.

**Table 2.** The diversity of cave arthropods from Java caves

Taxa	Family	Number of Species	TB/SB
<b>Crustacea</b>			
Brachyura	4	4	1
Natantia	2	6	4
Isopoda	5	20	12
<b>Myriapoda</b>			
Chilopoda	3	4	0
Diplopoda	3	6	3
<b>Arachnida</b>			
Acari	3	9	0
Opiliones	3	9	0
Schizomida	1	6	6
Pseudoscorpiones	1	1	1
Amblypygi	3	7	2
Uropygi	1	1	0
Araneae	10	25	0
<b>Hexapoda</b>			
Thysanura	1	1	0
Diplura	1	2	2
Collembola	9	21	15
Coleoptera	6	22	0
Dermaptera	2	4	1
Dictyoptera	2	5	3
Diptera	5	5	0
Hymenoptera	2	6	0
Orthoptera	2	4	0
Thysanoptera	1	1	0
Trichoptera	1	2	0
<b>TOTAL</b>	<b>71</b>	<b>172</b>	<b>50</b>





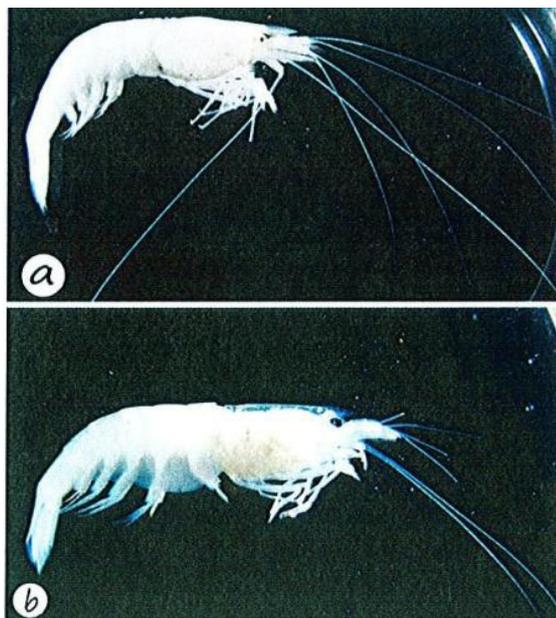
## HIRUDINEA

Hirudinea is found on the cave walls with reddish colouration and probably as a parasite of bats. This group is also found in caves in Papua and sporadically found in Sumatran caves (Deharveng et al, 2006). Unfortunately, the altitude of these findings are never reported. In Java, they are collected in two karst areas in Sukabumi (Gua Bunlayu) and Menoreh (Gua Sekantong). All of these karst are in the altitude about 700-800m asl and never collected in the caves with the altitude lower than 700m asl.

## CRUSTACEA

Crustacea is a common group that found in cave habitat both terrestrial and aquatic. They show the highest diversity of the cave obligate species. About 30 species from 11 families are recorded and 17 species are believed to be cave species.

**Decapoda.** Decapoda is a group mostly aquatic species, represented by two orders i.e. Brachyura and Natantia. Brachyura is composed of four families (Sesarmiidae, Parathelphusidae and two unidentified families). The first species of decapods from caves is cave crab, *Karstarma jacobsoni* (Ihle, 1912) (Sesarmiidae). The species is only found in Gunung Sewu karst in some caves a part of Briban Cave System such as Gua Jomblang, Gua Ngingrong, Gua Jurang Jero (Adji pers. comm.), Gua Gilap, Gua Sodong Dadapayu and Luweng Towati (Hidayat pers. comm.). They live in percolation water and rarely found in a main river. It is suggested that the crab is dependent on percolation water. *Parathelphusa convexa* is reported from Gua Ngingrong (Ihle, 1912). *Parathelphusa 'tridentata'* is collected from Gua Urang in Grobogan and two unidentified species are collected from Gua Cilalay and Gua Lauk (Banten).



**Figure 4.** The cave atyids from Gunung Sewu  
a. *Caridina* sp.1 with long rostrum, b. *Caridina* sp.2 with short rostrum (C. Rahmadi).

Natantia is represented by two families (Atyidae and Palaemonidae). Family Atyidae is found in Gunung Sewu, *Caridina* sp.1 and *Caridina* sp.2 with small eyes and white colouration. These two species are separated by the length of rostrum (Daisy Wowor pers. Comm.). They are found in Gua Gilap, Gua Bribin and Gua Jomblang and could be a new to science. The cave prawn *Macrobrachium poeti* (Holthuis, 1984) (Palaemonidae), is collected from Gua Sodong Mudal, Luweng Tong Pocot and Gua Ngingrong. In Gua Gilap, they are found living together with *Karstarma jacobsoni*. Other stygophilic species are commonly found in some underground water in several karst areas such as Gombong and Banten. In



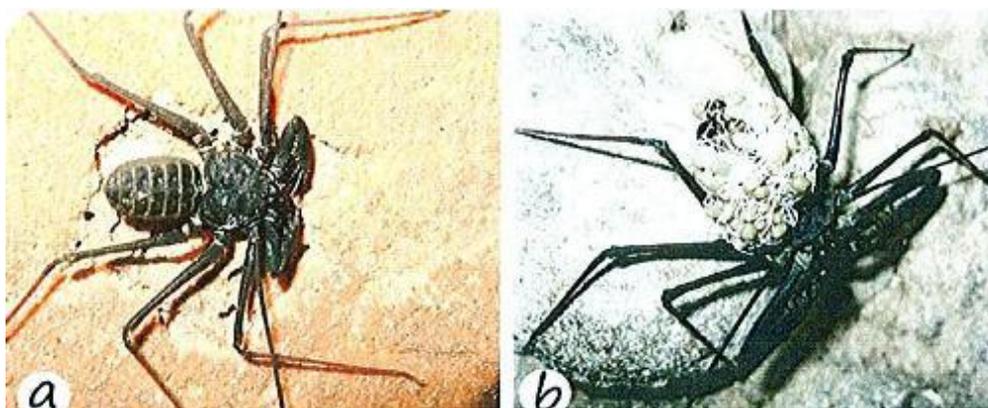


Grobogan, we collected one species of *Macrobrachium* sp. that have small eyes, white and elongated antenna and could be a second stygobitic species for java.

**Isopoda.** Isopoda is represented by terrestrial and aquatic species. The aquatic species are represented by *Stenasellus javanicus* (Cibinong) and *Stenasellus* sp. (Sukabumi). These species are found in the percolation water with very small population. *Stenasellus javanicus* is collected from Gua Cikaray (Cibinong) and only found in the single cave. A second record of *Stenasellus* sp. is found in Gua Buniayu (Sukabumi) about 100km from Cibinong at the altitude 800m asl. Terrestrial species are dominated by family Armadillidae is only collected from Gua Cikaray (Cibinong) and non cave adapted species. Trichoniscidae is family with white body and in each segment equipped with crest and possible to roll and found only in Gua Buniayu. Porcellionidae have some species and mostly epigean species. The most diverse is Philosciidae with 12 species encountered. They have highly adaptation into cave environment. Two cave species are described by Schultz (1985) namely *Tenebrioscia antennuota* and *Javanoscia elongate*. They are collected from caves in Gunung Sewu. Other species are also found in other karst areas and show highly adapted to cave environment.

## ARACHNIDA

**Schizomida.** About six species of schizomids are recorded. Two species are found in Tuban, one species in Grobogan, one species in Gombong and one species in Banten and some unidentified female specimens from Sukabumi and Cibinong. The species of schizoids belong to family Hubbardiidae that widely distributed in the world. In java, the schizomid is only represented by single species *Javazomus oculatus* (Cokendolpher and Sites, 1988) from forest habitat in Cibodas West Java. The species is firstly described under genus *Schizomus* and later Reddel and Cokendolpher (1995) created a new genus of *Javazomus*. The specimens from caves are never studied and remain undescribed. The morphological characters are shown some troglomorphic features such as one species from Tuban that has a pale colouration and no eyes spot.



**Figure 5.** A cave amblypygi from Java caves a. *Stygophrynus* sp. From caves in Tuban b. *Charon grayi*, carrying the nymphs from Gunung Sewu (C. Rahmadi).





**Amblypygi.** A cave whip-spider is represented by three genera i.e. *Charon*, *Stygophrynus* and *Sarax* from two families (Charontidae and Charinidae). All of these genera have specific distribution in Java caves. Genus *Charon* is represented by single species, *Charon Greyi* that has widely distributed from Singapore, Philippines, Kalimantan, Sulawesi, Papua and Solomon Island. In Java, this species is only found in the eastern part of Java started from Gunung Sewu (Yogyakarta) to farther east up to Madura. The species is never found in the western part of Java. *Charon Greyi* is found live in the same cave with *Stygophrynus* spp. only in Tuban and Madura.

Genus *Stygophrynus* is represented by at least five different species and four of them are believed to be new to science. The first species is described by Roewer (1928) namely, *Stygophrynus dammermani* Roewer, (1928) (Charontidae) collected from caves around Bogor. The distribution of this species reach the eastern most in Menoreh and found also in Krakatau Island on epigeal habitat (Rahmadi and Harvey, submitted paper). Other species are found in caves in Grobogan, Tuban and Madura. These three species are distinguished by the arrangement of cheliceral teeth. The new species of *Stygophrynus* is also discovered from the epigeal habitat in Ujung Kulon NP and this species is never found in the cave habitat (Rahmadi and Harvey, submitted paper). The distribution and biogeography of *Stygophrynus* in Java is interesting for further investigation.

Genus *Sarax* is small-sized species of whip-spider that commonly lives under stone or dead wood on cave floors. The first species of is described by Gravely (1915) namely *Sarax javensis* (Gravely, 1915) (Charinidae) from Bogor (as Buitenzorg). The habitat of this species is not reported by Gravely (1915). *Sarax* spp. are found in Sukabumi, Gunung Sewu and Grobogan. There are two different species of *Sarax* based on the number of spines on dorsal pedipalpal tibia.

**Uropygi.** Uropygi is a group of arachnid that have a tail on the end of the abdomen. In Java, there are four species of uropygi. These species are *Thelyphonus caudatus* Linnaeus (1758), *Thelyphonus asperatus* Thorell (1888), *Thelyphonus linganus* C.L. Koch and *Hypoctonus javanus* Thorell (1888). These four species, only one species is known live in caves, *Thelyphonus caudatus*. This species is found in Banten, Sukabumi, Cibinong, Gombong, Grobogan, Tuban and Madura. They live under stones and crawl on the cave walls. They are an active predator of other arthropods such as crickets and cockroaches.

**Pseudoscorpions.** Group of false-spider is less diverse in Java caves. The first species from Java is described by Tullgren (1912) namely *Stygiochelifer cavernae* (Tullgren, 1912). The species is collected from lava caves near Banyumas, Gua Lawa and live in guano piles and also collected in Gua Petruk (Gombong). The survey in Gua Lawa (lava caves) in April 2007 failed to collect some specimens from there. Since the cave is open for tourists, a lot of species maybe extinct from this type of locality.





**Opiliones.** Opiliones is an arachnid that commonly live on the leaf litters and some found in caves. We found at least three families (Assamiidae, Epedanidae and unidentified family). Family Assamiidae is represented by one species collected from Gua Jomblang (Gunung Sewu). Family Epedanidae is the most diverse family found in java caves with six species collected in Gombong Selatan, Grobogan, Menoreh, Gunung Sewu, Ciamis and Tuban.

**Araneae.** Araneae is a large group of arachnids and some species are known as cave species. In Java only one species is known described by Deeleman-Reinold (1995) namely *Athelphus javanensis*. The species is collected from caves in Gua Jatijajar. We collected 25 species from several families (Tetrablemmidae, Pholcidae, Sparassidae and some unidentified families).

## MYRIAPODA

**Diplopoda.** Diplopoda is dominated by family Cambalopsidae (*Hypocambala* sp.) that commonly found on guano habitats. They are represented by single species that indicated by number of eyes. A second group is Polydesmida that commonly live on the oligotropic habitats. They have white in colour and no eyes. Doratodesmida is also found in caves, but it might not be a cave species due to the present of eyes and reddish in colour.

**Chilopoda.** A common group of chilopods in Java caves is *Scutigera* spp. They are found in Banten, Cibinong and Grobogan. They are an active predator for cave crickets, cockroaches and other arthropods.

## HEXAPODA

**Diplura.** Diplura is only represented by a single family, Campodeidae. The family is suggested a cave adapted species. No one species has been described from Java. The described species are only known from caves in Maros Karst.

**Collenbala.** A large number of Collenbolan species are found in the caves and most of them are adapted to cave habitat. They are mostly dominated by family Entomobryidae, Paronellidae, Isotomidae, Neanuridae, Sminthuridae, Neelidae and Hypogastruridae. The most diverse family is Entomobryidae; they are represented by at least ten species and are mostly cave adapted species especially forming genus *Pseudosinella* spp. The paronellids species are represented by species of *Cypoderopsis* sp. and found in Gombong and Nusakambangan (Suhardjono et al., 2001).





**Figure 6.** *Diestrammena* sp. (Rhaphidophoridae) from Gua Buniayu (C. Rahmadi).

**Insecta.** Fifty species belong to 21 families and seven orders are collected from cave in Java. They consist of Coleoptera, Dermaptera, Dictyoptera, Diptera, Hymenoptera, Orthoptera, Thysanoptera and Trichoptera. Coleoptera is the most diverse in caves represented by 22 species. Several species are described from caves such as *Xeniaria jacobsoni* (Burr, 1912), *Rhaphidphora dammermani* (Karny, 1924). One species of Gryllidae, *Arachnomimus jacobsoni* (Chopard, 1924) are not collected during the survey. The species is only known from Gua Jatijajar. Other groups are less diverse in caves. Some of carabids beetles are non cave species mostly they have eyes and with colouration on the body. One species of Trichoptera is recorded

from Gua Buniayu and Gua Rengganis namely *Diplectrona fasciata* they live in the cave near the entrance. Both of the caves have underground rivers.

## VERTEBRATE

**Chiroptera.** Seventy six bat species are known from Java and during the survey 34 species are successfully recorded. The results shown that the cave have high contribution to bats diversity in Java. Most of the species in Java are found in caves.

The most diverse family is Rhinolophidae represented by 10 species, and secondly family Hipposideridae with 9 species. These families commonly roost in caves, and predicted have a higher echolocation compared with other families. The main character from Rhinolophidae and Hipposideridae is a modified nose, that useful for echolocation. Fruit bats (Megachiroptera) are rarely found in the cave due to the ability of echolocation. During the survey we found four fruit bats species, one of them (*Pteropus vampyrus*) is collected from outside caves in Tuban and other species (*Rousettus amplexicaudatus*, *Eonycteris spelaea* and *Cynopterus brchyotis*) have a roost in caves.



**Figure 7.** The colony of bats consists of million individuals of *Rousettus* sp., found in Gua Ngerong (Tuban) (C. Rahmadi).





**Table 4.** The diversity of bats from Java caves

Family	Number
<b>MICROCHIROPTERA</b>	
Emballonuridae	1
Hipposideridae	9
Molossidae	1
Megadermatidae	1
Nycteridae	1
Rhinolophidae	10
Vespertilionidae	7
<b>MEGACHIROPTERA</b>	
Pteropodidae	4
<b>TOTAL</b>	<b>34</b>



**Figure 8.** A species of bat, *Nycteris javanica* Collected from Gua Pawon (Grobogan Central Java) (Ph. C. Rahmadi).

A very large number of bats are found in three caves (Gua Lalay (Sukabumi), Gua Lowo Temandang and Gua Ngerong (Tuban). Thousands of *Chaerophon plicatus* are found in Gua Lalay, about two tons of guano are collected every two months from this cave. In Gua Lowo Temandung, more than 12,000 bats consist of Hipposideridae and Rhinolophidae are found. Gua Cilalay (Banten) have the highest species number of bats consist of eight species from three families. *Nycteris javanica* is found in three karst (Tuban, Gunung Sewu and Grobogan). More than 30 individuals of *Nycteris javanica* are found in Gua Lowo Belik and Gua Lowo Temandang. Usually, the population of *Nycteris javanica* is

never exceeded from 15 individuals. This record is an interesting finding and could be a new record for the population of *Nycteris javanica* in Java caves.

## CAVE FAUNA HIGHLIGHTS

Cave invertebrate are the most interesting groups in the cave ecosystem, they compose of up to 90% of cave species. Several known cave species are collected from type localities such as *Macrobrachium poeti* (Gunung Sewu), *Karstarma jacobsoni* (Gunung Sewu), *Tenebrioscia antennuata* (Gunung Sewu), *Javanoscia elongate* (Gunung Sewu), *Xeniaria jacobsoni* (Gombong Selatan), *Stenasellus javanicus* (Cibinong) and *Stygophrynus dammermani* (Cibinong). Several species, about seven species, are believed to be new to science which are *Stenasellus* sp. (Sukabumi), *Macrobrachium* sp. (Grobogan), *Stygophrynus*





n.sp.1 (Grobogan), *Stygophrynus* n.sp.2 (Tuban), *Stygophrynus* cf. *Moultoni* (Madura), *Philosciidae* (Gombong), *Heteropoda* sp. (Sukabumi), and *Caridina* sp. (Gunung Sewu). Most of these species are restricted to one karst area and never known from other karst areas.

For bat species, there is one species that rarely occurs in Javanese caves. The species *Nycteris javanica* are found with small colonies in two karst areas, Grobogan and Tuban. We failed to find the species in other karsts.

## BIOGEOGRAPHY OF CAVE FAUNA

The origin of cave obligate species may be interesting to review the biogeography of Java caves.

Some cave-obligate species from Java have biogeographical values. The cave aquatic isopods from Cibinong, *Stenasellus javanicus* and from Sukabumi (*Stenasellus* sp.) are only known from karst are in West Java. The genus is absent from central java to farther east up to East Java and Madura Island. They are apparently absent in Central and East Java and interesting for Javan caves fauna biogeography (Magniez and Rahmadi, 2006). Since the details collection on each karst area has been done and failed to find the presence of *Stenasellids* species in eastern part of java, we come to the conclusion that *Stenasellids* are only present in West java and absent from Central Java to eastern part of Indonesia, from Sulawesi to Papua (Rahmadi and Magniez, 2006). The *Stenasellids* are only known from Thailand, Cambodia, Sumatra (Magniez, 1989, 1992, 199), Borneo (Magniez 1982 Rahmadi and Suhardjono, 2004) to western part of java (Magniez and Rahmadi, 2006).

Other fauna show similar biogeographics patterns is whip-spider especially genus *Stygophrynus*.v The genus are well distributed in several caves in Burma, Thailand to Malay peninsula to Sumatra, Borneo and Java. The distribution in Java is only known in western part of Java to central part up to Menoreh Karst to the north east reach Grobogan and Tuban Karst across to Madura Islands. The genus is apparently absent in Gunung Sewu to farther east along the Southern Mountains up to Blambangan.

## ENDEMISM AND CONSERVATION VALUES

The most recent cave species described from Java, *Stenasellus javanicus* is only known from single cave in Cibinong (West Java). The specimens are collected only from two specimens, male and female, from single small puddle in Gua Cikaray. The recent records, they are found in small pool with only 5 specimens observed. They are highly dependent on the small pool with percolation water. They are never found in water bodies of underground rivers. The species is highly threatened by mining activities in the area and also caving activities in the cave. The species is believed to be site-endemic species and no epigean species exist. Conservation efforts are extremely needed to conserve the population in the near future.





Conservation value of each cave fauna species are known by their uniqueness (well adapted to cave environment: no eyes, elongated appendages, no pigments and other morphology and physiology adaptation), small populations especially for cave arthropods, site-endemic species, vulnerable to any disturbance and play an important role on ecosystem services especially bats.

Bats are the key species for the ecosystem equilibrium that effect the another organism (Primark, 1998). The dense population of human settlement and karst mining will be serious disturbance for cave ecosystems especially bats. The habitats destruction will give the big effect for bats survival (Johnston, 2002).

Conservation strategies that suggested for the decision maker were needed. Some of these are:

1. Further effort to conduct studies of cave biodiversity, including bats;
2. Specific conservation for species that include an IUCN red listed;
3. Conservation of cave roost and foraging habitat.

During the survey, one species in IUCN red listed data book was recorded i.e. *Nycteris javanica* with the status is Vulnerable. The species found in Gua Lowo Temandang, Gua Lowo Belik Cave, Gua Putri Asih (Tuban) and Gua Powon (Grobogan).

Vermeullen and Whitten (1999) mentions that biodiversity has several factors to consider for conservation purposed. All of the factors also relevant in cave fauna diversity in contribution to karst conservation. The factors are:

1. ***Evolutionary (phylogenetic) isolation of a species.***  
Caves are a place of evolutionary process of organism. Several cave species are believed to be evolved in the caves ecosystem.
2. ***Uniqueness of a species.***  
Cave faunas, especially arthropods, have a high level adaptation to cave environment. The adaptation are including morphology, physiology and behaviour adaptation. Morphology adaptation in cave arthropods to cope with complete darkness are small eyes or even no eyes, longer appendages to increase the capability of sense organs such as long antenna and legs.
3. ***The role of species in supporting the ecological system in which it occurs (keystone species).***  
Bats are the most important groups in terms of ecological system. Frugivorous and nectarous bats play an important role in the ecosystem process. The nectarous bats important to pollination the dominant plants such as mangrove trees. The cave in Tuban, Ngerong Cave, is home to a million individuals of five species of bats and





one of them is *Eonycteris spealaea* very important in the pollination of the plants. Other species frugivorous species, *Rousettus amplexicaudatus*, is important in the seed plant dispersal. Insectivorous species, *Rhinolopus* spp., are important in controlling the insect's especially agricultural pests. The loss of all the bat species will have a high impact on the collapse of the ecosystem function and economic loss.

#### 4. *Uniqueness of functional groups.*

Bats have a unique function in ecosystems such as to help control pest insects. A lot of bat caves in some karst areas are threatened by human activities. The loss of bat cave will have a dramatic effect on the stability of the ecosystem.

Tuban Karst has a lot of bat caves and this area is threatened by development of cement plant and this development is feared to be a threat to ecosystem balance in Tuban area.

#### 5. *The range size of the species occurring within an area.*

Java caves are a home of species which are restricted to certain ecological requirements and also has site specific species that are only found in certain places. Cave fauna's have several endemic species. Vermeullen and Whitten (1999) also made a criteria of endemism based on the size of the area. **A site-endemic species:** the range is up to 100km<sup>2</sup> but usually less than 1km<sup>2</sup>. Example: *Stenasellus javanicus* that only known from single cave in Cibinong and also one closely related species, *Stenasellus* n.sp., from tourist cave in Sukabumi, Buniayu Cave. These two species of cave stenasellids are only found in single caves in small karst areas.

The population size are very small and vulnerable to any disturbance a **local-endemic:** the species range about 100-10,000km<sup>2</sup>. Example: *Macrobrachium poeti* and *Karstarma jacobsoni* is only known in Gunung Sewu Karst. These species are present in several cave systems and found only in percolation water. A **regional-endemic:** the species of cave amblypygids from Bogor, *Stgophrynus dammermani*, firstly known only in Bogor caves. Recent discovery show that the species present in several caves from Banten caves to Menoreh karst (Central Java).

The issue to consider the karst area importance of cave biodiversity (adapted from UNEP-WCMC 2000):

1. Species richness or total number of species in given area;
2. Degree of endemism;
3. Cave adaptation;
4. Number of threatened species;
5. Importance for economically important species;
6. Biogeographic coverage.





## Chapter 5.

### **DISSEMINATION OF PROJECT RESULTS**



Overall results of the project are disseminated through several ways. We succeeded to publish in newspapers, TV stations, poster and leaflets, website, magazines, talks and presentations, national journals and plan to publish in international journals. We also shared the knowledge of cave fauna with local guides in tourist cave Gua Buniayu in West Java. The details of the dissemination of information are shown below:

#### *Newspapers*

There are several newspapers that published our work both general work in caves of java as well as specific location such as Tuban Karst (East Java). The title and newspaper are:

1. *Merekam Gua Menjelang Anjalnya* ( Koran Tempo, Friday 4<sup>th</sup> May 2007)
2. *Dari Penelitian LIPI tentang Fauna di Gua Taban (1): Di Gua Ngerong Hidup Keleawar Pemangsa Buah dan Madu* (Radar Bojonegoro, Monday 16<sup>th</sup> April 2007)
3. *Dari Penelitian LIPI tentang Fauna di Gua Taban (2):*
4. *Kelelawar Nyaris Punah* (Petani Terancam, Monday 16<sup>th</sup> April 2007)

#### *TV Stations*

1. *Para Penghuni Perut Bumi*, EXPEDITION - METRO TV, Friday 20<sup>th</sup> April 2007  
21.30pm WIB re run: 3 times
2. News on RCTI TV about the issues of bats in their contribution to ecosystem especially in Tuban area (West Java)
3. News on TVRI

#### *Talks*

We had the opportunity to give talks to local government in Jember (East Java) and Gunung Kidul (Gunung Sewu, Yogyakarta) about the importance of karst conservation and cave fauna.

1. Dissemination on karst and cave biodiversity in Jember, 30<sup>th</sup> August 2007. The opportunity was possible because of the invitation of **PUSREG JAWA (KHL)** Yogyakarta
2. Dissemination on karst and cave biodiversity on





3. Training of Senior High School Teacher organised
4. by KAPEDAL (The Office of Environmental Impacts Control), Gunung Kidul, Wonosari, 21<sup>st</sup> November 2007.

### **Seminars**

The project results are presented on:

1. The karst workshop organised by GEGAMA, faculty of Geography Gadjah Mada University (Yogyakarta, 27-29<sup>th</sup> August 2007)
2. "The cave fauna of Java: the preliminary results", presented in Symposium of The Society of Indonesian Taxonomic Fauna in Lampung, 13-14<sup>th</sup> November 2007 by Cahyo Rahmadi
3. "Cave bats in Karst Area of Java Island" presented in Zoology Colloquium, Faculty of Resource Science and technology, UNIMAS (University of Malaysia Sarawak) in Sarawak, 16<sup>th</sup> April 2008 by Sigit Wiantoro

### **Workshops**

Involved in the Workshop on Strategic Plan on Gunung Sewu Karst organised by Kememtrian Lingkungan Hidup Republic of Indonesia (Yogyakarta, 27<sup>th</sup> November 2007).

### **Poster and Leaflet**

Several posters were produced and distributed to all stakeholders.

### **Websites**

We also launched the website of the project on March 2008 [www.biospeleologi.web.id](http://www.biospeleologi.web.id). The contents of the web are general results of the project and put a highlight on some cave adapted species.

The project results is also published in the online news especially about the discovery of a second record of *Stenasellus* sp. In Sukabumi. <http://www.kompas.com/ver1/Iptek/0702/20/180808.htm>.

About the field work in Tuban area. [http://www.jawapos.com/index.php?act=detail\\_radar&id=158835&c=87](http://www.jawapos.com/index.php?act=detail_radar&id=158835&c=87)

The general results of the project are also found in the Koran Tempo online. [http://www.korantempo.com/korantempo/2007/05/04/Ilmu\\_da\\_Teknologi/krn,20070504,62.id.html](http://www.korantempo.com/korantempo/2007/05/04/Ilmu_da_Teknologi/krn,20070504,62.id.html)

The is also a personal website to make it easier to publish new discoveries. <http://cavernicoles.wordpress.com/project-overview/>





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### Scientific Journals

#### 1. National Journals

- a. Cave bat communities in Buniayu Cave (Submitted by Sigit Wiantoto to national peer reviewed Journal ZOO INDONESIA)
- b. Morphometric analysis of *Charon grayi* (Amblypygi) from Gunung Sewu (Planned to submit to ZOO INDONESIA written by Sidiq Harjanto, Cahyo Rahmadi and Hari Purwanto)
- c. Cave Arthropods diversity in Nusakanbangan Island

#### 2. International Journals

- a. **A new species of Amblypygi from Java** (submitted to Raffles Bulletin of Zoology)
- b. Other related topic on cave arthropods ecology





## Chapter 6.

# **THE IMPACTS OF THE PROJECT**

## REGIONAL IMPACTS

**Research Activities.** The project has had several impacts especially in the increase of awareness to cave fauna diversity. Involving two students during the project also was valuable especially in the promotion of the importance of cave fauna to student university and to increase the awareness to study about cave fauna.

The two students were Adhe Safitri (UIN Syarif Hidayatullah) and Rahmad (Institute Pertanian Bogor). Adhe Safitri is an undergraduate student from the University Islam Negeri Syarif Hidayatullah Jakarta who studied cave arthropods communities in Cikaray cave (Cibinong Karst, West Java). The research part of the project was to finish her undergraduate studies. Rahmad is an undergraduate student from Bogor Agricultural Institute Faculty of Forestry who studied the interpretation of cave fauna for ecotourism in Buniayu Cave (West Java) under the supervision of Dr Arzyana Sunkar.





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