

# Changes in the composition of the land snail fauna of Mt. Ciamprea, West Java, Indonesia

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**Abstract.** Mt. Ciamprea is a limestone outcrop surrounded by human settlements in West Java. To update the inventory of land snail species from Mt. Ciamprea and to compare it with the previous records, we sampled land snails at eight plots (10m x10m) in January 2013 and May 2014. In total, 1702 specimens belonging to 16 families and 34 species were collected. *Stomacosmethis jagori* (Cyclophoridae) was the dominant species comprising 24% of the individuals. The number of species was similar to a previous survey, in which 38 species were recorded, but the species composition was different. Sixteen of the previously recorded species were not found in our survey, but we could record 13 species that were not known from Mt. Ciamprea so far. Among them were two invasive species, *Lissachatina fulica* (Achatinidae) and *Bradybaena similaris* (Camaenidae) that colonized the area since the early 20th century. A more detailed survey will be necessary to ascertain whether and which previously recorded species are actually extinct on Mt. Ciamprea.

## 1 Introduction

Indonesia has the most extensive limestone outcrops (154.000km<sup>2</sup>) in South East Asia. Java, the most populated island in Indonesia, has 5500km<sup>2</sup> of limestone outcrops [1]. Limestone karsts are “arks” of biodiversity and often contain high levels of endemism [2]. This is particularly true for land snails which are abundant and species rich in karst areas because the calcium-rich soils favour their growth and reproduction [3,4]. Land snail endemism peaks on karsts because of the low dispersal abilities of land snails and the isolation of karst areas [5]. Low dispersal abilities and the requirement for undisturbed habitats make land snails vulnerable to extinction [6]. Limestone quarrying is the primary threat to karst biodiversity in Southeast Asia, where quarrying rates exceed those in other tropical regions and caused declines and extinctions among site-endemic taxa [2].

Many limestone outcrops in Java are located adjacent to or within urban areas and surrounded by human settlements. Mt. Ciamprea is such a limestone hill near Ciamprea village in West Java (Fig. 1). It is composed of long coral reefs from the Miocene that have been raised up to 350m above sea level [7]. For years, the area has been suffering from ongoing quarrying and land use

change towards agriculture and plantations. In the past years, some parts of the area also became a destination for hikers and campers. As a consequence, the area’s biodiversity is declining. Two endemic plants, *Zeuxine tjiampeana* and *Dipterocarpus hasseltii*, could not be re-found despite intensive research in the area [7]. Silvery Javan Gibbon (*Hylobates moloch*) used to inhabit Mt. Ciamprea, but could also not be found anymore [8].

Leschke [9] was probably the first who surveyed land snails at Mt. Ciamprea. He recorded five species from the mountain. Van Benthem Jutting [10] collected in 1930/1931 at Mt. Ciamprea. She discovered and described two new *Opisthostoma* species, *O. javanicum* and *O. uranoscopium* from Mt. Ciamprea. Whereas *O. javanicum* was later also recorded from other Indonesian islands, Madura, Bali, Borneo and Sulawesi, *O. uranoscopium* was only recently found in a few other localities in West Java and Banten [11]. Van Benthem Jutting [12-14] compiled the previous findings and listed 38 species of land snails from Mt. Ciamprea.

In face of the threat to the fauna on Mt. Ciamprea by quarrying, land use change and tourism, an updated record of the land snail fauna of the area is urgently needed. For this reason, we conducted a land snail survey on Mt. Ciamprea and compared the recorded species with those listed in the literature.

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## 2 Material and Methods

### 2.1 Study Site

Mt. Ciampea (also known as Mt. Cibodas) is located in Ciampea District, Bogor Regency, West Java, Indonesia ( $06^{\circ}33'05''S$  to  $06^{\circ}33'11''S$  and  $106^{\circ}40'59''E$  to  $106^{\circ}41'14''E$ , Fig. 1, 2). It ranges from 285 to 357m above sea level. The soil in Ciampea is alkaline to neutral (pH 6.5–7). Air temperature ranges from 27.7°C to 37.2°C and humidity from 60.2% to 77.3% [7]. Most of the area on the upper part is covered by secondary forest and limestone rocks, whereas the lower part is used for agroforestry and teak plantation.

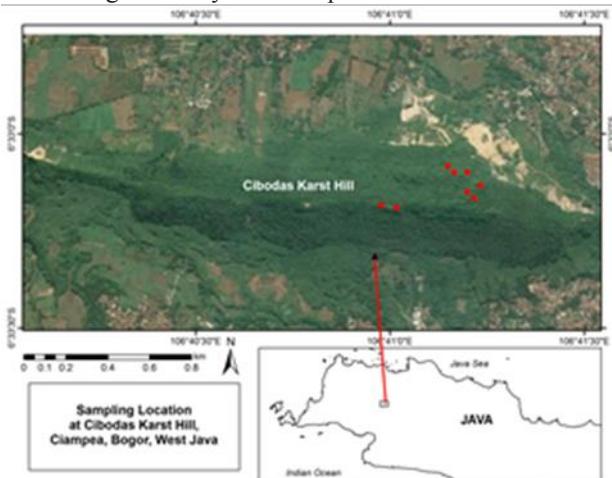


Fig. 1. Mt. Sampling location

### 2.2 Sampling and Determination

Samples were collected in January 2013 and May 2014. In total, eight plots of 10m x 10m each were sampled. The plots were located within the outcrops near or at the mouth of caves, and on limestone rocks. We applied a combination of visual searching and sorting a standardized volume of litter and soil as recommended for land snail inventories if repeated visits are not possible [15-17]. All living slugs and snails as well as their empty shells were collected by the junior author for one hour at each plot. In addition, 5 litres of soil and leaf litter (3–5cm of topsoil) were collected at each plot. The soil and leaf litter samples were put into water and the floating plant material and snails were collected with a sieve. Afterwards, the material was dried and sieved to pick out the microsnails. The snails were sorted and identified to species level using van Benthem Jutting [12-14], Vermeulen [18], Nurinsiyah & Hausdorf [11] and Nurinsiyah et al. [19].

### 2.3 Statistical Analysis

Every specimen was counted to reveal species richness and abundance. The similarity between past and present records was analysed using the Jaccard (absolute abundances) and Chao-Jaccard (relative abundances) indices with 100 bootstraps replicates with the Two-Community Measures as implemented in SpadeR [20].

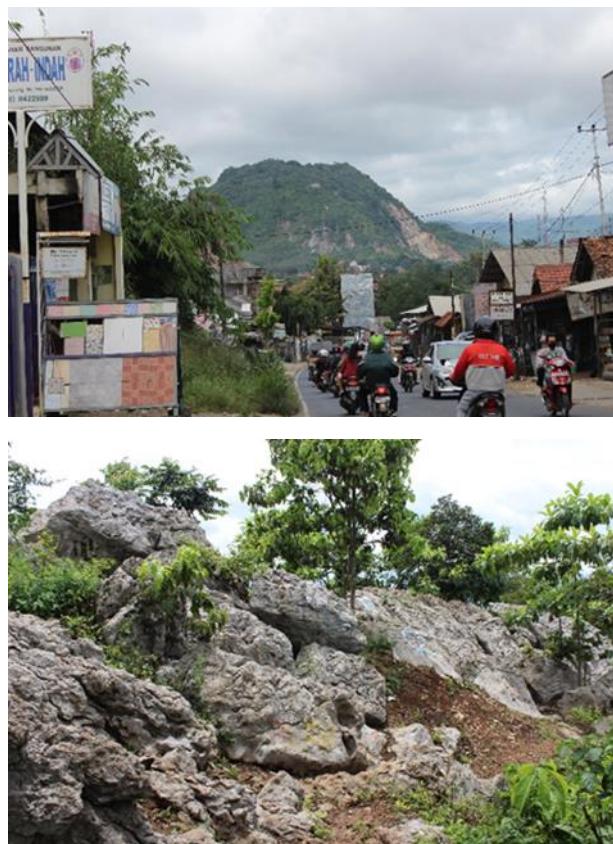


Fig. 2. Mt. Ciampea from below, the road between IPB University Dramaga and Mt. Ciampea (above). Sampling location at Lalana peak of Mt. Ciampea (below)

## 3 Results and Discussion

### 3.1 Species Diversity

In total, 1702 specimens belonging to 34 species from 16 families were collected at eight plots at Mt. Ciampea (Table 1). *Stomacosmethis jagori* (Cyclophoridae) was the dominant species comprising 24% of the individuals. Seven species were represented in our collection only by single specimens. Four of the recorded species were introduced species. Thirteen of the recorded species were not known from Mt. Ciampea so far. On the other hand, we could not recover 16 of the species recorded in previous surveys [12-14].

Empirical similarity indices (0.44-0.61) indicated strong differences between the species lists recorded in Mt. Ciampea during recent and historical (90 years ago) surveys (Table 2). However, the estimated similarity scores were much higher (0.81-1.00).

### 3.2 Discussion

Considering the 34 species found in our recent survey of Mt. Ciampea and the 38 species previously listed from that limestone outcrop [12-14], 50 of the 242 land snail species occurring on Java [16,21-22] are now known from that mountain (Table 1). Thus, 21% of the land snail fauna of Java were recorded from Mt. Ciampea, although it covers only 0.3% of the area of Java (4km<sup>2</sup> of

126700km<sup>2</sup>). This underscores the importance of Mt. Ciampela for the conservation of land snail diversity in Java.

Although limestone outcrops cover only 4% of Java, 54% (139) of the land snail species occurring on Java were recorded in these areas [22]. Land snail species abundance is also higher in limestone areas. 1702 specimens were found in eight plots during our survey on Mt. Ciampela, 1123 specimens in 20 plots in Sukolilo [23] and 2919 specimens in 40 plots in South Malang [24]. In contrast, only 399 specimens were recorded in 24 plots on volcanic bedrock in Halimun Salak National Park (Nurinsiyah *et al. in prep*). The higher abundance in the limestone areas is undoubtedly due to the importance of calcium carbonate for land snails (see introduction).

Thirteen of the species recorded in our survey were not listed in the literature from Mt. Ciampela [12-14]. Most of these new records were smaller species that were probably overlooked in previous surveys. However, *Lissachatina fulica* and *Bradybaena similaris* are large, invasive species that colonized Mt. Ciampela only after the survey by van Benthem Jutting in 1930/1931. The invasive alien species are mainly inhabiting disturbed areas. Forest conversion to plantation/agriculture,

massive quarrying, which reduced canopy coverage, and the increase of general human disturbance resulted in an increase of invasive species [24]. It is unlikely that the introduction of invasive species is the cause for the possible decrease of endemic species in Mt. Ciampela. Rather, both events might be the parallel results of habitat destruction. Sixteen species which were reported in the literature from Mt. Ciampela have not been found during our survey (Table 1). Among these species is *Opisthostoma uranoscopium*, which was originally described from Mt. Ciampela by van Benthem Jutting [10]. However, given that we have sampled at only 8 plots, we cannot exclude that some of these species are still living on Mt. Ciampela.

Actually, the high estimated similarity scores between our recent and previous surveys (Table 2) indicated that more sampling is necessary to ascertain the presence or absence of previously recorded species on Mt. Ciampela. This is urgently needed for planning conservation measures for rare and potentially endangered species considering that quarrying activities continue in the area. Reforestation, a stop in forest conversion and limiting quarrying spatially, are pivotal for a successful conservation of Mt. Ciampela's biodiversity.



**Fig. 3.** *Gyliotrachela fruhstorferi*, a Javan endemic, from Mt. Ciampela (scale bar: 0.5mm)

**Table 1.** Land snail species and specimens recorded in Mt. Ciampela in a recent survey (2013, 2014) and by van Benthem Jutting [12-14]

Family	Species	PLOTS								Literature
		1	2	3	4	5	6	7	8	
Hydrocenidae	<i>Georissa javana</i> Möllendorff, 1897	-	-	3	-	4	3	1	-	+
Cyclophoridae	<i>Chamalycaeus crenilabris</i> (Möllendorff, 1897)	1	28	1	5	1	1	-	-	+
Cyclophoridae	<i>Chamalycaeus fruhstorferi</i> (Möllendorff, 1897)	-	-	-	-	-	-	-	-	+
Cyclophoridae	<i>Stomacosmethis jagori</i> (Martens, 1860)	-	55	162	71	104	13	-	-	+
Cyclophoridae	<i>Cyclophorus perdix</i> (Broderip & Sowerby, 1830)	-	-	-	-	-	-	-	-	+
Cyclophoridae	<i>Cyclophorus rafflesii</i> (Broderip & Sowerby, 1830)	-	-	1	-	-	-	-	-	-
Cyclophoridae	<i>Japonia ciliocinctum</i> (Martens, 1865)	-	6	6	29	6	5	1	2	+
Cyclophoridae	<i>Japonia grandipilum</i> (Boettger, 1891)	-	-	-	-	-	-	-	-	+
Cyclophoridae	<i>Japonia obliquistriata</i> Bullen, 1904	1	-	-	-	-	-	-	-	+
Cyclophoridae	<i>Opisthoporus corniculum</i> (Mousson, 1849)	-	-	-	-	-	-	-	-	+
Diplommatinidae	<i>Diplommatina auriculata</i> Möllendorff, 1897	-	-	-	-	-	-	-	-	+
Diplommatinidae	<i>Diplommatina baliana</i> Fulton, 1899	9	4	71	25	71	6	17	-	+
Diplommatinidae	<i>Diplommatina nevilli</i> (Crosse, 1879) <sup>1</sup>	-	-	-	-	-	-	-	-	+
Diplommatinidae	<i>Opisthostoma javanicum</i> van Benthem Jutting, 1932	-	-	1	-	-	-	-	-	+
Diplommatinidae	<i>Opisthostoma uranoscopium</i> van Benthem Jutting, 1932*	-	-	-	-	-	-	-	-	+

Pupinidae	<i>Pupina bipalatalis</i> Boettger, 1890*	-	-	-	-	-	-	-	+
Pupinidae	<i>Pupina treubi</i> Boettger, 1890	-	-	-	-	-	-	-	+
Achatinidae	<i>Allopeas clavulinum</i> (Potiez & Michaud, 1838)**	-	8	-	-	-	-	-	+
Achatinidae	<i>Allopeas gracile</i> (Hutton, 1834)**	4	11	-	-	6	-	-	+
Achatinidae	<i>Lissachatina fulica</i> (Bowdich, 1822)**	-	2	5	-	-	3	-	-
Achatinidae	<i>Paropeas achatinaceum</i> (Pfeiffer, 1846)	-	-	3	9	-	14	-	-
Achatinidae	<i>Paropeas acutissimum</i> (Mousson, 1857)	-	-	18	43	3	7	-	10
Charopidae	<i>Philalanka nannophya</i> Rensch, 1932	-	-	2	-	-	-	-	-
Charopidae	<i>Philalanka tjbodasensis</i> (Leschke, 1914)	-	-	-	-	-	-	-	+
Enidae	<i>Apoelus glandula</i> (Mousson, 1848)	-	-	-	-	-	1	-	-
Gastrocoptidae	<i>Gyliotrachea fruhstorferi</i> (Möllendorff, 1897)* (Fig. 3)	4	125	13	4	18	5	-	+
Valloniidae	<i>Pupisoma dioscoricola</i> (Adams, 1845)	-	-	4	-	7	-	-	+
Trochomorphidae	<i>Trochomorpha appropinquata</i> (Martens, 1864)	-	-	2	10	-	2	-	1
Trochomorphidae	<i>Trochomorpha bicolor</i> Martens, 1864	-	-	-	-	-	-	-	+
Trochomorphidae	<i>Trochomorpha strubelli</i> Boettger, 1890*	-	-	2	2	-	-	-	+
Chronidae	<i>Kaliella barrakporensis</i> (Reeve, 1852)	3	-	7	8	30	1	0	1
Dyakiidae	<i>Elaphroconcha bataviana</i> (Pfeiffer, 1842)	-	-	37	2	4	-	-	1
Dyakiidae	<i>Elaphroconcha javacensis</i> (Férussac, 1821)	-	-	-	-	1	-	-	-
Euconulidae	<i>Coneuplecta microconus</i> (Mousson, 1865)	2	7	2	1	5	11	2	-
Euconulidae	<i>Coneuplecta sitaliformis</i> (Möllendorff, 1897)	-	-	-	-	-	1	-	-
Euconulidae	<i>Liardetia convexoconica</i> (Möllendorff, 1897)	1	1	4	1	-	-	2	-
Euconulidae	<i>Liardetia javana</i> (Boettger, 1890)	-	-	-	-	-	-	-	+
Euconulidae	<i>Liardetia scandens</i> (Cox, 1871) <sup>2</sup>	-	5	4	3	13	2	-	-
Euconulidae	<i>Liardetia pisum</i> (Möllendorff, 1897)	-	-	-	-	-	-	-	+
Helicarionidae	" <i>Helicarion</i> " <i>albellus</i> Martens, 1867	-	-	1	2	7	-	1	1
Helicarionidae	" <i>Helicarion</i> " <i>perfragilis</i> Möllendorff, 1897	-	-	-	-	-	-	-	+
Ariophantidae	<i>Microcystina chionodiscus</i> Vermeulen, 1996	-	-	2	-	1	-	-	-
Ariophantidae	<i>Microcystina gratilla</i> van Benthem Jutting, 1950	10	7	97	54	63	29	8	-
Ariophantidae	<i>Microcystina nana</i> (Möllendorff, 1897)	3	4	3	-	-	-	-	+
Ariophantidae	<i>Microcystina sinica</i> Möllendorff, 1885	-	-	2	2	1	-	-	-
Camaenidae	<i>Bradybaena similaris</i> (Férussac, 1821)**	-	3	-	-	-	-	-	-
Camaenidae	<i>Chloritis crassula</i> (Philippi, 1844)	-	-	-	-	-	-	-	+
Camaenidae	<i>Chloritis fruhstorferi</i> Möllendorff, 1897*	-	-	1	-	-	-	-	-
Camaenidae	<i>Landouria winteriana</i> (Pfeiffer, 1842)	-	2	15	132	20	3	-	3
Camaenidae	<i>Landouria</i> sp. ( <i>rotatoria</i> non Pfeiffer, 1842) <sup>3</sup>	-	-	-	-	-	-	-	+
<b>Number of species</b>		<b>34</b>							<b>38</b>

\* endemic to Java

\*\* introduced

<sup>1</sup> *Diplomatina canaliculata* Möllendorff, 1886 is a synonym

<sup>2</sup> *Liardetia indifferens* (Boettger, 1891) is a synonym

<sup>3</sup> recorded as *Landouria rotatoria* by van Benthem Jutting [11]. Not identical with that species (see Nurinsiyah et al. [19]), but probably an unnamed species.

**Table 2.** Similarity scores between past and present records from Mt. Ciampea calculated with SpadeR.

Index	Empirical	Estimated
Jaccard	0.44	0.81
ChaoJaccard	0.44	1.00
Bray-Curtis	0.61	0.81

## 4 Conclusion

Our land snail survey in Mt. Ciampea showed that the species composition is different from that recorded about 90 years ago. However, a more extensive survey considering also areas not covered in our study is necessary to complete the list of currently occurring species and to map their occurrences on Mt. Ciampea as basis for conservation planning.

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