



Local Population's Knowledge And Perceptions On The Biodiversity And Conservation Status Of Land Snails In The Region Of Lamto Reserve At The Centre Of Ivory Coast

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Abstract

Local population can play an important role in the sustainable management of biodiversity in protected area. This paper focuses on investigating local population's knowledge and perceptions on land snail's biodiversity and conservation status, by (1) testing their ability to recognize different species of land snails, (2) examining the factors involved in the reduction of land snail's biodiversity, and (3) collecting their points of view on land snail's biodiversity conservation status. Two hundred and sixty (260) people from four villages around Lamto Reserve were interviewed using structured questionnaire with six land snails supporting photos (three macro

snails and three micro snails). The results showed that all the respondents had at least once seen the macro snails selected. More than 78% were able to recognize them without the pictures and more than 88% with the pictures. More than 85% of respondents had at least once seen the selected micro snails. Only less than 25% were able to recognize them with the pictures and less than 8% without the pictures. The considered socio-demographic variables were significantly associated with knowledge of the selected land snails. Climate change and human activities (pesticides overuse, edible land snail's consumption and selling and forest fires) have been mentioned by local population as the fundamental causes involved in land snail's biodiversity reduction in this region. The number of respondents with positive attitude (62.91%) towards land snail's biodiversity conservation in Lamto Reserve was significantly higher than the one with negative attitude (37.69%) ($P < 0.001$). Lamto Reserve management staff must increase the consciousness raising campaign in rural communities close to the Reserve in order to reduce the number of people who do not support biodiversity conservation.

Keywords: Land Snail Knowledge, Lamto Reserve, Local Population Perception, Biodiversity Conservation

Introduction

Ideally, protected areas should serve as cores of conservation and protection of the large biodiversity to improve human well-being by providing goods and services (Vodouhê *et al.*, 2010; Muñoz Brenes *et al.*, 2018). Unfortunately, previous studies highlighted the continuous and increasing reduction of biodiversity despite protected area expansion (Phalan *et al.*, 2013; Hill *et al.*, 2015). Adjacent population to protected areas has been considered for a long time as a potential actor of biodiversity destruction and loss of protected areas (Ikpa *et al.*, 2009). Indeed, population develops dependence on the natural resources and the satisfaction of their needs and, generally, in illicit way induces biodiversity destruction and loss (Brandon & Wells, 1992; Ansong & Røskaft, 2011).

However, local population can strongly support actions for the sustainable management of biodiversity in protected areas if this management is based on their practices and knowledge, and if it takes into account a greater satisfaction of their basic needs (Wells *et al.*, 1992). Through their traditional knowledge, local populations offer a critical source of basic environmental data for conservation and resource management (Thornton & Scheer, 2012). In some cases, integration of local population's knowledge into conservation has been associated with enhanced species abundance (Poepoe *et al.*, 2005) and biodiversity (Xu *et al.*, 2005).

Local population's knowledge of land snails is important because snails are the most reliable indicators of terrestrial biological richness and environmental conditions (Nrurinsiyah *et al.*, 2016; Altaf *et al.*, 2017). Numerous studies have demonstrated the significance of land snails as important links in the dynamics of natural and human-dominated ecosystems (Skeldon *et al.*, 2007; Bloch, 2012; Douglas *et al.*, 2013). The high land snail species diversity (Lydeard *et al.*, 2004), their numerical abundance and ability to colonize diverse habitat types (Asuquo & Anyanwu, 2018), have made them popular organisms to everyone (d'Ovidio *et al.*, 2019). In rural communities, land snails are used as an important ingredient in traditional medicine (Agbelusi & Ejidike, 1992) and the flesh is well appreciated by various populations in terms of diet (Amani *et al.*, 2016). Some of these snails are among the important pests for agriculture (Raut & Barker, 2002; Jayashankar *et al.*, 2012). Thus, local people who frequently interact with snails in their local environment may develop a broader knowledge of the life histories, behavior, and seasonal changes in the composition and abundance of those snails.

Therefore, this paper focuses on investigating local population's knowledge and perceptions on land snail's biodiversity and conservation status by (1) testing their ability to recognize different species of land snails, (2) examining the factors involved in the reduction of land snail's biodiversity, and (3) collecting their points of view on land snail's biodiversity conservation status.

Material and Methods

Study Area

This study was carried out in four localities around Lamto Reserve (Pacobo: 6°11'30"N, 4°56'54"O; Zougoussi: 6°15'20"N, 5°02'51"O; Aheremou 2: 6°12'53"N, 4°58'41"O; and Kotiessou: 6°11'56"N, 6°3'44"O) (Figure 1). These localities were selected based on their proximity to the Reserve following the directions North-South and West-East. This zone is dominated by savannah including open grassland, island forest, and gallery forest. Also, they are characterized by four seasons: a long rainy season from March to July, a short dry season in August, a short rainy season from September to October, and a long dry season from November to February (Abbadie *et al.*, 2006). The mean annual precipitation is about 1200 mm. Local inhabitants of this area are composed of autochthonous "Baoulé" (major ethnic group), allochthonous Malinké, and Senoufo and natives of Burkina Faso, Mali, and Guinea. Subsequently, they practice mainly shifting burned cultivation, cocoa and coffee crops, food crops (yams, plantains and rice), fishing and hunting.

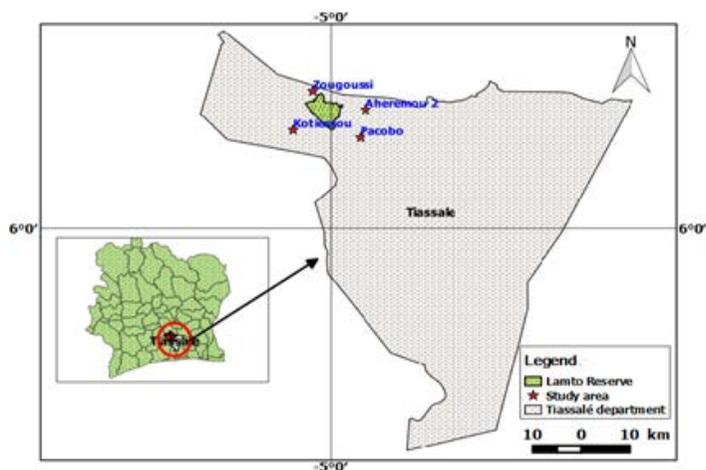


Figure 1. Map of Tiassalé division indicating Lamto Reserve and the localities of study

Study Species

A photographic support of six land snail's species among which three macro snails (diameter's size above 5 mm: *Achatina achatina*; *Achatina fulica*; *Archachatina ventricosa*) and three micro snails (diameter's size under 5 mm: *Saphtia lamtoensis*; *Striosubulina striatella*; *Quickia concisa*) was used for the interview in order to determine the extent of knowledge about these snails. These snails were common in Reserve and its rural environment and were sprung from a previous inventory study of malacofauna in Lamto Reserve and surrounding area (unpublished data). The macro snail's species were expected to be familiar to the participants while the micro snail's species is assumed to be unknown or less known to the participants because of their small size.

Data Collection with Questionnaires

In March 2019, a direct survey was conducted in these four villages. A structured questionnaire was used to interview, in isolation, each of the volunteer who was at least 18 years old. The questionnaires were prepared in French but local translator was recruited in each village to facilitate the interview when a participant could not speak French. Each questionnaire had 23 questions and included questions about the respondent's gender, age, ethnic group, educational level, his/her ability to recognize the selected snail species, the factors involved in snail biodiversity reduction, and perception about land snail biodiversity conservation in the Lamto Reserve. Pictures were used to assess the ability of local population to recognize snails (Figure 2).

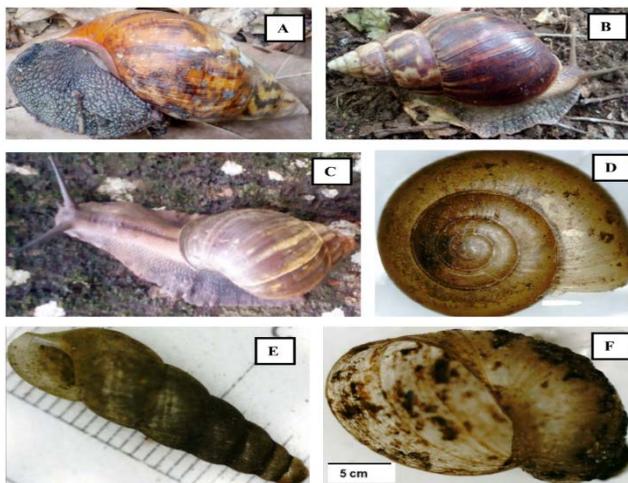


Figure 2. Pictures of selected land snails. **A:** *Achatina achatina* (Linné, 1758); **B:** *Achatina fulica* (Bowdich, 1822); **C:** *Archachatina ventricosa* (Gould, 1850); **D:** *Saphitia lamtoensis* (De Winter, 2008); **E:** *Striosubulina striatella*; (Rang, 1831); **F:** *Quickia concisa* (Morelet, 1848)

Data Analysis

Data processing and analysis were performed using the statistical software Sphinx Plus² version 5.0. and R version 3.6.2. The non-parametric test (chi-squared test) was used to assess the relationships between socio-demographic variables and the respondents' knowledge about selected snails. The comparison of local population attitudes towards land snail conservation in Lamto Reserve was made using Mann-Whitney test at $p=0.05$ level.

Results

Socio-demographic Characteristics of the Surveyed Populations

In total, 260 people were interviewed among them, i.e., 130 male respondents and 130 female respondents (Table 1). The highest number of respondents were recorded with age group range from 25 to 45 years old (149 respondents), with no education respondents (134 respondents), and Baoulé ethnic group respondents (203 respondents). Among localities, Aheremou 2 had the highest number of respondents (75 respondents) (Table 1).

Table 1. Number of respondents according to socio-demographic variables (total number of respondents: n=260)

Socio-demographic variables	Total number of respondents	
Localities of study	Pacobo	70
	Aheremou 2	75
	Kotiessou	61
	Zougoussi	54
Gender	Male	130
	Female	130
Ages	18≥age≥24 years	39
	25≥ age≥45 years	149
	age≥45 years	72
Educational levels	No education	134
	Primary school	65
	Secondary school and higher	61
Ethnic groups	Baoulé	203
	Malinké	4
	Senoufo	9
	Burkinabé	10
	Other*	34

* Other represents another ethnic group (Ivoirian's allochthonous) living in this area

Knowledge of Individual Land Snail Species

All respondents had at least once seen the selected macro snails. More than 78% were able to recognize them without the pictures and more than 88% with the pictures (Table 2). Among the macro snail species, *Achatina fulica* was less known by respondents compared to *Achatina achatina* and *Archachatina ventricosa*. More than 85% of respondents had at least once seen the micro snails selected, but only less than 25% were able to recognize them with the pictures and less than 8% without the pictures (Table 2). Among these micro snail species, *Saphtia lamtoensis* was more familiar to respondents than *Striosubulina striatella* and *Quickia concisa*.

Table 2. Percentage of respondents who had known the snails in question, those who had recognized them with the pictures, and those who had only seen the snails (total number of respondents: n=260)

Localities of study	Species (scientific names)	Respondents who had known snails without pictures (%)	Respondents who had recognized snails with pictures (%)	Respondents who had only seen the snails (%)
Pacobo	<i>Achatina achatina</i> (Linné, 1758) *	98.60	100	100
	<i>Archachatina ventricosa</i> (Gould, 1850) *	97.14	100	100
	<i>Achatina fulica</i> (Bowdich, 1822) *	80.00	95.71	100
	<i>Striosubulina striatella</i> (Rang, 1831)	4.28	4.00	92.86
	<i>Saphtia lamtoensis</i> (De Winter, 2008)	7.14	14.28	95.71
	<i>Quickia concisa</i> (Morelet, 1848)	0.00	2.40	94.28
Aheremou 2	<i>Achatina achatina</i> (Linné, 1758) *	100	100	100
	<i>Archachatina ventricosa</i> (Gould, 1850) *	98.67	100	100
	<i>Achatina fulica</i> (Bowdich, 1822) *	80.00	97.33	100
	<i>Striosubulina striatella</i> (Rang, 1831)	0.00	6.67	90.67
	<i>Saphtia lamtoensis</i> (De Winter, 2008)	4.00	14.67	94.67
	<i>Quickia concisa</i> (Morelet, 1848)	0.00	5.33	88.00
Kotiessou	<i>Achatina achatina</i> (Linné, 1758) *	100	100	100
	<i>Archachatina ventricosa</i> (Gould, 1850) *	98.40	100	100
	<i>Achatina fulica</i> (Bowdich, 1822) *	78.70	88.50	100
	<i>Striosubulina striatella</i> (Rang, 1831)	3.28	14.75	85.24
	<i>Saphtia lamtoensis</i> (De Winter, 2008)	6.60	22.95	95.08
	<i>Quickia concisa</i> (Morelet, 1848)	0.00	6.56	88.52
Zougoussi	<i>Achatina achatina</i> (Linné, 1758) *	100	100	100
	<i>Archachatina ventricosa</i> (Gould, 1850) *	100	100	100
	<i>Achatina fulica</i> (Bowdich, 1822) *	83.30	96.50	100
	<i>Striosubulina striatella</i> (Rang, 1831)	0.00	22.22	85.18
	<i>Saphtia lamtoensis</i> (De Winter, 2008)	7.41	24.07	96.30
	<i>Quickia concisa</i> (Morelet, 1848)	0.00	12.96	90.94

The specieses with asterix are macro snails and those without asterix are micro snails

Influence of Socio-demographic Variables on Knowledge of Land Snails

The variability of the visited localities had a significant influence on the knowledge of the selected snails ($\chi^2=45.11$; $dl=6$; $p<0.001$). Zougoussi had the highest proportion of respondents with perfect knowledge of snails (59.26%), while Pacobo had the lowest proportion (21.43%). However, Pacobo recorded the lowest proportion of respondents with poor knowledge (7.14%), while the highest (24.00%) was obtained in Aheremou 2 (Table 3).

The gender of respondents had a significant influence on knowledge of selected snails ($\chi^2=10.504$; $dl=2$; $p<0.010$). Among male respondents, 43.08% had perfect knowledge against 29.23% of female respondents. Only 9.23% of male respondents had a poor knowledge of snails against 22.31% of the female respondents (Table 3).

The age of respondents had also a significant influence on knowledge of selected snails ($\chi^2=50.857$; $df=4$; $p<0.001$). None of the younger respondents ($18 \geq \text{age} \geq 24$ years old) had perfect knowledge of snails, while older respondents ($\text{age} \geq 45$ years old) had the highest proportion (50%). Moreover, among the respondents who had poor knowledge of snails, young respondents were the most represented (48.72%) in contrast to the older respondents (8.33%) (Table 3).

The educational level of respondents had a significant influence on knowledge of selected snails ($\chi^2=37.937$; $df=4$; $p<0.001$). The respondents with primary school level had the highest perfect knowledge (50.77%), while no education respondents recorded the lowest (30.60%). However, no education respondents were the least represented among those with a poor knowledge of snails (6.72%) (Table 3).

The ethnic group of respondents had a significant influence on knowledge of selected snails ($\chi^2=31.265$; $df=8$; $p<0.001$). Baoulé ethnic group's respondents had the highest perfect knowledge (41.38%), while no respondent from Burkina Faso had a perfect knowledge (Table 3). Respondents from Burkina Faso were the most numerous among those with poor knowledge of snails (70%) (Table 3).

Table 3. Level of knowledge of selected snails according to socio-demographic variables

Socio-demographic variables		Perfect knowledge (5-6 snails known) (%)	Good knowledge (3-4 snails known) (%)	Poor knowledge (0-2 snails known) (%)	Total number of respondents
Localities of study	Pacobo	21.43	71.43	7.14	70
	Aheremou 2	26.67	49.33	24.00	75
	Kotiessou	44.26	39.34	16.40	61
	Zougoussi	59.26	25.92	14.82	54
Gender	Male	43.08	47.69	9.23	130
	Female	29.23	48.46	22.31	130
Ages	$18 \geq \text{age} \geq 24$ years	0.00	51.28	48.72	39
	$25 \geq \text{age} \geq 45$ years	38.93	50.33	10.74	149
	$\text{age} \geq 45$ years	50.00	41.67	8.33	72
Educational levels	No education	30.60	62.68	6.72	134
	Primary school	50.77	32.31	16.92	65
	Secondary school and higher	32.79	32.79	34.42	61
Ethnic groups	Baoulé	41.38	45.81	12.81	203
	Malinké	25.00	50.00	25.00	4
	Senoufo	22.22	55.56	22.22	9
	Burkinabé	0.00	30.00	70.00	10
	Other*	20.59	64.70	14.71	34

* Other represents another ethnic group (Ivoirian's allochthonous) living in this area

Perception of Local Population on the Causes of Land Snail's Biodiversity Reduction

Globally, 191 respondents (73.46%) had quoted human activities (pesticide overuse, edible land snail's consumption and selling and forest fires) as a fundamental cause of land snail's biodiversity reduction, while 111 respondents (42.69%) had mentioned the effect of climate change. Only 2 respondents (0.77%) had highlighted other cause such as predation. According to the visited localities, Kotiessou (82%) and Zougoussi (61.10%) recorded the highest proportion of respondents who had mentioned respectively human activities and climate change as the major causes of land snail's biodiversity reduction (Figure 3). Beyond human activities and climate change listed in all localities, other cause (predation) had been stressed in Aheremou 2 and Pacobo in roughly the same proportion (respectively 1.3% and 1.4%) (Figure 3).

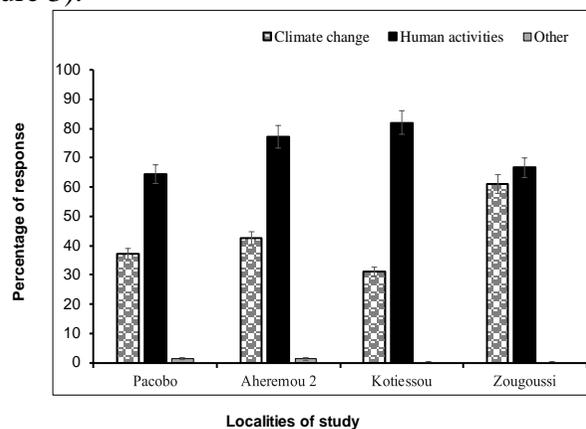


Figure 3. Percentage response patterns from respondents across localities of study regarding the causes of land snail's biodiversity reduction

Perceptions of Local Population towards Land Snail's Biodiversity Conservation in Lamto Reserve

Overall, 98 respondents (37.69%) were unfavorable to snail conservation in Lamto Reserve while 162 respondents (62.31%) were favorable. The difference between respondents with positive attitude (favorable) to snail's conservation and those with negative attitude (unfavorable) was significant (Mann-Whitney test; $p < 0.001$). The respondents in favor of snail conservation are those who give their approval to respect the conservation measures in force in the Lamto Reserve. Thus, according to the visited localities, the highest proportion of respondents in favor of snail conservation was obtained in Zougoussi (81.48%) and the lowest in Kotiessou (44.26%) (Figure 4).

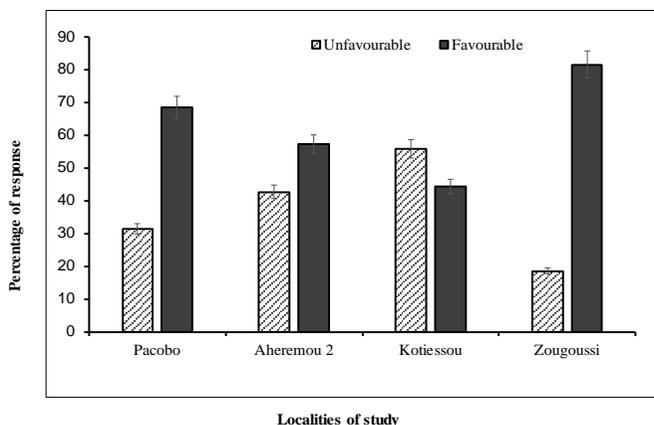


Figure 4. Percentage response patterns from respondents across localities of study regarding the respect of land snail's conservation measures in Lamto Reserve

Discussion

Knowledge of Individual Land Snail Species

Overall, selected land snails were well known by respondents. This result could be due to the distribution of these species which are common and widespread in variety of habitats including open grassland, wooded grassland, fallow, and forest (Idohou *et al.*, 2013; Dar *et al.*, 2017). Difference in knowledge between macro and micro snails could be linked to their size. Indeed, because of their large size, macro snails attract more attention from respondents compared to micro snails usually found in litter (Douglas *et al.*, 2013). Among macro snails, *Achatina achatina* and *Archachatina ventricosa* (edible snails) were widely known certainly because they are well appreciated in human diet in Côte d'Ivoire (Dosso *et al.*, 2007; Amani *et al.*, 2016).

The knowledge of selected snails was significantly influenced by the variability of study localities. A contrary result was obtained by Ansong and Røskaft (2011) around Subri Forest Reserve of Ghana. The highest number of respondents with perfect knowledge of snails was obtained in Zougoussi, while the lowest number was recorded in Pacobo. This could be due to a difference in the development stage of these localities. Indeed, compared to Zougoussi, Pacobo had a relatively more advanced stage of development. In Zougoussi, almost all the populations were farmers. As a result, they could have more contact with snails. This couldn't be the case of Pacobo with varied sectors of activities (Boguhe *et al.*, 2011).

The male respondents recorded the highest perfect knowledge of snails compared to the female respondents. The different roles that exist between men and women particularly in most of Baoulé farmer's communities could contribute to men's ability to know snails. Indeed, although women support significantly their husbands in field activities (Ruf, 2016), the men spent more time wandering in forests while women were in charge of housework (De

Rouw, 1991). No younger respondents had a perfect knowledge of selected snails, while the older respondents recorded the largest number of people. This could be due to the fact that young respondents were less experienced compared to older. According to Senanayake (2006), local knowledge results from experience and this knowledge is building on the experience of the past and present generation. Respondents with primary school level had the highest perfect knowledge of selected snails. A contrary result was obtained by Mmassy and Røskaft (2013) in Tanzania. Baoulé ethnic group's respondents had the highest perfect knowledge of selected snails and the poorest knowledge was recorded with the respondents from Burkina Faso. This result could be due to the activities, food habit, and the civilization of these groups. Indeed, the Baoulé ethnic groups are generally farmers in the villages; they spend more time in forest and appreciate very well the flesh of snails in diet (Amani *et al.*, 2016). Such a lifestyle might improve their opportunities to see and become familiar to snail's species. This couldn't be the case of respondents from Burkina Faso who were mostly cattle breeders (FAO, 2018) and perceive edible snails as totem.

Perceptions of Local Population on the Causes of Land Snail's Biodiversity Reduction and on their Conservation Status in Lamto Reserve

This study disclosed that local population living around Lamto Reserve was cognizant of the causes of land snail's biodiversity loss. Climate change and human activities were identified by respondents as the major causes of land snail's biodiversity reduction. Similar results were reported in scientific publications among others, like Chiba and Cowie (2016) who showed that climate change and habitat loss due to human activities such as deforestation, cultivation, mineral extraction, and urbanization constitute the main causes of land snail's extinction on oceanic islands. In addition, Nicolai and Ansart (2017) underlined that human-driven habitat loss through intensified urbanization, agriculture, and forestry dramatically increased the impact of climate change and endangers the species living in restricted habitat and with low dispersal such as land snails. Finally, excessive and misuse of pesticides result in environment contamination causing biodiversity loss particularly land snails (Nkontcheu *et al.*, 2017; Baroudi *et al.*, 2020).

About 38% of all the respondents had negative perception of land snail's biodiversity conservation in Lamto Reserve. Indeed, most of local populations living around Lamto Reserve are farmers, fishermen and hunters and the Reserve management law prohibits their access to such activities. This may generate a strong and negative opinion on the management and the conservation of biodiversity as reported by Vodouhê *et al.* (2010). Besides, they complain that Reserve establishment evicted local population from their

former areas and the Reserve management policy doesn't take into account the development of their localities through the implementation of project and infrastructures such as construction of schools and hospitals. This perception corroborates with the work done by Torri (2011). These people believe that they receive no benefit from the Reserve and often defy the ban on hunting and resource extraction. When they are apprehended by the Army in charge of protecting Reserve and enforcing management laws, they are subjected to the rigours of the law and this reinforces their negative perception of the Reserve's management. This position wasn't shared by the majority of respondents to whom conservation of biodiversity in Reserve is important because of endangered animal and plant species that are well conserved in the Reserve.

Conclusion

At the end of this study, it can be concluded that the majority of respondents had a good knowledge of the selected land snails (with a focus on macro snails) and the causes of their biodiversity reduction. However, given that all the selected snails were common in the Lamto Reserve and its surrounded rural area, the local population's knowledge in some particular young male and female persons was poor for certain species (micro snails in the majority). The considered socio-demographic variables were significantly associated with knowledge of the selected land snails. The majority of respondents were favorable towards land snail biodiversity conservation in Lamto Reserve. In others words, they hold positive attitudes towards Reserve management.

We further recommend to the Lamto Reserve management staff to pursue collaboration with the rural communities close to the Reserve for best management. This collaboration based on the negotiations, exchanges, and awareness rising could reduce the number of people who do not support Reserve biodiversity conservation.

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