SPECIES COMPOSITION AND COMMUNITY STRUCTURE OF TERRESTRIAL SMALL MAMMALS IN TANOÉ-EHY SWAMP FOREST (SOUTH-EAST IVORY COAST): IMPLICATION FOR CONSERVATION

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Tanoé-Ehy Swamp Forest (TESF) is one of the most valuable conservation sites in Ivory Coast. It harbours an exceptional biodiversity with numerous endangered plants and animals. Indeed, several recent studies have been carried out in TESF to consolidate judgment of its importance for conservation in Ivory Coast. These investigations have mentioned the presence of threatened monkeys and frogs. Currently, small mammals of the TESF remain unknown despite the consensus around their importance in natural biotopes. Yet small terrestrial mammals are known to be good indicators of the conservation status of many tropical ecosystems. This study is a preliminary exploration of terrestrial small mammal communities in the Tanoé-Ehy Swamp Forest. It aims to determine species composition and reveal their implication in the conservation of the Tanoé-Ehy Swamp Forest. Thus, the three main habitat types (dryland forests, swamp forests and raphials (*Raphia*-dominated community)) were sampled using conventional Sherman and Victor wooden snap traps. With a trapping effort of 8400 trap nights, 294 individuals, representing nine species of rodents and four species of shrews were collected. The rodent community was dominated by *Hylomyscus simus* (n = 135), followed by *Praomys rostratus* (n = 65) and *Malacomys edwardsi* (n = 18). *Crocidura buettikoferi* (n = 22) was the most abundant shrew. The species richness and diversity index were higher in drylands than in swamp forests and raphials. Swamp forests showed the highest number of trapped animals (n = 126), followed by the dryland forests (n = 107) and the raphials with 63 individuals. One-way ANOVA test revealed significant differences ($p \leq 0.05$) between the abundance of terrestrial small mammals of the three sampled habitat types. Similarity indices showed that dryland and swamp forests were largely colonised by the same species. Three species are listed as threatened according to the criteria of the International Union for the Conservation of Nature (IUCN). Those are one rodent, *Hylomyscus baeri*, listed as Endangered (EN), and two shrews, *Crocidura buettikoferi* and *Crocidura grandiceps*, which are both Near Threatened (NT). This study reinforces the importance of TESF for fauna conservation in Ivory Coast.

Key words: conservation, Côte d'Ivoire, diversity indices, Rodents, Shrews, swamp forest

Introduction

The Ivorian forests are acknowledged for their high biological richness, species diversity, and endemism. Indeed, the Ivorian forests are part of the 35 world's biodiversity hotspots (Kuper et al., 2004; Mittermeier et al., 2011). However, these forests are highly threatened by human activities (Chatelain et al., 1996). In Ivory Coast, about 120 000 km^2 of forest have disappeared in less than 40 years (Ake-Assi & Boni, 1990; Chatelain et al., 1996). With a deforestation rate of 6.5% per year, Ivory Coast exhibits one of the highest forests lost in the world (Schmidt, 1990). This phenomenon results not only in the release of significant amounts of greenhouse gases in nature (Fearnside, 2000; DeFries et al., 2002), but also in the irreversible disappearance of most sensitive components of the biological diversity (DeFries et al., 2002). To mitigate this phenomenon, the Ivorian government has initiated the creation of Volunteer Nature Reserves (VNR) since 2002. The aim of this decision was to strengthen its traditional conservation policy based on national parks and other Protected Areas. A Volunteer Nature Reserve designates a nature reserve created on the initiative of the local community, public establishment or particular who aspires to preserve an area, an ecosystem or a remarkable landscape belonging to it (Adou-Yao et al., 2013). The Tanoé-Ehy Swamp Forest (TESF) is a community forest suitable for the conservation of endangered animal and plant species in the Upper Guinean forests (Koné et al., 2008; Kpan et al., 2014; Missa et al., 2015). This forest is an ideal site for the implementation of integrated activities combining research, conservation and community management of natural resources. To further enhance protection, it has been recommended to collect and update scientific information for this forest (Koné et al., 2008; Kpan et al., 2014). Presently, research and conservation actions are ongoing in this Volunteer Nature Reserve. Zoological groups that have been studied are primates (Gonedele Bi et al., 2008, 2012, 2013), fishes (Konan et al., 2013, 2014) and amphibians (Kpan et al., 2014). Studies concerning flora are limited to those of Adou-Yao (2007) and Missa et al. (2015). So far, faunistic data from Tanoé-Ehy Swamp Forests are fragmentary (Koné & Akpatou, 2004; Kpan et al., 2014). Thus, TESF deserves additional studies covering other zoological groups. Such novel studies should focus on species that are sensitive to disturbances or that could help better evaluate the level of habitat integrity. In this context, terrestrial small mammals, which ecological importance has already been demonstrated (Adam et al., 2015; Bantihun & Bekele, 2015), are eligible.

Terrestrial small mammals (rodents and shrews) are important because of their multiple functional roles in the ecosystem, particularly in trophic networks as an almost unlimited food source for many predators such as small carnivores, snakes, raptors (Angelici, 2000; Luiselli & Angelici, 2000). They have many beneficial interactions with plants such as seed dispersal, seed germination and pollination of flowers (Gautier-Hion et al., 1985; Pearson et al., 2001) contributing to the recolonisation of forest gaps. They are also good bio-indicators to assess the forest ecosystem health because of their high species richness and habitat preference. They occur in almost all habitats (Barriere et al., 2006). Their short lifecycle compensated by a rapid population dynamic allows them to react rapidly to habitat disturbance (Delattre et al., 1992; Nicolas et al., 2009). In addition, species richness and abundance of terrestrial small mammals are regularly used to establish a disturbance gradient (Nicolas et al., 2009; Avenant, 2011).

This study aims to contribute to a better knowledge of the mammalian fauna in the TESF. Indeed, exploration of terrestrial small mammals of TESF will help better appreciate their importance in the dynamic of this particular ecosystem. A survey of terrestrial small mammals (rodents and shrews) of the TESF has been carried out to (i) draw up a preliminary list of terrestrial small mammals, (ii) determine species assemblages in the main habitats and (iii) assessing conservation status of terrestrial small mammals according to the International Union for the Conservation of Nature (IUCN, 2019) criteria.

Material and Methods

Study site

The Tanoé-Ehy Swamp Forest (TESF) is located in south-east Ivory Coast (5.083–5.250° N, 2.750– 2.883° W, Fig. 1). It is watered with an average annual rainfall of 1925 mm (Avenard et al., 1971). The climate is of the subtropical type and is under influence of two climatic seasons, one dry season from January to February and one rainy season from March to December. The temperature varies between 22°C and 30°C with an average of 26°C (Adou-Yao, 2007). The TESF is drained by numerous tributaries of the River Tanoe and the lagoon Ehy. The vegetation is mostly lowland forest with a peek of the mountain less than 100 m (Avenard et al., 1971). The soils in the TESF are hydromorphic (clayey and silty) in the southern part. These are marshy areas from siltation by lagoon deposits, coastal peat. Indeed, the study area consists of a mosaic of dryland forests, swamp forests and raphials. For this study, these three habitats types were sampled.

The dryland forest is characterised by the absence of ground water. The dominant plant species in this habitat are *Anthostema aubryanum* Baill., *Baphia nitida* Lodd., *Uapaca guineensis* Willd., *Raphiostylis ferruginea* Engl., *Mammea africana* Sabine, *Gaertnera paniculata* Benth, and *Morinda longifolia* G. Don (Missa et al., 2015).

The swamp forest is dominated by plant species such as *Uapaca paludosa* Aubrév & Leandri, *Hallea ledermannii* (K. Krause) Verdc, *Combretum aphanopetalum* Engl. Diels, *Xylopia rubescens* Oliv., *Cytosperma senegalensis* (Schott) Engl. and *Spondianthus preussii* Engl. (Missa et al., 2015). This habitat is permanently or seasonally inundated.

The raphial comes from the reconstitution of the marshland and is described as secondary swamp forest (Avenard et al., 1971). In this habitat, the dominant plant species are *Raphia hookerii* G. Mann & H. Wendl, *Anthostema aubryanum* Baill., *Uapaca paludosa* Aubrév & Leandri and *Xylopia rubescens* Oliv. (Missa et al., 2015).

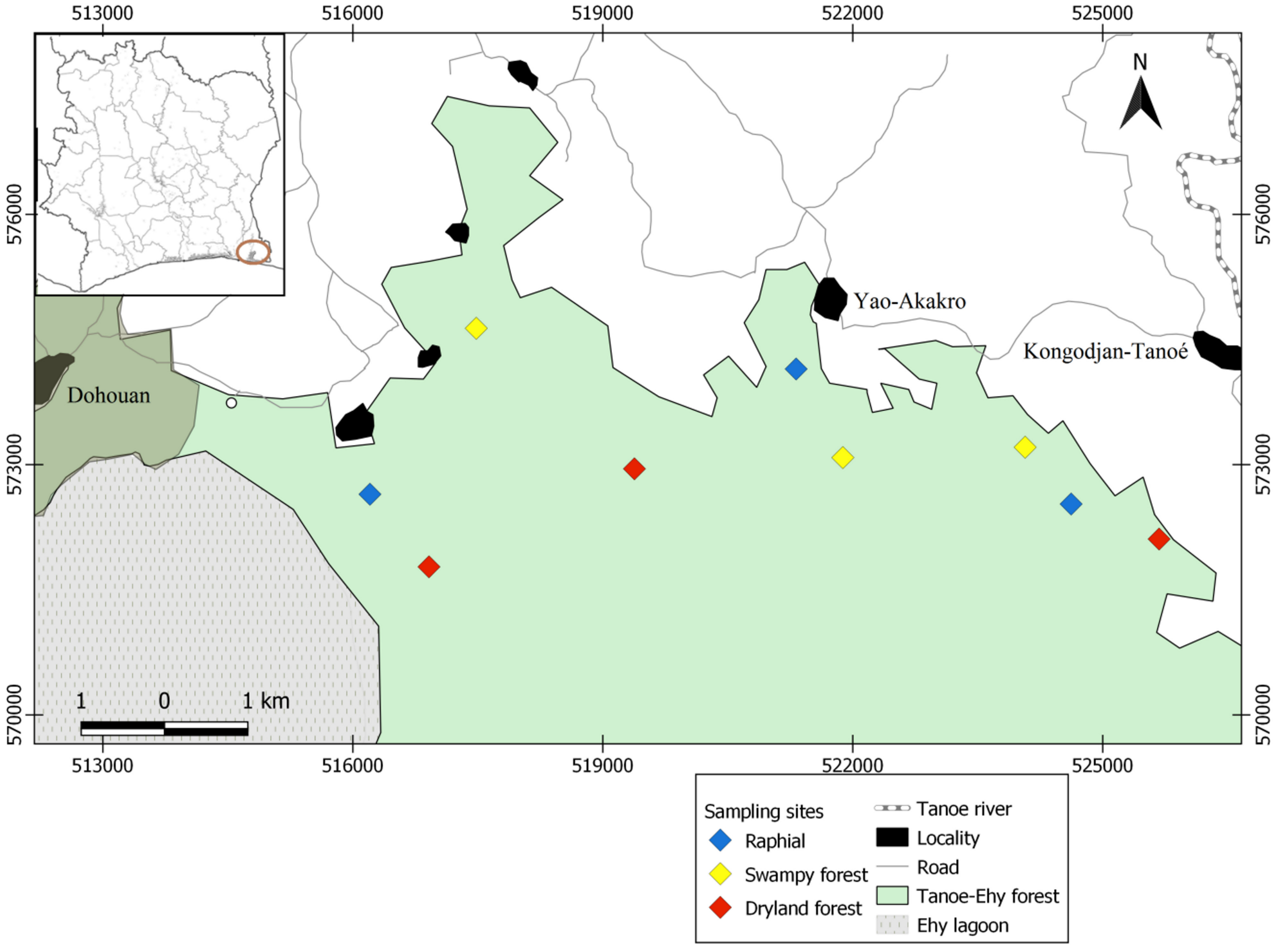

Fig. 1. Study area and small mammal sampling sites in the Tanoé-Ehy Swamp Forest.

Small mammal sampling

Sampling covered the period of September 2017 to March 2019, divided into four trapping sessions. At each trapping session, all habitat types were sampled. Sherman (SFA, HB Sherman Traps, Inc., Tallahassee, FL, USA, with dimensions 23 × 9 × 7.5 cm) and Victor traps (Woodstream Corp. Lititz, PA, USA; 9.8 × 4.5 × 0.5 cm) were used to capture small mammals. A total of 12 plots were sampled in the TESF, representing four square plots of 2500 m^2 each for each of three habitats types. Five traplines of 50 m each, spaced 10 m apart from each other, were plotted on each plot. On each trapline, 10 trapping stations spaced at 5 m intervals were set, made up of two traps (one Sherman and one Victor traps) per station. Thus, each plot was investigated with 100 traps including 50 Sherman traps and 50 Victor traps. All traps remained open for seven consecutive days and were checked every morning. The trapping effort was 700 trap nights per plot.

Traps were baited with fresh palm (*Elaeis guineensis* Jacq.) nuts and fresh cassava (*Manihot esculenta* Crantz) chips. Baits were renewed immediately after removal of the animal in the trap. However, all baits were systematically renewed after three consecutive trapping days.

Captured animals were identified, sexed and weighted. External measurements (head and body length, tail length, hind-foot length, and ear length) were recorded. Only non-identified animals (few specimens of *Malacomys*, *Praomys*, *Mus*, *Mastomys* and shrews) in the field were euthanised, preserved in 90% alcohol and brought back to the laboratory for additional examination. These voucher specimens were identified based on crania-dental analysis (Nicolas, 2003; Akpatou et al., 2007) compared to our specimen collection. Rodents and shrews were named according to the current taxonomy and nomenclature (Happold, 2013; Happold & Happold, 2013). The other animals which were well identified were tagged in the ear and released.

Data analysis

Several ecological indices were used to describe the structure of small mammal communities of the TESF. Trapping success (T) is defined as the number of individuals captured per 100 night traps: T = (n/E) × 100, where n: number of animals captured and E: trapping night (Kadjo et al., 2013). Relative abundance (RA) is the expression of the importance of each species compared to all those recorded in a particular site. Relative abundance was used to appreciate how common or rare a species is, compared to other species in a particular habitat: $RA = n_i/N$, where n_i: number of individuals of species «i» as a whole and $N = \Sigma n_i$ (total number of individuals captured).

Biological diversity was estimated using Shannon index defined as follows: $H' = -\sum p_i \log_2 p_i$ with $p_i = (n_i/N)$, where n_i: number of individuals of a species in a sample and N: total number of individuals of all species in the same sample (Shannon, 1948). The estimation of species regularity in different habitats was made from the computation of equitability index (E): $E = H'/H'_{max}$ where H'_{max}: maximum value of H', $H'_{max} = \log_2 S_{obs}$ (S_{obs}: number of species observed). Species richness is estimated from the Chao1 estimator (Chao, 1984). The diversity *t* test (Magurran, 1988) was used to compare Shannon (H') and equitability (E) indices between different habitats. Analyses were performed using the PAST 3.25 software.

Sorensen similarity index (S) was used to estimate similarities in faunal composition (Tchapgnouo et al., 2012). This index measures the similarity between lists of species from two different sites. For two lists A and B, with «A» as number of species of site x, «B» as number of species of site y and «C» as number of species common to both sites x and y, $S_{xy} = [2C/(A+B)] \times 100$. S_{xy} varies from 0% to 100%. $S_{xy} = 0\%$ when there are no common species between the two sites. S_{xy} reaches 100% when both lists are identical.

One-way ANOVA was used to compare the species abundance (RA). The Chi-square test was used to compare the trapping success between traps. The Kruskal-Wallis test was used to compare the trapping success between habitats. A Principal component analysis (PCA) was used to identify the correlation between small mammal abundance and habitat types (Pardini, 2004). PCA was carried out using XLSTAT software version 2019.

Results

Trap success

During this study, 294 individuals were caught in 8400 trap nights. The trapping success (T) was 4.46%, 3.78%, and 2.25% respectively for swamp forest, dryland forest and raphial, the over all trapping success was 3.52%. The Kruskal-Wallis comparison test showed that the trapping success varied significantly ($p = 0.03$) between swamp forest and raphial. No significant difference ($p > 0.05$) exist between the trapping success of dryland forest and the two other habitats (raphial and swamp). A total of 170 individuals were captured with Sherman traps (trap success = 4.04%) and 124 individuals with Victor wooden snap traps (trap success = 3%). The number of individuals caught per trap type was significantly higher with Sherman traps ($\chi^2 = 12.06$, df = 1, $p < 0.01$).

Species composition

The 294 terrestrial small mammals represented thirteen species, including nine rodents and four shrews (Table 1). The rodent community was dominated by *Hylomyscus simus* Aellen et Coolidge, 1930 (n = 135). It was followed by *Praomys rostratus* Miller, 1900 (n = 65), *Malacomys edwardsi* Rochebrune, 1885 (n = 18). The least represented rodent species were *Malacomys cansdalei* Ansell, 1958 (n = 7), *Hylomyscus baeri* Heim de Balsac and Aellen, 1965 (n = 5), *Mus musculoides* Smith, 1834 (n = 5), *Mastomys natalensis* (Smith, 1834) (n = 1) and *Dephomys defua* (Miller, 1900) (n = 1). *Crocidura buettikoferi* Jentink, 1888 (n = 22) was the most abundant shrew. The least represented shrew species were *Crocidura jouvenetae* Heim de Balsac, 1958 (n = 5), *Crocidura olivieri* Lesson, 1827 (n = 3) and *Crocidura grandiceps* Hutterer, 1983 (n = 1).

Species relative abundance per habitat

In the swamp forest, *Hylomyscus simus* was significantly abundant (ANOVA, $p < 0.001$; n = 71; RA = 56.8%). It represents more than half of the individuals captured in this habitat. It was followed by *Praomys rostratus* (n = 21; RA = 16.8%) and *Crocidura buettikoferi* (n = 10; RA = 8%) (Fig. 2). In the raphial, *Hylomyscus simus* (n = 21; RA = 33.33%) and *Praomys rostratus* (n = 21; RA = 33.33%) were the most dominant species (ANOVA, $p < 0.05$) (Fig. 2). In dryland, *Hylomyscus simus* (n = 43; RA = 40.57%) remained the most abundant species (ANOVA, $p < 0.05$) followed by *Praomys rostratus* (n = 23; RA = 21.70%) and *Malacomys edwardsi* (n = 14; RA = 13.21%) (Fig. 2).

Table 1. Species collected in the study area, number of individuals, relative abundance and conservation status. Trapping effort per site was of 2800 trap nights

Species	Swamp forest	Raphial	Dryland forest	Total	Relative abundance (%)	Conservation status (IUCN)
Shrews						
Crocidura buettikoferi Jentink, 1888	10	9	3	22	7.48	NT
Crocidura grandiceps Hutterer, 1983			1	1	0.34	NT
Crocidura jouvenetae Heim de Balsac, 1958	4		1	5	1.7	LC
Crocidura olivieri (Lesson, 1827)		3		3	1.02	LC
Total Shrews	**14**	**12**	**5**	**31**		
Rodents						
Dephomys defua (Miller, 1900)		1		1	0.34	LC
Hylomyscus baeri Heim de Balsac & Aellen, 1965	3		2	5	1.7	EN
Hylomyscus simus (G.M. Aellen & Coolidge, 1930)	71	21	43	135	45.91	LC
Lophuromys sikapusi (Temminck, 1853)	8		4	12	4.08	LC
Malacomys cansdalei Ansell, 1958	1	2	4	7	2.38	LC
Malacomys edwardsi Rochebrune, 1885	3	1	14	18	6.12	LC
Mus musculoides Smith, 1834			5	5	1.7	LC
Mastomys natalensis (Smith, 1834)	4	5	6	14	4.76	LC
Praomys rostratus (Miller, 1900)	21	21	23	65	22.11	LC
Total Rodents	**111**	**51**	**101**	263		
Total (Shrews and Rodents) (N=294)	**125**	**63**	**106**			
Species number	**9**	**8**	**11**			
Trap success	**4.46%**	**2.25%**	**3.78%**			
Shannon index (H')	**1.44**	**1.6**	**1.74**			
Equitability	**0.65**	**0.77**	**0.72**			
Chao1	**11**	**8.5**	**11.5**			

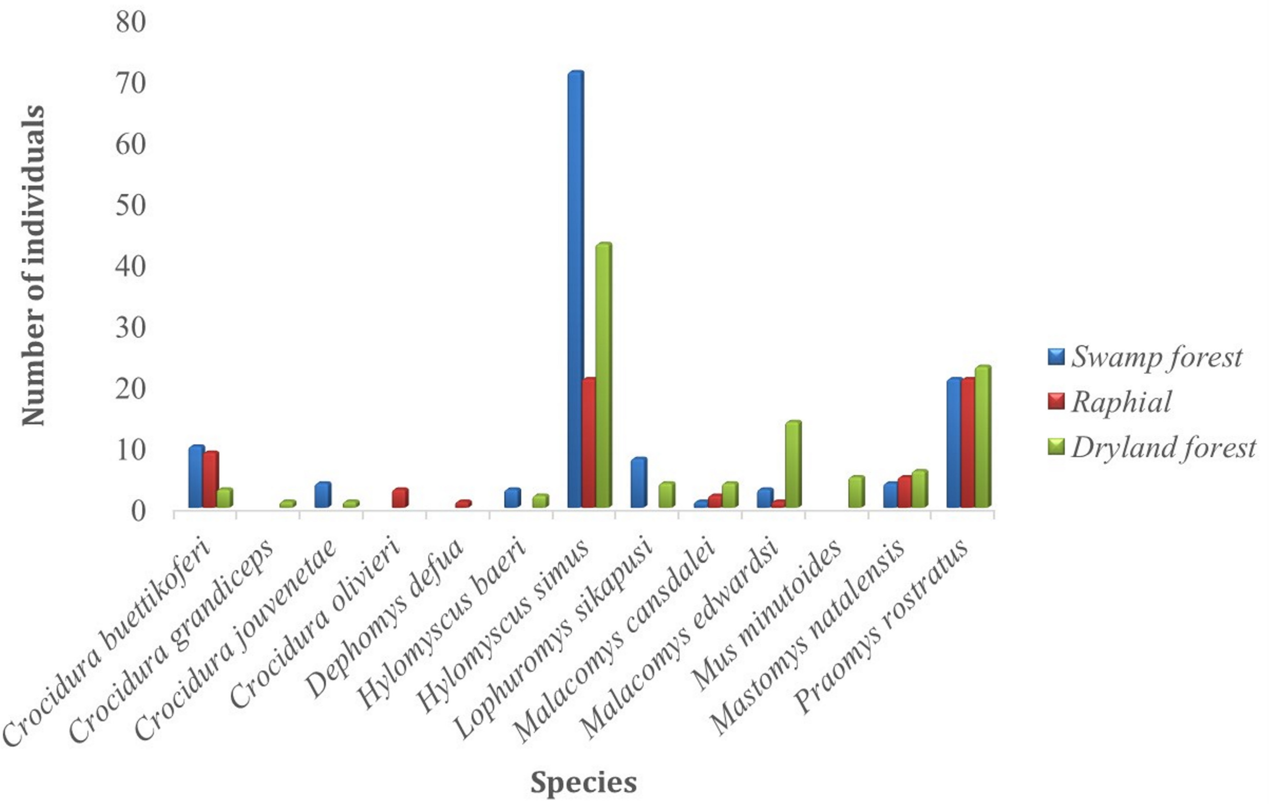

Fig. 2. Abundance of terrestrial small mammal species in three different types of habitats of the Tanoé-Ehy Swamp Forest.

Diversity index

The diversity indices (Table 1) show that the small mammal community in the dryland forest has a higher species richness (S = 11) than the swamp forest (S = 9) and the raphial (S = 8). The highest value of Shannon index (H') was recorded in dryland forest (H' = 1.74). It was followed by raphial (H' = 1.6) and the lowest value was observed in the swamp forest (H' = 1.44) (Table 1). The pairwise comparisons of habitat diversity index values H' using the diversity *t* test showed a significant difference (p = 0.04) between dryland forest and swamp forest. No significant difference (p > 0.05) was observed between the other habitats. The equitability was the highest (E = 0.77) in raphial and the lowest (E = 0.65) in swamp forest (Table 1). No significant differences of equitability were observed between habitats (p > 0.05).

Similarity

Estimations of similarity indices between the three habitats reveal that the dryland forest and swamp forest were very similar in terms of species richness (S_{xy} = 90%). The terrestrial small mammal recorded in the raphial were 70.59% similar to those of the swamp forest. The largest species variation (S_{xy} = 52.63%) was observed between dryland forest and raphial.

Correlations between small mammal abundance and habitat types

A biplot (Fig. 3) shows the two axes of principal component analysis (PCA) of the abundance (number of specimens) of rodent and shrew species in the three habitat types of the Tanoé-Ehy Swamp Forest (TESF). In the PCA, 55.56% and 44.44% of the total variability is explained by the first and second axes respectively. The first axis separates the dryland forest from flooded forests (swamp forest and raphial). This axis was positively correlated with some species: *Crocidura grandiceps*, *Hylomyscus baeri*, *Malacomys cansdalei*, *Malacomys edwardsi*, *Mastomys natalensis*, *Mus musculoides* and *Praomys rostratus*. These species, except *Hylomyscus baeri*, were strongly associated with the dryland forest. The other species were negatively correlated with axis 1. The second PCA axis shows a clear separation between the three habitats. *Crocidura jouvenetae*, *Hylomyscus simus*, *Hylomyscus baeri* and *Lophuromys sikapusi* were positively correlated to axis 2 and they were mostly associated with swamp forest. *Dephomys defua* and *Crocidura olivieri* were strongly associated with raphial (Fig. 3).

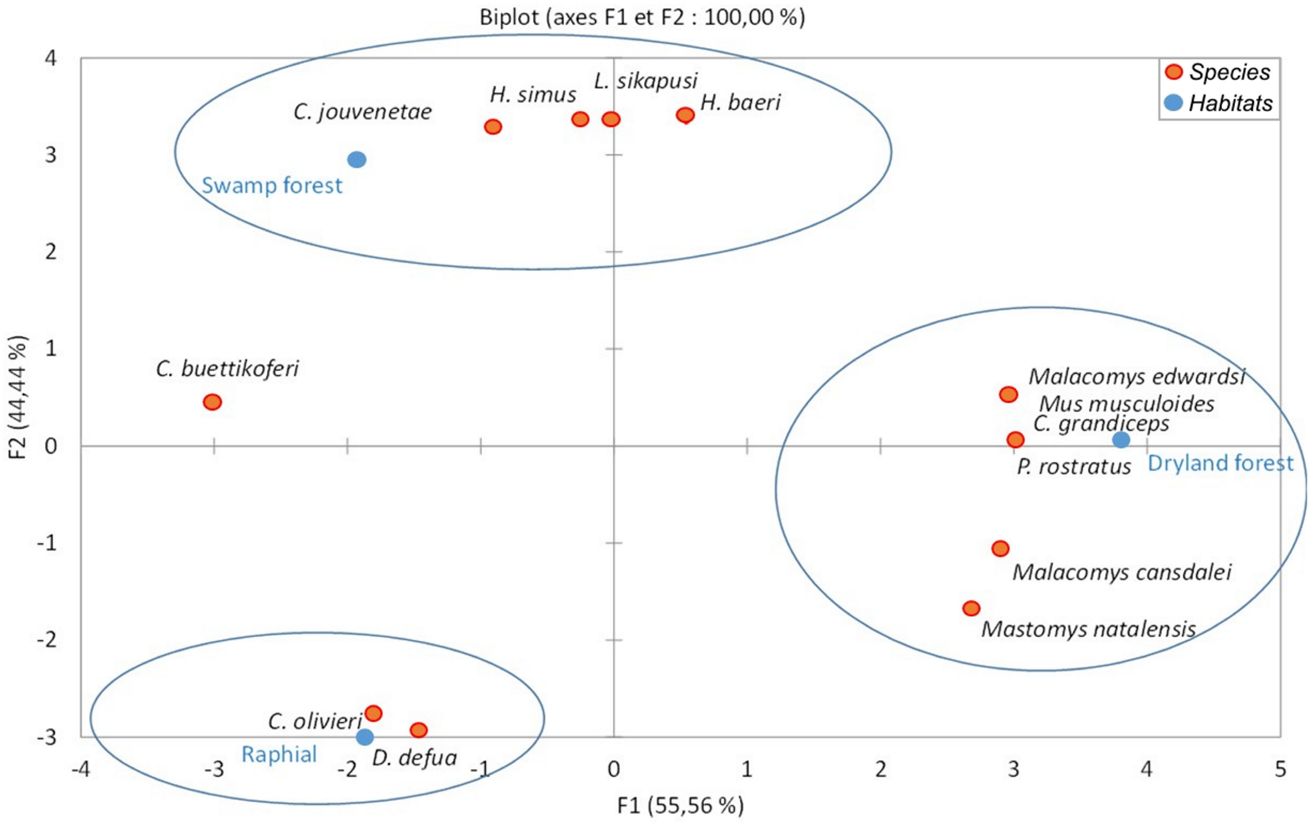

Fig. 3. Principal component analyses showing correlation between small mammal abundance and habitat types in the Tanoé-Ehy Swamp Forest. Designations: C.: *Crocidura*; D.: *Dephomys*; H.: *Hylomyscus*; L.: *Lophuromys*; P.: *Praomys*.

Discussion

Thirteen species of terrestrial small mammals were identified during this study. This specific diversity is composed of the main species found in most of forest habitats subjected to fragmentation phenomena. Terrestrial small mammals recorded at the Tanoé-Ehy Swamp Forest (TESF) were relatively similar to those of most littoral forests in Ivory Coast (Dosso, 1983; Decher et al., 2005; Akpatou et al., 2018). However, the comparison with previous studies should be considered with caution. Though all of these studies were carried out in almost similar environments, there are many other important factors to consider. These are bait types, trapping period and effort, microhabitats and level of habitat fragmentation. It is proven that the variation of these factors can influence the performance of trapping devices (Nicolas et al., 2010). One particularity of this study is the low species richness compared to that reported for the well protected Taï National Park (17 species, Akpatou et al., 2018) (Table 2). However, it is higher than those recorded in Banco National Park (11 species, Kadjo et al., 2013) and other sites in Ivory Coast (Decher et al., 2005).

The terrestrial small mammal community in TESF is dominated by forest dwelling species (*Hylomyscus simus*, *Praomys rostratus*, *Malacomys edwardsi*). This result confirms that the Tanoé-Ehy Swamp Forest is relatively well preserved.

According to the PCA results, most of the forest species were strongly associated with dryland forest (*Malacomys cansdalei*, *Malacomys edwardsi*, *Crocidura grandiceps*, and *Praomys rostratus*) and with the swamp forest (*Hylomyscus simus*, *Hylomyscus baeri*, and *Crocidura jouvenetae*). The presence of *Malacomys cansdalei* and *Malacomys edwardsi* in all habitats types reflects the relative integrity of the TESF.

However, the capture of species such as *Lophuromys sikapusi*, *Mastomys natalensis*, *Mus musculoides* and *Crocidura olivieri* is an evidence of human actions in the forest. The presence these species clearly indicates the infiltration of riparian populations into the forest as observed during field work through tree felling and clearing for agricultural needs. These anthropogenic actions are common in African forests and often lead to the emergence of new pioneer species (Nicolas et al., 2010; Iyongo et al., 2012).

Hylomyscus simus and *Praomys rostratus* are the most abundant in the three habitats sampled. Both species are known for their high adaptive capacity and ability to colonise several habitat types (Dosso, 1983; Happold, 2013). Species of the genus *Hylomyscus* and *Praomys*, notably *Hylomyscus stella* and *Praomys misonnei*, are known for their great swimming and climbing abilities (Nicolas, 2003). These qualities may be present in their respective sibling species *Hylomyscus simus* and *Praomys rostratus*. The swimming and climbing capacities have undoubtedly enabled *H. simus* and *P. rostratus* species to better adapt to forests on hydromorphic soil (swamp forest and raphial) at the TESF. This may explain their relatively higher abundance in these two habitats compared to other species.

Table 2. Summary of the main small mammal species inventories carried out in Ivory Coast. Only studies that are subject to comparison of richness and specific diversity were retained in the table

Locality	Date of collect	Trap type	Trapping effort	Bait	Species richness		References
					Rodents	Shrews	
Tanoé-Ehy Swamp Forest	September 2017 to March 2019	Sherman traps, snap traps	8400 trap nights	Palm nuts, cassava	9	4	This study
Taï National Park	March to June 2010	Sherman traps, pitfalls	8610 trap nights	Palm nuts	11	6	Akpatou et al., 2018
Taï National Park	October 1996 to November 1998	Pitfalls, Sherman traps, snap trap	61 920 trap nights	Palm nuts	-	10	Churchfield et al., 2004
Banco National Park	November 2007 to January 2008	Sherman traps, Longworth traps	5014 trap nights	Palm nuts, smoked fish	7	4	Kadjo et al., 2013
Haute Dodo classified forest	March to April 2002	Pitfalls, Sherman traps, snap trap	680 trap nights	Palm nuts	7	5	Decher et al., 2005
Cavally classified forest	March to April 2002	Pitfalls, Sherman traps, snap trap	1180 trap nights	Palm nuts	7	3	Decher et al., 2005

In the swamp forest, *Malacomys* accounts for 8.5% of the total catches and has a relatively low abundance in swamp forest and raphial. This result seems surprising, particularly for *M. cansdalei*, as it is known for its preference for moister swampy habitats (Happold, 2013). Additional data of *M. cansdalei* are necessary for a better understanding of its habitat preference in the Tanoé-Ehy Swamp Forest. Of the two species, *M. edwardsi* and *M. cansdalei*, present in the Upper Guinean forests, *M. edwardsi* is recognised as the most abundant (Dosso, 1983; Happold, 2013; Kadjo et al., 2013; Akpatou et al., 2018). The results of this study are in agreement with these authors.

Hylomyscus baeri, identified during our study, is an Endangered species according to IUCN (2019) criteria for species conservation status. This species has a restricted range in West Africa such as Ivory Coast, Ghana (Gautun & Bellier, 1970; Robbins & Setzer, 1979), a disjunct record from Panguma, Sierra Leone (Grubb et al., 1998), and a record from Ziama, Guinea (Nicolas et al., 2006). The population size and trend of this species is not yet clarified. *Hylomyscus baeri* is known only from very few collections, despite intensive investigations in these areas. Deforestation is probably a major threat to this species. Moreover, its typical localities (Adiopodoume, Grand-Lahou, Zegbe and Divo) in Ivory Coast are under high human pressure (Gautun & Bellier, 1970). This species needs strong conservation actions such as research on distribution, population size, trends, and monitoring.

Only four shrews were collected at the TESF. The relative abundance of shrews was larger in raphial and swamp forest than in the dryland forest. The ubiquitous *Crocidura buettikoferi* is the most abundant shrew's species in TESF. Hydromorphic environments, regularly wet, contain more invertebrates (earthworms, Isopods, small gastropods and insects) (Leeper & Taylor, 1998) known to be relevant food for shrews of the genus *Crocidura* (Churchfield et al., 2004).

Despite these potentialities for shrews their richness in TESF is lower than obtained in Taï National Park and Haute Dodo classified forest (Churchfield et al., 2004; Decher et al., 2005; Akpatou et al., 2018). The lower diversity of shrew species observed in TESF could be explained in part by the trapping device used in the three habitats investigated.The device for trapping terrestrial small mammals integrating pitfall traps gives better yields with regard to shrew's diversity (Nicolas et al., 2009; Akpatou et al., 2018). In this study, no pitfall line was installed.

The species richness of small mammals was higher in dryland forest compared with the swamp forest and the raphial. Similar results have been observed in forest on Mount Doudou in Gabon (Nicolas et al., 2004). In general, the equitability ($E \geq 0.63$) was high in the three habitat types inventoried. This shows that the population of terrestrial small mammals in TESF was co-dominated by several species. However, the high dominance of *H. simus* in the swamp forest justifies the low equitability ($E = 0.63$) observed in this habitat. The trapping success demonstrates that Sherman traps were significantly more effective in capturing terrestrial small mammals than wooden snap traps. The trapping success was higher in swamp forest than in dryland forest. Similar results have been observed in the same habitat types in Gabon (Nicolas, 2003). Similarity indices show that the dryland and swamp forests were mainly populated by the same species. The Tanoé-Ehy Swamp Forest is dominated by swamps; terrestrial small mammals have to be adapted to this environment with hydromorphic soil and dry soil in places. The phenomenon of adaptation to different local biotopes is well known in terrestrial small mammals (Kennis, 2012).

The Tanoé-Ehy Swamp Forest is a sanctuary of many species of primates, amphibians and plants which are classified as threatened according to the IUCN (2019). This study has identified three terrestrial small mammals considered by IUCN (2019) as of conservation concern. These are *H. baeri* classified as Endangered (EN) and *C. buettikoferi* and *C. grandiceps* as Near Threatened (NT). These species could benefit from the conservation programmes granted to the emblematic species of the TESF.

Conclusions

This study is a preliminary survey of the terrestrial small mammal diversity and abundance of the Tanoé-Ehy Swamp Forest. The thirteen species of terrestrial small mammals collected during this study enrich the scientific knowledge of the mammalian fauna of this forest. The confirmation of forest dwelling species is encouraging for the preservation of the TESF. This must be done taking into account their high sensitivity to fragmentation and disturbance. In addition to the above, today the Tanoé-Ehy Swamp Forest is one of the revenant sites for the conservation of the Endangered *Hylomyscus baeri* in Ivory Coast. Thus, the presence of numerous species of conservation concern in this Volunteer Nature Reserve underscores the urgent need for its effective protection. As a result, the full protection of the TESF is a challenge for researchers and conservationists.

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ВИДОВОЙ СОСТАВ И СТРУКТУРА СООБЩЕСТВ НАЗЕМНЫХ МЕЛКИХ МЛЕКОПИТАЮЩИХ В ЗАБОЛОЧЕННОМ ЛЕСУ ТАНОЭ-ЭЙХИ (ЮГО-ВОСТОЧНОЕ ПОБЕРЕЖЬЕ КОТ-Д'ИВУАР): ПРИРОДООХРАННОЕ ЗНАЧЕНИЕ

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Заболоченный лес Таноэ-Эйхи (ЗЛТЭ) является одним из наиболее значимых участков для сохранения природы в Кот-д'Ивуаре. Он отличается исключительным богатством биоразнообразия, включая многие исчезающие растения и животные. Действительно, в последние годы в ЗЛТЭ были проведены исследования с целью уточнить данные о его важности для сохранения биоразнообразия в Кот-д'Ивуаре. Эти исследования коснулись угрожаемых видов обезьян и лягушек. В настоящее время данных о мелких млекопитающих в ЗЛТЭ нет, несмотря на общее мнение об их важности в природных местообитаниях. Тем не менее, известно, что мелкие наземные млекопитающие являются хорошими индикаторами состояния сохранения многих тропических экосистем. Настоящая работа является первым исследованием сообществ наземных мелких млекопитающих в заболоченном лесу Таноэ-Эйхи. Оно направлено на определение видового состава и выявление подходов к сохранению ЗЛТЭ. Было выбрано три основных типа местообитаний (засушливые леса, заболоченные леса и рафиалы (леса с доминированием *Raphia* sp.)) с использованием обычных ловушек Шермана и деревянных пружинных ловушек Виктора. В результате 8400 ловушко-ночей, было поймано 294 особи, относящиеся к девяти видам грызунов и 4 видам насекомоядных. В сообществе грызунов доминировали вид *Hylomyscus simus* (n = 135), а также *Praomys rostratus* (n = 65) и *Malacomys edwardsi* (n = 18). *Crocidura buettikoferi* (n = 22) имел наибольшее обилие среди насекомоядных. Видовое богатство и индекс разнообразия были выше в засушливых лесах, чем в заболоченных лесах и рафиалах. Заболоченные леса показали наибольшее число пойманных животных (n = 126), меньшее число было поймано в засушливых лесах (n = 107) и рафиалах (n = 63). Однофакторный дисперсионный анализ показал значительные отличия ($p \leq 0.05$) между обилием наземных мелких млекопитающих в трех изученных типах местообитаний. Индексы сходства показали, что засушливые и заболоченные леса были в значительной степени заняты одними и теми же видами. Три вида являются угрожаемыми, согласно критериям МСОП. Из них один вид грызунов, *Hylomyscus baeri*, имеет статус Исчезающий (Endangered – EN), а два вида насекомоядных, *Crocidura buettikoferi* и *Crocidura grandiceps*, имеют статус близких к уязвимому положению (Near Threatened – NT). Это исследование подчеркивает важность ЗЛТЭ для сохранения фауны в Кот-д'Ивуаре.

Ключевые слова: грызуны, заболоченный лес, индексы разнообразия, Кот-д'Ивуар, насекомоядные, сохранение