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Detecting intruders: assessment of the anthropophilic ant fauna (Hymenoptera: Formicidae) in the city of Abidjan and along access roads in Banco National Park (Côte d'Ivoire)

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Abstract
Remnant natural habitats within and surrounding urbanized areas are becoming increasingly important for maintaining local biodiversity. We used tuna bait to survey and assess ant community diversity in the ten municipalities of Abidjan city and its included natural habitat of Banco National Park. Although ant communities in urban environment differ generally from the ant fauna found in natural habitat (Banco National Park), we recorded the presence of 20 ant species shared by both habitats. We observed the occurrence of tramp ants and well-adapted urban ant species like *Paratrechina longicornis* and *Tetramorium simillimum* along the access roads of this national park. The findings of this study are important as they show the importance of Banco National Park in the conservation of biodiversity in urban areas but also the threat of invasion by anthropophilic species that may influence biodiversity within this park.

Keywords: Anthropophilic ants; urban habitat; invasion; City of Abidjan; Banco National Park

Introduction

Last 50 years, one serious environmental issue remains the growth of urban ecosystems. More than 50% of global human population lives in urban areas, with nearly 70% projected to live in urban areas by 2050 [1]. However cities are not dispersed randomly at global scale, but are often located in/near biodiversity hotspots. They impact local and regional biodiversity [2-3] and cause the loss of biodiversity via urbanization processes. For example, urbanized area creates an attractive habitat for species able to live in disturbed habitats. That allows the new combinations of species through both introductions of exotic species to parks and gardens and the migration of invasive species [4].

Yet, many tropical urban matrixes often include a mosaic of vegetation types which constitutes remnant natural habitats and green areas associated with urbanized areas. These can take the form of parks and gardens, recreation parks and nature reserves, conservation parks and national parks [5]. These green areas provide many ecosystem services [6] and serve as nourishment, shelter, and habitat to a wide variety of animal species [7-8]. Although several studies reported that urban green areas have excellent potential for biodiversity conservation, their management remains a challenge because of urban development.

In the city of Abidjan, the recent explosion of new urban areas is known as a major cause of degradation of its surrounding forest and environment [9-10]. The Banco National Park (BNP) is a unique natural ecosystem located inside this metropolis. Unfortunately, the park is still under pressures by activities of burgeoning and growing populations, and is probably also exposed to invasion of anthropophilic species from its surrounding urban areas. In face of this urbanization pressure, the need to provide ecological information on the conservation status of Banco National Park (BNP) is fundamental for its integrity and long-term conservation.

Many studies report that ants are one of the most important groups of invertebrates that can be used to assess the biological consequences of urbanization [11-12]. This group of insects is generally known as good indicators for changes in the environment [13-14]. In fact, some ant species are remarkable examples of animals adapted to urban habitats [15-16]. These ant species, called "Tramp species" [17], achieve wide distribution and abundance, and could also occur outside their usual distribution range. According Moreira *et al.*, [18], human contact with these ants can be observed in residences, commercial establishments and hospitals where they cause discomfort due to their presence in food facilities and public health centres.

Numerous studies show that tramp ant species share characteristics that facilitate their introduction into new environment [19-20], however, very few studies have reported the introduction of ant species from urban environments into remnant natural habitat associated to urbanized areas.

In this paper we discuss the results of an ant survey in urban and remnant natural habitat (municipalities of Abidjan and access roads of Banco National Park) in Abidjan, Côte d'Ivoire. This is the first and pioneer study that reports a survey on the diversity of anthropophilic ant fauna in West African urban areas. This study evaluates the potential use of ant as indicator species to monitor biodiversity in West African cities. Our study have two aims: (1) Assess ant diversity, abundance and species composition of urban areas in Abidjan and its included natural habitats, especially access road of Banco National Park (BNP); (2) To detect intruder ants like tramp species in access roads of Banco National Park.

Material and Methods

Description of the study area

The study was conducted in Côte d'Ivoire, precisely in the ten municipalities of Abidjan and it included natural park: the Banco economical National Park (5°21'N - 5°25'N to 4°01'W - 4°05'W) that covers an area of 37.44 Km^2 (Fig. 1). The climate regime is subequatorial and the annual mean temperature and precipitation are 27.4 °C and 1733 mm, respectively. We sampled ant community each municipality (Table 1) and on the three access roads of Banco National Park as follow: The roads "Voie Andokoi" (municipality of Yopougon) and "Voie Attécoubé" (municipality of Attécoubé) lead to the arboretum located at the centre of park are covered and bordered by forest trees with treefall gap in places. A third road "Voie Sagbé" (municipality of Abobo) is a runoff road bordered by wild banana trees and some rare big trees allowing sunlight impacts directly on the sandy soil.

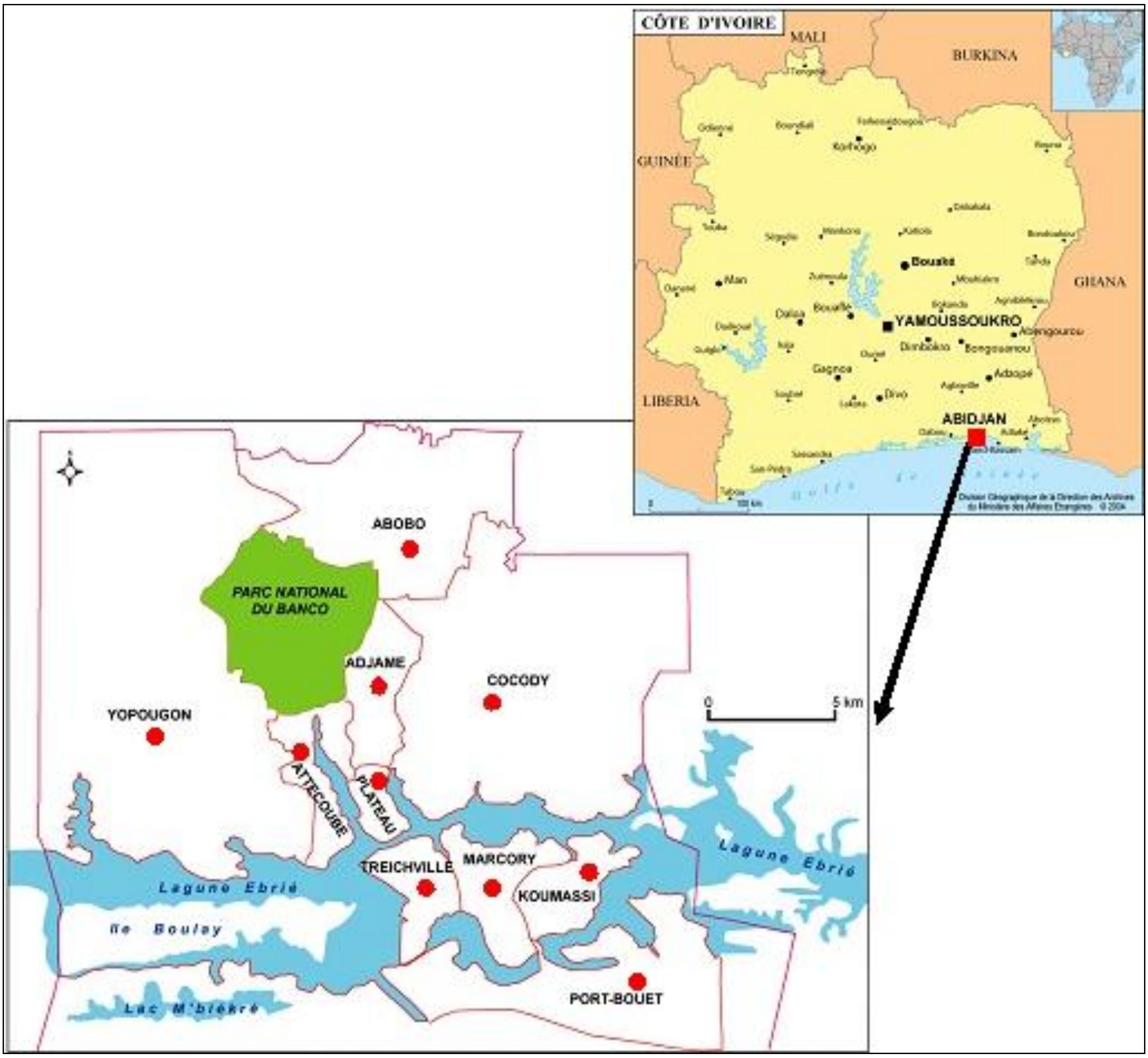

Fig 1: Location of the city of Abidjan with it municipalities and Banco National Park. (Source: BNETD)

Ant sampling

Ants were sampled using tuna baits in Abidjan and in the Banco National Park (BNP). Municipalities of Abidjan and each access road of BNP were considered as a study site and on each site we put in place three linear transect (Table 1). All sampling was performed between 8 and 12 o'clock on the morning from January to April 2009. A total of 780 bait stations were placed along 39 linear transects and their coordinates were registered using a Global Positioning System (GPS). Transects of 200 m long were always separated at least 500 m from each other to ensure independence of samples. The transects were distributed as follows: 30 in the municipalities of Abidjan (3 transects per municipality) and 9 on the different access roads of Banco National Park (3 transects per road). Twenty baits were set up every 10 m along the linear transects and exposed for 60 minutes. Ants were collected twice an hour i.e. 30 minutes and 60 minutes after bait placement and stored separately in individual pill box of 2ml filled with Ethanol (96%). In total we collected 120 samples for each site.

Ants were identified considering workers overall. For polymorphic worker caste we did not count major worker and minor worker as separate morphospecies. All ants were determined at genus level using the pertinent key of Bolton [21]. For species level, identification keys of Bolton [22-25] were used. We used also Dr Yeo Kolo's ant reference collection in Lamto Ecological Station. Voucher specimens of this collection were identified using ant specimens deposited at Natural History Museum of London; Musée d' Histoire Naturelle de Paris and Museum of Comparative Zoology, Cambridge, USA. When species-level identification was not possible, distinct specimens were sorted according to morphospecies. All unidentified ants were pinned and labelled but were not included in analyses. All identified ants specimens were deposited at Lamto Ecological Research Station at Taabo in Côte d'Ivoire.

Table 1: Sampling sites and areas in Abidjan's municipalities and on the Access-roads of Banco National Park.

Municipalities	Location	Latitude	Longitude
Abobo	Sagbé	05°25'07.7''N	004°01'51.0''W
	Avocatier	05°26'07.6''N	004°01'25.8''W
	Agbékoi	05°25'45.9''N	004°00'50.7''W
Adjamé	FraternitéMatin	05°20'48.6''N	004°01'02.0''W
	Bracodi	05°21'40.6''N	004°01'34.1''W
	Williamsville	05°22'04.4''N	004°01'27.9''W
Attécoubé	Cité Fermont	05°21'29.2''N	004°02'01.3''W
	Marché	05°20'59.3''N	004°02'01.1''W
	Gare	05°20'36.5''N	004°02'04.4''W
Cocody	Riviera	05°21'13.1''N	003°58'10.0''W
	Saint-Jean	05°20'10.0''N	004°00'12.7''W
	Angré	05°24'11.5''N	003°59'09.7''W
Marcory	Polymed	05°18'27.6''N	003°59'32.8''W
	Zone 4	05°17'47.1''N	003°59'14.3''W
	INJS	05°18'26.5''N	003°59'14.6''W
Koumassi	Place Inchallah	05°17'57.8''N	003°57'21.6''W
	Zone industrielle	05°17'28.4''N	003°57'04.9''W
	Terminus du bus 05	05°18'43.6''N	003°56'39.9''W
Plateau	Boulevard de la République	05°19'19.5''N	004°01'14.6''W
	Palais de justice	05°19'49.1''N	004°01'09.9''W
	Immeuble la Pyramide	05°19'22.5''N	004°00'59.3''W
Port-Bouet	Vridi	05°15'20.8''N	003°59'52.0''W
	Phare	05°14'56.3''N	003°57'13.6''W
	Abattoir	05°15'37.9''N	003°58'08.1''W
Treichville	Siège de la SOTRA	05°17'08.2''N	004°00'30.0''W
	Palais de la culture	05°18'39.6''N	004°00'41.2''W
	RueNananYamousso	05°18'21.3''N	004°00'17.2''W
Yopougon	Niangon	05°19'51.4''N	004°06'06.0''W
	Toit rouge	05°19'45.2''N	004°03'40.10''W
	Gesco	05°21'55.1''N	004°06'08.0''W
Banco Park	Voie Attécoubé	05°21'55.6''N	004°02'49.2''W
	Voie Andokoi	05°22'49.1''N	004°03'44.5''W
	Voie Sagbé	05°20'36.5''N	004°02'42.2''W

Data analysis

For statistical analysis, we pooled samples of 30 minutes and 60 minutes and obtained a total of 60 samples for each site. Because ants are social insects, we preferred occurrences over individual abundance to avoid bias due to sampling near nest [26]. We considered following ant fauna characteristics for analysis: Relative occurrence defined as the total number of occurrences for a species in a given habitat/total number of occurrence for all species; Species richness was defined as the number of observed species for the whole transect in a given site. The Shannon-Wiener diversity index (H') and it Evenness (E) were calculated to measure α-diversity.

We used EstimateS v9.0 [27] to plot species accumulation curves, representing the cumulated rarefied number of species in function to the number of sample and species occurrences. We used also the non-parametric Chao2 estimator to calculate the expected number of species. The observed number of species was then compared with the expected number of species as a tool to evaluate sampling efficacy. A Chi-square test was conducted to determine whether the number of species by subfamily varied according to habitat types. The significance of the variation among species richness in each habitat type was tested using One-way analysis of variance (ANOVA) followed by Honestly Significant Difference (HSD) post hoc pairwise comparison tests to identify differing sites. Furthermore, Rank-Abundance Species curves were performed with Microsoft Excel to examine the structure of ant species assemblage in the study areas.

The Bray-Curtis index was calculated to measure β-diversity and quantify the similarity of species composition between transects of each habitat type (Abidjan and BNP). We then performed a two-dimensional ordination with non-metric multidimensional scaling (NMDS) by using a Bray-Curtis index value to visually compare similarity patterns among transects of each habitat. The ordination was tested using a non-parametric analysis of similarity (ANOSIM) based on 1000 permutations and post hoc Bonferroni pairwise comparison. Past Software v3.09 [28] was used to compute diversity index and to plot the Non-metric Multidimensional Scaling (NMDS). It has been also used for all statistical tests and $P \leq 0.05$ was taken as an indicator of statistical significance.

Results

Ant species richness and diversity

The observed and expected species richness in the different sampling sites of each habitat are showed in Table 2. Sampling coverage (mean ± SD) was 68.2±13.8% and 80.6±10.2% for BNP access roads and Abidjan municipalities, respectively. The species accumulation curves continued to grow for all sites of each habitat (Fig.2). 91 species (Table 3) were collected in the two habitat types with 56 species in the urban area (Abidjan municipalities) and 55 species in the natural areas (the access roads of BNP). Similar numbers of subfamilies and genera were found in both habitats (Fig. 3). Five subfamilies: Myrmicinae; Formicinae; Dolichoderinae; Ponerinae; and Dorylinae belonging to 23 genera were recorded by order of decreasing species richness. The number of species by subfamily varied with habitat type (χ^2=14.41, *df* =5, *P*=0.013). Fig. 3 also showed that Myrmicinae were the most abundant and species-rich subfamily in each habitat. The frequencies of occurrence were high for Dolichoderinae (11%) and low for Ponerinae (5%) in urban areas, whereas in BNP we found 9% and 6%, respectively. Dorylinae were rare in urban habitat with 2% in comparison to the natural habitat with 6% of frequency of occurrence.

Of the ten municipalities of Abidjan, Adjamé and Abobo were the most ant species rich with 28 species. Port-Bouet and Treichville were the poorest with 16 species (Table 2, one-way ANOVA for observed species richness: F=3.562, *df*=9; *P*<0.05). The post-hoc pairwise comparisons based on Tukey's HSD shows a significant difference between Port-Bouet and Koumassi (Q=5.032, *P*=0.02) and between Port-Bouet and Adjamé (Q= 1, *P*=0.04). Among the access roads of Banco National Park, Voie Attécoubé had the highest species richness with 31 species.

The diversity index varied little among habitats with an average of 2.7±0.2 and 2.5±0.1 for Shannon index respectively in municipalities and on access roads of Banco National Park. The Evenness was 0.6±0.07 and 0.48±0.1, respectively. The rank species abundance curves based on relative occurrence showed that ant communities could be divided in three classes for both Abidjan's municipalities and Access roads of Banco National Park (Fig. 4). In the first class, we had a small number of ant species which predominate communities with a relative occurrence higher than 10%, then, the second class, the most important one in term of abundance, is formed of frequent species with relative occurrence between 1% and 10%. At last, in the last class, under the threshold of 1%, we had rare species. Also, we observed that on the access road of Banco National Park, the abundance of rare species remains steady whereas in Abidjan's municipalities the fall of rare species persists before stabilizing.

Table 2: Metrics of ant diversity (mean ± SD) in Abidjan's municipalities and on the access road of Banco National Park.

Sites	Observed species	Chao 2	Samples Coverage (%)	Shannon Index	Evenness
Municipalities of Abidjan					
Abobo	28	35	80	2.6	0.67
Adjamé	28	35	80	2.7	0.53
Attécoubé	19	28	67.8	2.5	0.63
Cocody	23	27	85.2	2.6	0.57
Marcory	19	20	95	2.6	0.70
Koumassi	26	28	93	2.8	0.65
Plateau	25	30	83.3	2.7	0.64
Port-Bouet	16	19	84.2	2.2	0.64
Treichville	16	26	61.5	2.3	0.57
Yopougon	23	30	76.6	2.3	0.43
Mean	**22.3±4.6**	**27.8±5.3**	**80.6±10.2**	**2.7±0.20**	**0.6±0.07**
Access roads of Banco National Park					
Voie Attécoubé	31	54	57.4	2.5	0.38
Voie Andokoi	26	41	63.4	2.5	0.49
Voie Sagbé	26	31	83.8	2.7	0.58
Mean	**27.6±2.8**	**42±11.5**	**68.2±13.8**	**2.5±0.1**	**0.48±0.10**

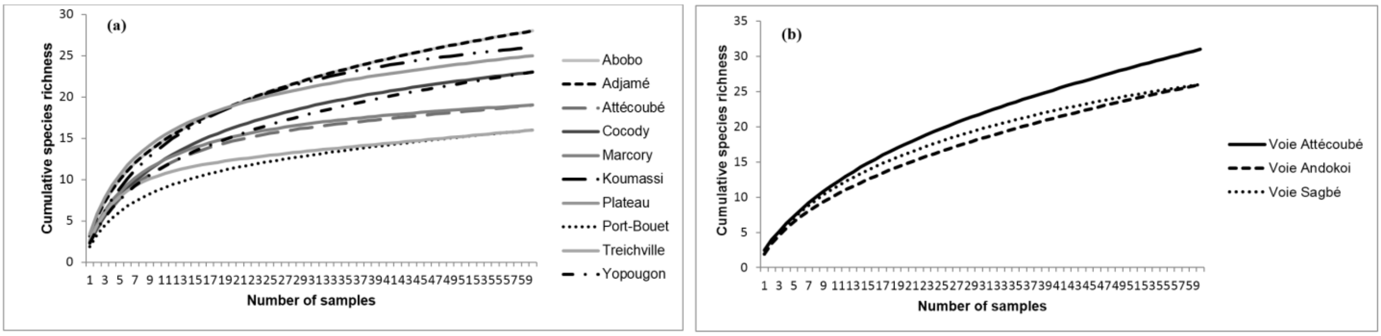

Fig 2: Species accumulation curves in **(a)** municipalities of Abidjan and **(b)** access roads of Banco National Park. Each curve showing the cumulative species richness in function of the number of sample collected on each site.

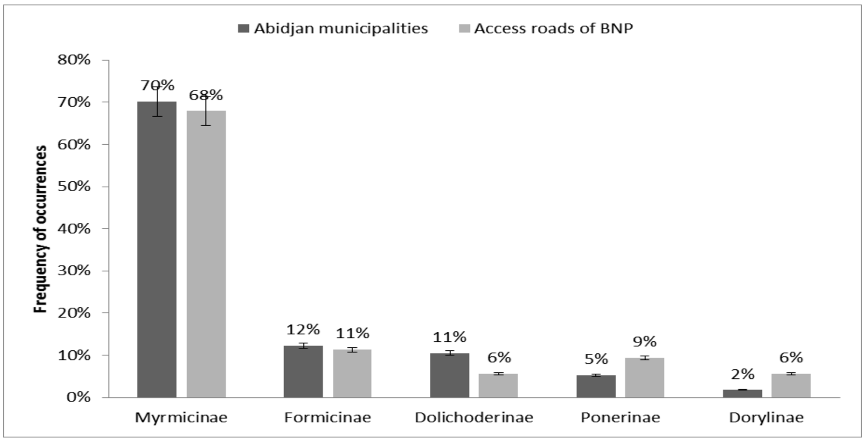

Fig 3: Variation of frequency of occurrence of observed species for five subfamilies in Abidjan's municipalities and Access roads of Banco National Park.

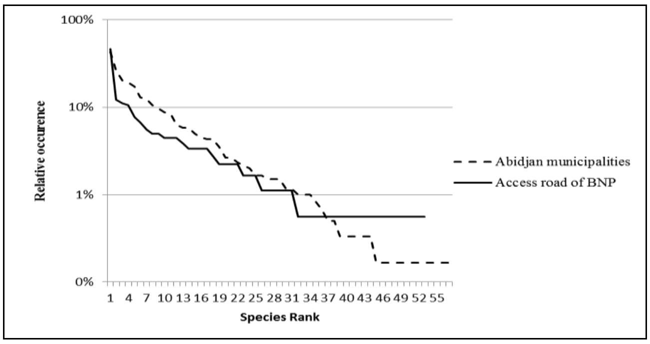

Fig 4: Rank species Abundance curves for Abidjan's municipalities and access roads of Banco National park.

Species composition and detection of tramp ants

The Non-metric Multidimensional Scaling (NMDS) based on the values of Bray-Curtis similarity (Fig. 5) showed a clear difference between the two habitats (overall ANOSIM: R=0.93, P< 0.0002). We also found differences among transects of municipalities (ANOSIM: R=0.26, *P*<0.005) and between transects in Banco National park (ANOSIM: R=0.70, *P*<0.005). The most abundant species in urban areas were *Monomorium bicolor*, *Paratrechina longicornis*, *Pheidole* sp.8, *Trichomyrmex destructor*, *Pheidole* sp.2, *Tapinoma luteum*, *Tetramorium simillimum*, *Monomorium pharaonis*, *Pheidole* sp.20, *Monomorium* sp.15, *Tetramorium rhetidum*. On the access roads of Banco National Park the most abundant ants species were, *Pheidole buchholzi*, *Pheidole* sp.16, *Pheidole* sp. 21, *Crematogaster striatula* (Emery, 1892), *Carebara perpusilla*, *Oecophylla longinoda*.

Out of 91 ant species only 20 species were shared between Abidjan's municipalities and access roads of Banco National Park (Table 3). Each habitat had specific ant species: 36 species specific to municipalities and 35 species specific to access roads of BNP (Table 3). Likewise, out of 20 ant species shared between habitats, *Nylanderia weissi*; *P. longicornis*; *Pheidole sp.*2; *Pheidole sp.*20; *Pheidole sp.*8; *Tapinoma lugubre*; *Tetramorium sericeiventre* and *T. simillimum* have a high prevalence in urban area compared to Banco National Park. These species appeared also on the access roads of Banco National Park (Table 3).

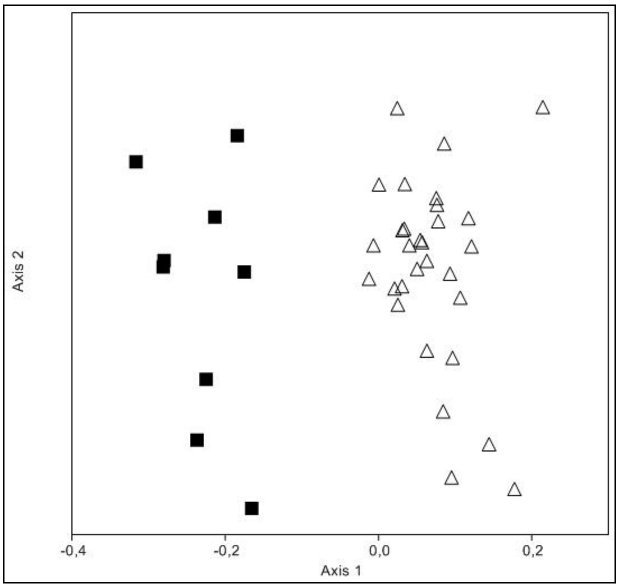

Fig 5: Non-metric multidimensional scaling plot from Bray-Curtis index showing differences in species composition between municipalities of Abidjan and Banco National Park. Filled square showing transects of BNP and white triangles those of municipalities (R^2=0.82, stress=0.17).

Table 3: Total occurrences of ant morphospecies collected in Abidjan's municipalities and on the access roads of Banco National Park.

Subfamilies/*Species*	Voie Sagbé	Voie Andokoi	Voie Attécoubé	Abidjan
Dolichoderinae				
Tapinoma sp.4	0	0	0	1
Tapinoma lugubre Santschi, 1917	9	0	0	26
Tapinoma luteum (Emery, 1895)	0	0	0	108
Tapinoma melanocephalum Fabricius, 1793	0	0	0	38
Dorylinae				
Dorylus sp.2	0	0	2	0
Dorylus nigricans terrificus Santchi, 1923	2	0	0	0
Dorylus nigricans arcens(Westwood, 1847)	0	10	0	2
Formicinae				
Camponotus acvapimensis Mayr, 1962	0	0	0	12

Camponotus brutus Forel, 1886	0	0	1	0
Camponotus maculatus (Fabricius, 1782)	0	7	0	1
Camponotus vividus (Smith, 1858)	0	0	0	8
Lepisiota sp.3	0	0	0	1
Lepisiota egregia (Forel, 1913)	0	0	0	10
Nylanderia arlesi (Bernard, 1953)	0	0	2	1
Nylanderia weissi (Santschi, 1911)	2	0	0	30
Oecophylla longinoda (Latreille, 1802)	27	0	2	0
Paratrechina longicornis (Latreille, 1802)*	1	0	0	159
Polyrhachis decemdentata André, 1889	0	2	4	1
Polyrhachis militaris (Fabricius, 1782)		1	0	0
Myrmicinae				
Cardiocondyla emeryi Forel, 1881*	0	0	0	22
Cardiocondyla shuckardi Forel, 1891	0	0	0	11
Carebara sp.10	0	1	0	0
Carebara elementeitae (Patrizi, 1948)	0	0	1	0
Carebara perpusilla (Emery, 1895)	0	17	1	0
Carebara thoracica (Weber, 1950)	0	1	0	0
Crematogaster sp.2	0	0	0	2
Crematogaster sp.5	0	0	0	2
Crematogaster sp.7	1	0	0	0
Crematogaster sp.9	0	1	0	0
Crematogaster sp.13	1	0	0	0
Crematogaster sp.14	2	0	0	0
Crematogaster sp.16	5	3	1	0
Crematogaster sp.18	8	0	0	0
Crematogaster sp.19	1	0	0	0
Crematogaster sp.20	1	0	0	0
Crematogaster striatula Emery, 1892	8	15	4	5
Monomorium sp.5	0	1	0	0
Monomorium sp.13	0	0	2	0
Monomorium sp.14	0	0	0	3
Monomorium sp.15	0	0	0	60
Monomorium sp.16	0	0	0	30
Monomorium bicolor Emery, 1877	0	0	0	399
Trichomyrmex destructor (Jerdon, 1851)*	0	0	0	117
Monomorium dolatu Bolton, 1987	0	0	0	6
Monomorium egens Forel, 1910	1	2	1	0
Monomorium florícola (Jerdon, 1851)*	0	0	0	6
Monomorium invidium Bolton, 1987	0	0	0	1
Monomorium occidentale Bernard, 1953	0	0	0	10
Monomorium pharaonis (Linnaeus, 1758)*	0	0	0	67
Pheidole sp.1	0	0	0	1
Pheidole sp.2	3	0	1	115
Pheidole sp.3	1	1	1	7
Pheidole sp.4	0	1	4	3
Pheidole sp.7	14	2	2	7
*Pheidole*sp.8	0	1	0	122
Pheidole sp.9	0	0	0	30
Pheidole sp.11	0	0	1	0
Pheidole sp.16	2	8	12	0
Pheidole sp.18	0	0	0	35
Pheidole sp.19	0	10	0	0
Pheidole sp.20	0	4	0	64
Pheidole sp. 21	0	0	20	2
Pheidole sp. 22	0	0	0	1
Pheidole buchholzi Mayr, 1901	17	35	45	0
Pheidole excelens Mayr, 1862	7	1	8	16
Solenopsis sp. 1	0	0	0	9
Solenopsis sp. 2	0	0	0	35
Solenopsis sp. 3	0	0	0	15
Tetramorium sp. 5	0	0	0	6
Tetramorium sp. 14	0	0	0	1
Tetramorium aculeatum (Mayr, 1866)	0	0	2	0
Tetramorium anxium Santschi, 1914	2	1	1	0
Tetramorium brevispinosum (Stitz, 1910)	3	2	3	0
Tetramorium caldarium(Roger, 1857)*	0	0	0	12
Tetramorium calinum Bolton, 1980*	0	0	5	2
Tetramorium eminii (Forel, 1894)	0	0	0	16

Tetramorium furtivum(Arnold, 1956)	0	1	0	0
Tetramorium minimum (Bolton, 1976)	0	0	0	2
Tetramorium rhetidum Bolton, 1980	0	0	0	53
Tetramorium sepositum Santschi,1918	3	0	0	0
Tetramorium sericeiventre Emery, 1877	1	0	2	13
Tetramorium simillimum (Smith, 1851)*	0	0	1	74
Tetramorium versiculum Bolton, 1980	0	1	0	0
Tetramorium zapyrum Bolton, 1980	0	6	2	0
Ponerinae				
Anochetus africanus (Mayr, 1865)	1	0	0	0
Bothroponera soror (Emery, 1899)	0	0	1	0
Leptogenys conradti Forel, 1913	0	0	1	0
Mesoponera ambigua (André,1890)	0	0	0	1
Odontomachus troglodytes Santschi, 1914	0	0	3	6
Paltothyreus tarsatus(Fabricius, 1798)	0	0	4	1
Platythyrea tenuis Emery, 1899	1	0	0	0

(*) = introduced or tramp species according other studies [17, 19, 29]

Discussion

Ant species richness, diversity and abundance

Our findings showed a high sample coverage (>60%), suggesting that the sampling protocol employed allowed us to collect more than half of the expected species. However, the species accumulation curves continued to rise in all sites. These results are consistent with Gotelli *et al.*, [30] who argued that it is rare to reach a complete sampling of invertebrate, particularly for ants where previously undetected species can be found after decades of continuous sampling.

Our study revealed also a notable diversity and richness of the ant fauna of the city of Abidjan (56 species) and Banco National Park (55 species) and the distinctiveness of the ant community of Banco National Park in spite of its location inside urban area. During this survey, we found no significant difference for the number of species between the different access roads of Banco National Park, suggesting that the ant communities in each access road have a particularly ant rich fauna. However, the Chao 2 estimates of species richness predicted that the Voie Attécoubé supported a greater richness than both Attécoubé and Sagbé access roads.

When the ant richness and diversity from each municipality were compared, a low variation was found which might be due to the resemblance of habitat characteristics in municipalities due to urbanization [31-32]. In fact, the strong urbanization of Abidjan could have created an intensive managed and homogenous landscape in all municipalities. These homogenous habitats favoured synanthropic ant species that become abundant and replace species unable to tolerate disturbance.

Myrmicinae was the most species rich subfamily followed by Formicinae, Dolichoderinae, Ponerinae and Dorylinae. The dominance of Myrmicinae is paralleled by their numerical importance within the world ant fauna [33, 21]. Usually, many ant species of this subfamily are considered as Generalized Myrmicinae. The Generalized Myrmicinae are characterised by their wide geographical distribution due to their higher resistance to environments with or without disturbance. They have the ability to dominate environment where Dominant Dolichoderinae are absent or rare and they recruit quickly and defend clumped food resources [34]. Likewise in absence of competitive dominant species, they seem to act as dominant and regulate the access of others species to the baits [35]. Our findings confirm the results of Yeo [36] and Koné [37] who surveyed ants in both protected and disturbed habitat of Lamto and Oumé, respectively. They found that Formicinae were more abundant than Ponerinae whereas in our study the subfamily of Formicinae were more abundant after Myrmicinae. We found that Dolichoderinae were more abundant in the urban area than in Banco National Park, probably because species of this subfamily have a preference for hot and open habitats as reported by Lévieux [38] and Yeo [36]. The opposite pattern was observed and corroborates the results of Koné [37] who asserted that Ponerinae are overall predators and sensitive to shifts of microclimate. In our studies all Ponerinae species collected are generalist predators **[36]**. Their decline in urban habitat might be due to the replacement of natural habitat by urbanization causing a rarity of prey and explaining their decline or disappearance [39-40].

Several urban ant species were detected on the access road of the Park. In both habitat types the dominant species were represented by a few species with high prevalence. In the municipalities, these species were in the majority tramp species or specialist of hot and open habitats. For the access roads of Banco National Park these species are tree-dwelling or specialist of forested habitats. The group of frequent species regrouped the most numerous ant species. The Myrmicinae of genus *Crematogaster, Monomorium, Pheidole and Tetramorium* were highly prevalent in this group for both habitats. The rare species had the same number of occurrences on the access road. However in urban habitats this trend was different. This finding suggests that the most dominant species of each habitat have in fact a dominant role in structuring the community. It could also explain the replacement of remaining ant species in urban habitat by others species more adapted to this type of habitat.

Species composition and detection of tramp ants on access roads

Our study showed a strong difference of ant species composition between the municipalities of Abidjan and Banco National Park. It is also interesting to mention that a strong difference was observed between transects of access roads of Banco National Park. As for the municipalities of Abidjan, the low dissimilarity between transects suggests the resemblance in ant community within the urban areas and strengthens the argument of biotic homogenization reported in many studies [41-42, 32]. In spite of the dissimilarity between the city of Abidjan and its included natural park, we detected 20 shared ant species. Among these species *Paratrechina longicornis, Tapinoma lugubre, Tetramorium simillimum, Pheidole* sp 2, *Pheidole* sp 8 and *Pheidole* sp 20, highly prevalent in urban area, occurred also on access roads of Banco National Park. The presence of two recognized tramp species *P. Longicornis* and *T. simillimum* [17, 43-44] respectively on "Voie Andokoi" and "Voie Attécoubé" (Table 3) suggest the evidence of introduction of tramps species into Banco National Park from the surrounding urban habitat through the access roads. During their expansion these ants, also abundant in urban areas probably find suitable nest sites along the access roads to Banco National Park as a result of habitat disturbance caused by visitors. These results corroborate other studies that reported the habitat disturbance as a cause of introduction of behaviourally dominant ant species [45-47] or invasive species which tolerate broader environmental variables and thus spread more widely than native species

Conclusion

This study demonstrates that despite the inclusion of Banco National Park in a strong urbanized area such as the city of Abidjan, it has still conservation assets. It shows also that anthropophilic ant species could introduce natural habitats and threat the local biodiversity. An interesting prospect of this study will be to conduct further studies and monitoring to identify the invasion fronts and to assess biotic homogenization of ant community on access roads by anthropophilic species.

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