American Journal of BioScience
2026, Vol. 14, No. 6, pp. 155–163
https://doi.org/10.11648/j.ajbio.20261406.13

Research Article

House Dust Mites Associated with Indoor Habitats of Allergic Individuals in Abidjan, Côte d'Ivoire

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Abstract

House dust mites are the main source of aeroallergens worldwide. Exposure to mite allergens has been widely associated with sensitization and the development of allergic diseases. This study aimed to assess the diversity, abundance and distribution of house dust mites (HDM), as well as to analyse their relationships with microclimatic parameters in indoor environments. A total of 255 dust samples were collected from 60 domestic habitats by vacuuming sofas and bedding during December and July 2023. Indoor temperature and relative humidity were also measured. Mites were counted and identified using an optical microscope. The rate of mite presence in the indoor habitats of allergic individuals was high at 93.3%. The main family of mites was Pyroglyphidae (44.6%). *Dermatophagoides pteronyssinus* was the most frequent species (24.9%), followed by *Dermatophagoides farinae* (19.7%). The family of Echimyopodidae was represented by *Blomia tropicalis* (14.3%) and the Glycyphagidae family by *Glycyphagus domesticus* (8.1%). Temperatures were higher in December, whereas relative humidity was higher in July ($p < 0.001$). There was a significant positive correlation between the number of mites and the physicochemical parameters ($r_{july} = 0.780$; $r_{december} = 0.529$; $p < 0.001$). These results indicate that the species of *Dermatophagoides* spp, *Blomia tropicalis*, and *Glycyphagus domesticus* are the most dominant mites in our region, and the increase in temperature and relative humidity were positively associated with increased mite abundance. Therefore, knowledge of the local mite fauna would improve the means of studying the link between allergen exposure and sensitisation and would provide a framework for future ecological and allergenic studies, including the development of additional mite extracts for diagnostic testing.

Keywords

House Dust Mites, Indoor Habitats, Allergic Individuals, Côte D'Ivoire

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Received: 22 October 2026; **Accepted:** 31 October 2026; **Published:** 13 November 2026

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1. Introduction

Mites are present in household dust worldwide and represent common sources of allergens. The role of exposure to dust mite allergens in sensitization and the development of allergic diseases, particularly asthma and rhinitis, has been recognized in many parts of the world [1-3]. Mites are present in bedding, carpets, upholstery, stuffed animals, books, and clothing. They feed primarily on humans and domestic animals skin scales colonized by fungi, yeasts, and bacteria, although they may also benefit from other organic detritus that accumulates in homes [4]. Beyond their medical relevance as important sources of aeroallergens, house dust mites represent an important ecological group whose distribution and abundance are strongly determined by microclimatic conditions, housing characteristics, and human activities [5, 6].

The severity of allergic reactions may depend on factors such as the number of mites and their concentration. Typically, there are 300 mites per 1 gram of house dust and 5,000 mites can be found in just 1 gram of mattress dust under ideal breeding conditions. A concentration greater than 100 mites per gram is considered a risk factor for sensitization to allergies [7-11]. The most common domestic mite species found worldwide include *Dermatophagoides pteronyssinus*, *Dermatophagoides farinae*, *Euroglyphus maynei* and *Blomia tropicalis* [1, 12]. Morphological studies of house dust mites in Côte d'Ivoire remain extremely scarce, particularly those based on detailed taxonomic identification. But sensitization studies have shown that *D. pteronyssinus* is the most prevalent species [13]. Many factors, including temperature and relative humidity inside habitats can influence growth and prevalence of mites [7, 12, 14, 15]. The district of Abidjan, located in Ivory Coast, a hot and humid equatorial climate, with average temperatures ranging from 24.2 ℃ to 27.4 ℃ and high relative humidity (78-87%) throughout the year [16]. Such situations are favorable to the reproduction of dust mites from houses. This study was conducted to determine the dust mite species that circulate in Abidjan.

2. Materials and Methods

2.1. Study Area, Design and Ethical Approval

The study was conducted in the district of Abidjan between December 2022 and July 2023 and has concerned the homes of patients declared allergic to dust mites. The municipalities selected for sampling in the Abidjan district were: Abobo, Adjame, Bingerville, Cocody and Yopougon. The study protocol has been approved by the Ethics Committee of the Pasteur Institute of Côte d'Ivoire and a duly completed informed consent was accepted by each voluntary participant. For participants younger than 18 years, consent was obtained from their legal guardians.

2.2. House and Dust Sampling

A total of 60 domestic and professional habitats whose inhabitants were allergic to dust mites were visited. 150 mg dust samples were collected from carpets and furniture covered with fabric in living rooms, as well as from beds, mattresses, pillows, sheets, in bedrooms, in kitchens and offices or rooms. The local temperature and relative humidity were measured at the time of dust collection using a thermohygrometer (Climi Aeris). 60 samples of kitchen dust, 60 from the living room or bedding, were taken each month, for the domestic habitats. On the other hand, 16 dust samples were taken in the offices and rooms for professional habitats. A total of 256 (150 mg) dust samples were taken over the period analyzed. The sampling was carried out for 2 min on an area of 1 m^2 at using a vacuum cleaner, in which filter papers were integrated. These filter papers containing the dust samples were identified separately according to the site of sampling, placed in plastic bags and stored at -20 ℃ prior to shipment to the department zoology, South Parks Roads, University of oxford, United Kingdom, for analysis.

2.3. Counting and Identification of Mites

In the laboratory, the samples were sieved (500 µm pores) to remove large particles and fibers, after which the fine dust was weighed. The mites were extracted using the technique proposed by Hart and Fain [17]. This technique is based on the density difference between ethanol and a saturated aqueous solution of NaCl. All the mites present in each sample were collected using a fine needle under a stereomicroscope and placed in a drop of Hoyer's medium on a microscope slide. After clarification, the mites were identified and counted using the taxonomy keys [12, 17-22].

Identification was performed to species level unless key morphological appendages were not sufficiently preserved or visible. The density of mites was expressed as the number of mites per gram of fine dust.

2.4. Statistical Analysis

Statistical analysis was performed using R software (version 4.5.0). The frequency of mite species identified under the microscope was expressed as a percentage. The median values obtained from the indoor temperature and relative humidity during the different months were compared using the Wilcoxon signed-rank test. p value < 0.05 were considered statistically significant. The physicochemical factors (Temperatures and Relative Humidity) and the number of mites isolated from domestic dust samples were analyzed using the Spearman correlation test.

3. Results

3.1. Indoor Temperature and Relative Humidity

The values of temperature and relative humidity inside the houses were between 22 to 31 ℃ (median = 28.20 ℃) and from 73 to 83% (median = 77%) in December, and from 22.5 to 33 ° C (median = 27.20 ℃) and from 62 to 80% (median = 76%) in July (Figure 1). On the other hand, in offices, temperature values ranged from 21.5 and 30.4°C (median = 26°C) and relative humidity from 64.5 to 77% (median = 70.44%) in December. In July, temperature ranged from and 22.3 to 25° C (median = 24.10°C) and 62 to 73% (median = 67.5%) in July (Figure 2).

3.2. Morphological Identification of Mites in the District of Abidjan

From 256 dust samples, 93. 3% (239 of the 256) revealed at least one species of mite. A total of 2277 mites were isolated and the mite number in the surveyed homes varied between 0 and 15180 mites /g of dust. In this study, 2277 mite specimens were isolated, of which 1791 belonged to the Cohort Astigmatina (Orden Sarcoptiformes), 300 to the Orden Trombidiformes (suborder Prostigmata), and 186 to the Orden Mesostigmata. The identification of isolated mites belonging to the Cohort Astigmatina has enabled four species to be identified within the families Pyroglyphidae, Glycyphagidae and Echimyopodidae.

Dermatophagoides pteronyssinus, of the Pyroglyphidae family, was the most dominant mite (24.9%), followed by *Dermatophagoides farinae* (19,7%), *Blomia tropicalis* (14,3%), *Glycyphagus domesticus* (8,1%). Other mites also belonging to the Orden of Sarcoptiformes have been identified at the genus level such as *Listrophorus* sp, *Knemidokoptes* sp, and *Sarcoptes* sp. Mites belonging to the Orden Trombidiformes, Suborder Prostigmata have been identified at the level of genus, and in total two genera (*Cheyletus* sp, *Tarsonemus* sp.) of two families were detected. The identification of mites belonging to the Mesostigmata was also done at the level of the species *Dermanyssus gallinae*, but also at the genus level *Kleemannia* sp and *Hypoaspis* sp (Table 1).

Depending on the municipalities, the highest proportions of positive samples were observed in Abobo (22.2%), Bingerville (21.5%), and Adjame (20.5%), suggesting higher levels of environmental exposure in these areas. Cocody showed an intermediate level of exposure (19.7%), whereas the lowest proportion was recorded in Yopougon (15.8%) (Figure 3).

3.3. Relationship Between Microclimatic Parameters and Mite Abundance

Our study revealed a significant positive correlation between temperatures, relative humidity, and the number of mites. During July, temperature showed a moderate positive correlation with mite density ($r=0.628$, $p < 0.001$), while relative humidity exhibited a stronger correlation ($r=0.780$; $p < 0.001$). In December, correlations were weaker for temperature ($r=0.291$; $p =0.024$) but remained significant for relative humidity ($r=0.529$; $p < 0.001$). Overall, these findings indicate that relative humidity was the main environmental factor associated with mite proliferation, particularly during periods characterized by higher moisture levels (Figure 4).

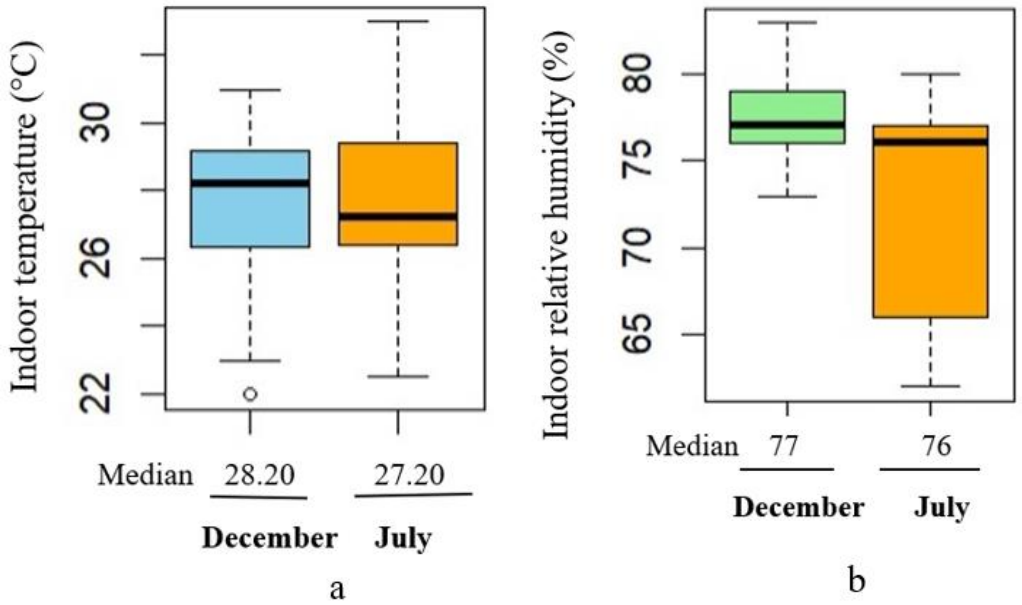


Figure 1. *Temperature (a) and indoor relative humidity (b) values measured in the houses. Comparisons bet ween median values were performed using the Wilcoxon signed-rank test, p <0.00001.*

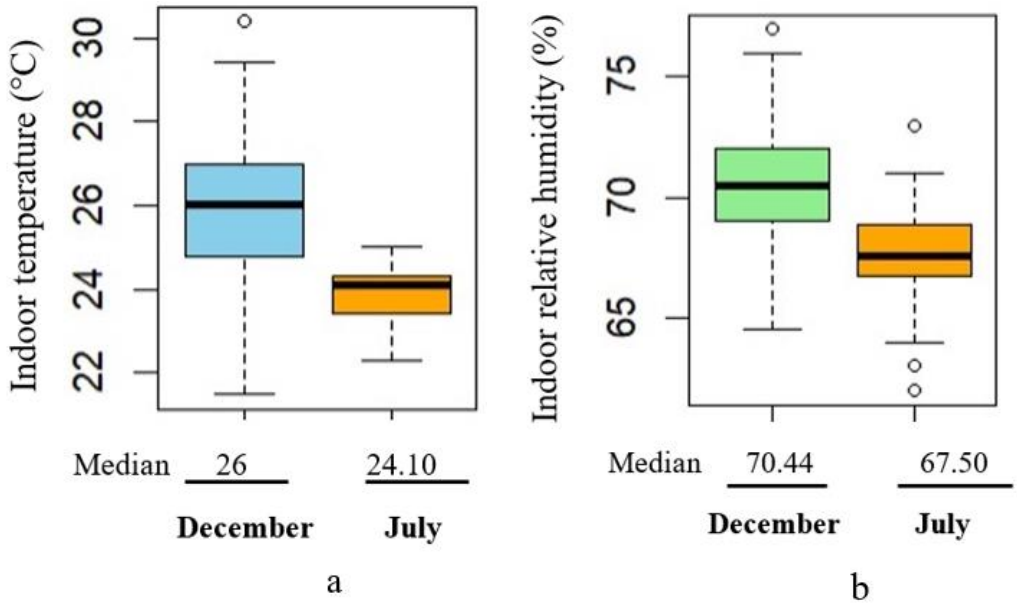


Figure 2. *Temperature (a) and indoor relative humidity (b) values measured in the offices.*

Comparisons between median values were performed using the Wilcoxon signed-rank test, p <0.0001.

Table 1. *Mite species and abundance in household dust (n=256) in District Abidjan, Côte d'Ivoire.*

Mites	**Count (%)**
Cohort Astigmatina	1791
Echimyopodidae *Blomia tropicalis*	327 (14,3)
Glycyphagidae	
Glycyphagus domesticus	186 (8,1)
Pyroglyphidae	1017 (44,6)
Dermatophagoides farinae *Dermatophagoides pteronyssinus* Listrosphoridae	450 (19,7) 567 (24,9)
Listrophorus Epidermoptidae *Knemidokoptes* sp	69 (3,1) 72 (3,2)
Sarcoptidae *Sarcoptes sp*	120 (5,2)
Orden Mesostigmata	186
Dermanyssidae *Dermanyssus gallinae* Laelapidae *Hypoaspis* sp Ameroseiidae *Kleemannia* sp	48 (2,1) 66 (3) 72 (3,2)
Orden Trombidiformes	300
Cheyletidae *Cheyletus* sp	204 (9) 96 (4,2)

Mites	Count (%)
Tarsonemidae *Tarsonemus* sp	
Total	2277 (100)

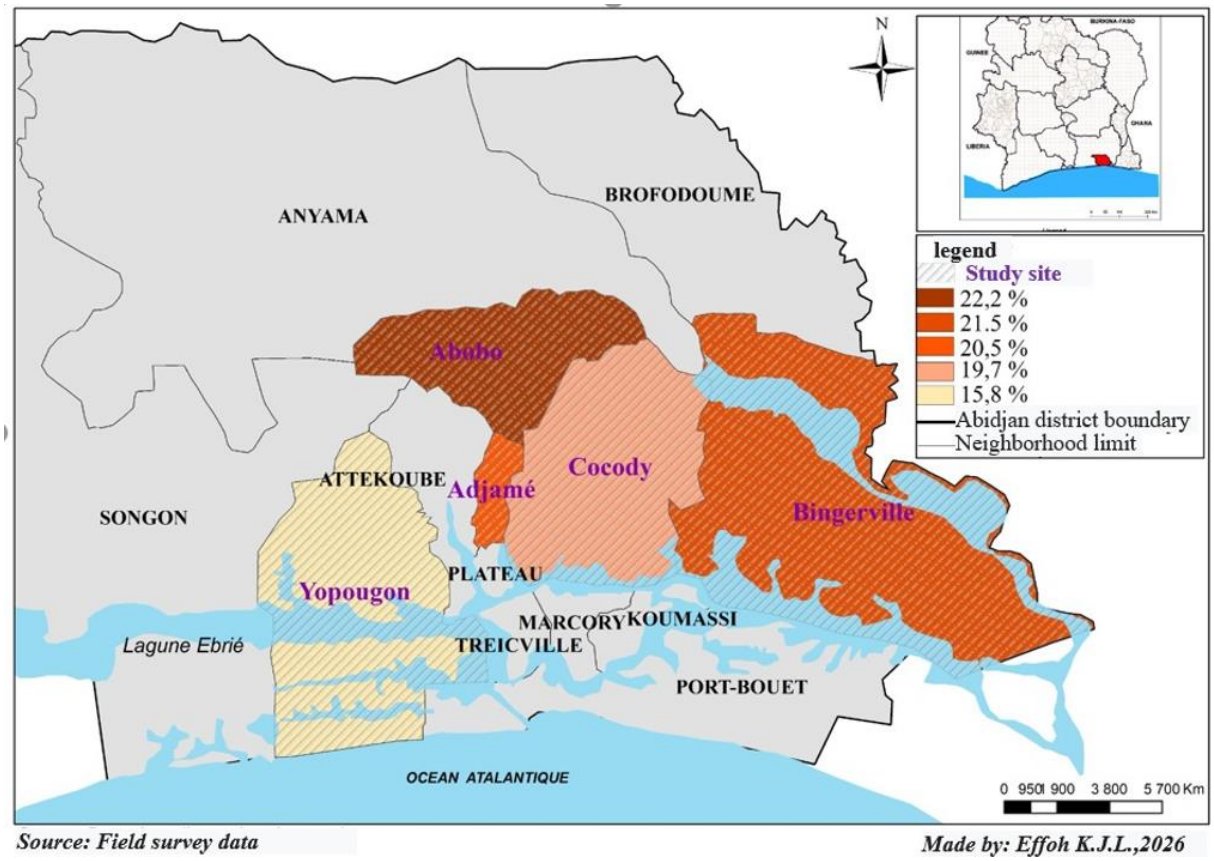
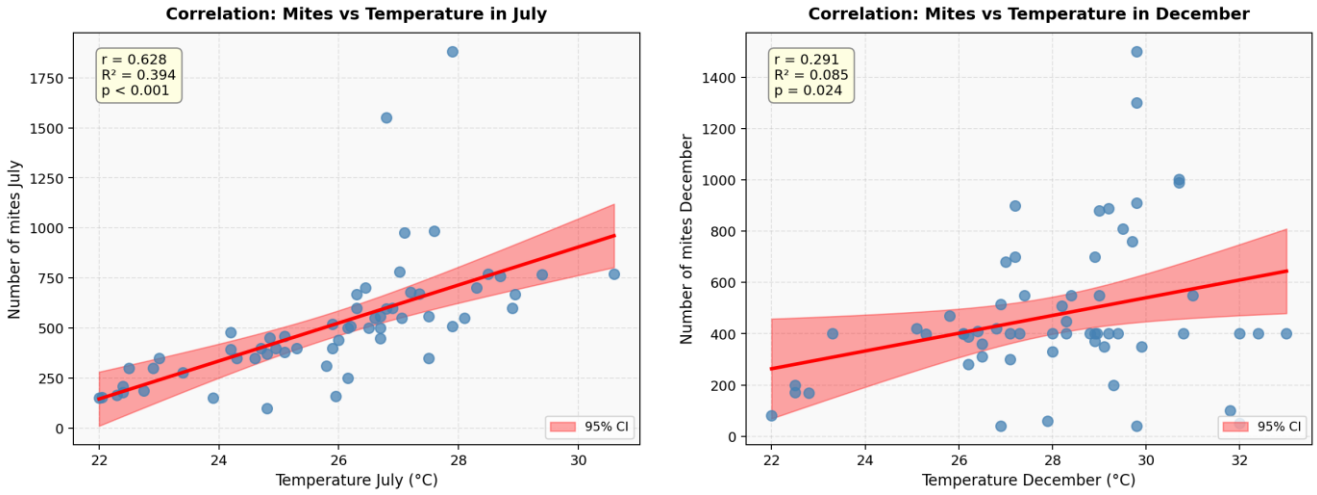


Figure 3. *Spatial distribution of prevalence rates in the Abidjan district.*



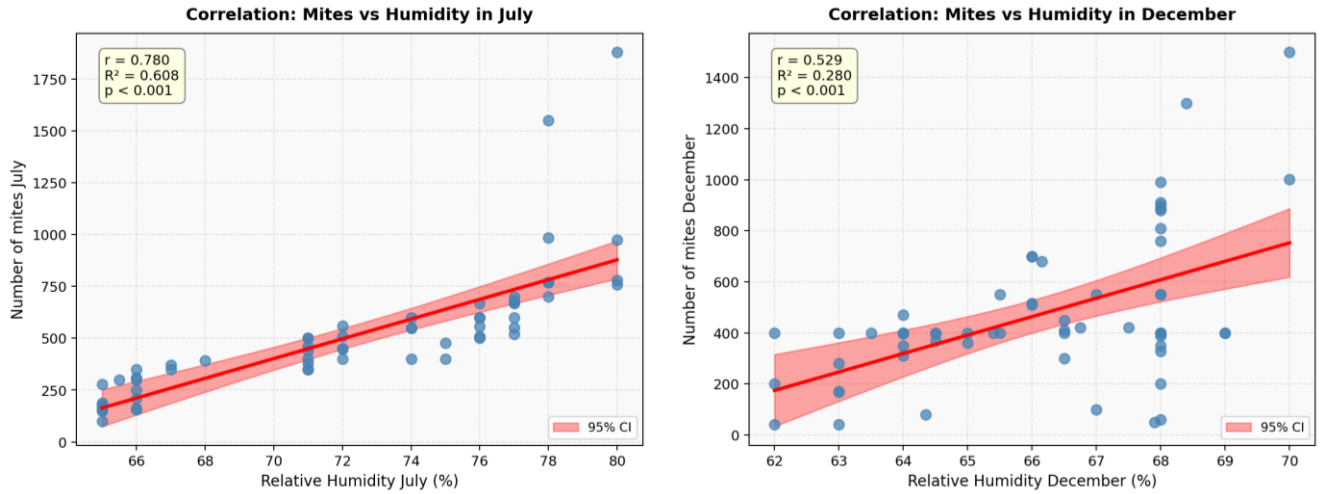


Figure 4. *Correlation between physicochemical parameters and abundance of mites.*

4. Discussion

This study revealed a high prevalence of high prevalence of the houses dust mites, with 93.3% of the samples analyzes testing positive. This proportion indicates that dust mites are widely present in the dust of the homes studied in Abidjan. This rate is higher than those reported in several studies conducted in other countries [7, 23-29].

However, this difference should be interpreted with caution, as the observed variations may result from both the environmental characteristics of the study sites and differences in sampling protocols and identification methods. Nevertheless, the high proportion of positive samples observed in Abidjan indicates that the environments studied provide favorable habitats for the maintenance of mite populations.

Several environmental factors such as building characteristics (age of houses, building materials and dwelling size), which influence indoor climatic conditions (temperature and humidity), as well as differences in individual lifestyles (presence of pets, carpets, ore mattresses, and cleaning methods) could contribute to this widespread presence [6, 30, 31]. In tropical regions such as Abidjan, climatic conditions can favor the persistence of dust mites, particularly when indoor relative humidity helps limit water loss and support their development. House dust mites absorb water molecules from their microenvironment though their cuticle and therefore require high ambient humidity to compensate for excessive water loss [4, 32]. In countries with seasonal climate variations, the number of houses dust mites in influenced by corresponding seasonal fluctuations, with the highest numbers observed during periods of high humidity [6, 33-35].

Taxonomic analysis identified several groups of mites, among which the Pyroglyphidae family was particularly prominent. *D. pteronyssinus* accounted for 24.9% of the identified mites, while *D. farinae* and *B. tropicalis* accounted for 19.7% and 14.3% respectively. These results indicate the coexistence of the several species in the studied household environments, with a significant presence of species recognized for their allergenic potential.

The predominance of *D. pteronyssinus* and *D. farinae* in our study is consistent with data from the literature, which recognize these two species as major sources of house dust allergens worldwide [25, 36]. Their presence in the environments studied is consistent with their ability to colonize indoor habitats that offer organic resources and favorable microclimatic conditions. In particular, humidity, temperature, and the availability of organic debris may contribute to their persistence in house dust.

The presence of *B. tropicalis*, which accounts for 14.3% of the identified mites, is also a significant finding. This species is particularly associated with tropical and subtropical our study is consistent with Abidjan's climate and underscores the importance of considering tropical species when characterizing household mite fauna. Although its proportion is lower than that of *D. pteronyssinus* and *D. farinae*, its presence attests to the diversity of potential allergen sources in the environments studied. Indeed, *B. tropicalis* is recognized as a major source of respiratory allergens in tropical regions. Its detection is therefore of particular interest for the study of allergic sensitization in this geographic context.

Furthermore, the detection of *G. domesticus* contributes to the observed taxonomic diversity. Other taxa, notably *Cheyletus, Tarsonemus, Knemidokoptes, and D. gallinae*, were also identified, albeit less frequently. This diversity shows that house dust is not a habitat occupied exclusively by species traditionally associated with respiratory allergies. It can also harbor taxa with different ecological requirements and lifestyles. Thus, the presence of certain mites associated with stored foodstuffs, as well as predatory taxa or those linked to other hosts, may reflect the diversity of substrates, microhabitats, and resources available in the sampled environments [3, 23, 37, 38]. These observations highlight the value of a broader

taxonomic approach to better characterize the mite communities present in indoor environments. The differences in abundance observed among the municipalities of Abidjan suggest that the distribution of mites is not uniform across all studied sites. This heterogeneity may reflect the diversity of domestic environments and local conditions.

Analysis of environmental parameters revealed a significant association between relative humidity and mite abundance, with a Spearman correlation coefficient of r= 0.908 ($p< 0.00001$). This association suggests that, under the conditions studied; variations in relative humidity were closely linked to variations in the abundance of the mite. The results are consistent with other studies on the relationships between indoor microclimate and mite population dynamics. Humidity is a biologically relevant parameter, as these organisms are sensitive to the moisture conditions of their environment [5, 39]. Nevertheless, its influence also depends on the species in question, the duration of exposure to ambient conditions, and the microhabitat in which the mites thrive. The conditions measured in a room therefore do not necessarily reflect those found in bedding, upholstery, or accumulated dust.

The frequent presence of mites in the homes of sensitized patients underscores the importance of characterizing the domestic environment in which these individuals live. Identifying species makes it possible, in particular, to document the diversity of mites likely to contribute to allergen exposure. This information is relevant for future research on the relationships between species present in homes, household allergens, and patients 'sensitization profiles.

The results therefore justify further investigation of house dust mites in Côte d'Ivoire, taking into account species diversity and microclimatic variations. They also provide a descriptive basis for guiding additional studies on household practices and exposure-reduction measures.

Limits

The interpretation of the results must take several limitations into account. First, the study was conducted in the homes of patients sensitized to dust mites. Therefore, the results cannot be directly generalized to al homes in Abidjan. Second, the collection of samples at two different times of the year does not necessarily allow for the characterization of all seasonal fluctuations in dust mite populations. Third, the identification and counting of dust mites in the analyzed dust samples do not constitute a direct measure of allergen concentration in indoor air. Finally, the observed associations between environmental parameters and dust mite abundance do not, on their own, demonstrate a causal relationship. Despite these limitations, this study provides data on presence, diversity and distribution of the house dust mites in the homes of sensitized patients in Abidjan. It thus helps document an aspect of the domestic environment in Côte d'Ivoire that remains insufficiently characterized and serves as a foundation for future research integrating environmental measurements, allergen exposure, and clinic data.

5. Conclusion

The high proportion of dust samples testing positive for dust mites (93.3%) indicates their widespread presence in the environments studied. The most common species in our region are *Dermatophagoides spp*., *B. tropicalis*, and *G. domesticus*. Furthermore, increases in temperature and relative humidity were positively associated with mite abundance, underscoring the importance of microclimatic conditions in their distribution and dynamics within the studied environments.

Abbreviations

NaCL	Sodium Chloride
D. pteronyssinus	Dermatophagoides Pteronyssinus
D. farinae	*Dermatophagoides Farinae*
B. tropicalis	*Blomia Tropicalis*
G. domesticus	*Glycyphagus Domesticus*
D. gallinae	Dermanyssus Gallinae

Acknowledgments

The authors sincerely thank all those who agreed to participate in this study and to allow dust samples to be collected from their homes.

Author Contributions

Kouadjane Gnagoran Agnes Emilie: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing

Yapo-Crezoit Chiaye Claire: Conceptualization, Data curation, Investigation, Methodology, Supervision, Validation

Boahene Samuel: Data curation, Methodology

Sika Ake Sosthene Henoc: Data curation, Methodology

Soro Yaya: Supervision, Validation

Conflicts of Interest

The authors declare no conflicts of interest.

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