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Phlebotomine Sandflies (Diptera: psychodidae) in Different Localities of Dhamar Governorate,Yemen.

دراسة الذباب الرملي (Diptera: psychodidae) في مناطق مختلفة من محافظة ذمار، اليمن.

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الملخص

يسعى هذا البحث إلى حصر أنواع ذبابة الرمل الناقلة لمرض الليشمانيا الجلدي الذي يسببه طفيلي الليشمانيا المداري المتوطن في محافظة ذمار والذي انتشر في شمال شرق اليمن. في هذه الدراسة جمعت حشرات ذبابة الرمل (Diptera: psychodidae) من قريتين هما: الحمة، والأحساء، إذ جمعنا بمعدل مرة واحدة في كل شهر، وذلك من خلال الدراسة الممتدة من شهر مايو إلى شهر نوفمبر، خلال عام 2023، حيث استخدمنا في عملية الجمع المصائد الزيتية، وتم وضعها داخل المنازل وخارجها. و بلغ عدد العينات المجموعة خلال هذه المدة 385 عينة، بنسبة (62.08٪ إناث، و/ 37.92٪ ذكور)، وتتألف هذه العينات من خمسة أنواع، مقسمة على جنسين هما: Phlebotomus بنسبة (65.88٪) و Sergentomyia بنسبة (34.12٪)،والخمسة الأنواع هي: *Phlebotomus sergenti* بنسبة (51.17٪) ، *Phlebotomus papatasi* بنسبة (12.47٪) ، *Phlebotomus alexandri* بنسبة(4.16٪) ، *Sergentomyia taizi* بنسبة(22.34٪) و *Sergentomyia africana* بنسبة(9.87٪). كان النوع *Ph. sergenti* هو السائد في المناطق المدروسة الحمة والأحساء، تليها الأنواع *Se. taizi* و *Ph. papatasi*. على مدار دورة حياتها النشطة التي استمرت ثمانية أشهر، التي امتدت من مايو إلى نوفمبر، فأظهرت الدراسة كثافة لنشاط ذباب الرمل نمطًا ثنائيا، إذ شهدت المنطقتان المدروستان قمة النشاط الأولى في يونيو، وحدثت قمة النشاط الثانية في شهر أكتوبر في الأحساء، و في شهرأغسطس في الحمة، ويشير هذا النشاط إلى احتمالية عالية لخطر الليشمانيا المدارية، والليشمانيا الكبرى. لذا يمكن أن تساعد هذه الدراسة في بناء خطط مناسبة وفعالة لمكافحة النواقل من خلال توفير معلومات عن الوفرة والثراء، والاتجاه الموسمي، ونسبة الجنس، ودرجة وجود أنواع مختلفة من ذباب الرمل في هذه المنطقة .

الكلمات المفتاحية: داء الليشمانيا الجلدي، الانتشار، ذبابة الرمل،محافظة ذمار اليمن..

Abstract:

The present study aimed to reveal the cutaneous leishmaniasis disease caused by *Leishmania tropica*, which is endemic in Dhamar Governorate and has become an outbreak in the country's northeastern in Yemen. In this study, sandflies (Diptera: psychodidae) were collected from two villages ,Al-Hamh and Al-Ahsaa. Sandflies were collected once a month from May to November 2023, using sticky traps that were put in both home and non-home locations.385specimens were collected (62.08%females/ 37.92% males). The sample comprised five species, divided into two classes: Phlebotomus (65.88%), formed by *Phlebotomus sergenti* (51.17%),*Phlebotomus papatasi* (12.47%)and *Phlebotomus alexandri*(4.16%) and Sergentomyia (34.12%),based on *Sergentomyia taizi*(22.34%) and *Sergentomyia africana*(9.87%).*Ph. sergenti* predominated in Al-Hamh and Al-Ahsaa followed by *Se. taizi* and *Ph. papatasi*. Over the course of their eight-month active life cycle, which ran from May to November, the population dynamics displayed a bimodal pattern, with the two examined stations noticing their first peak in June and the second peak occurring in October for Al-Ahsaa and August for Al-Hamh. This activity indicated a high potential risk of *Leishmania tropica* and *Leishmania major*. This study can help build suitable and efficient vector control plans by providing information on the abundance, richness, seasonal trend, sex ratio, and degree of presence of various sand fly species in this dynamic area.

Keywords: cutaneous leishmaniasis, fauna, sandflies, Dhamar, Yemen

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Introduction

Many microorganisms that cause diseases in humans and animals are spread by sandflies. Leishmaniasis is one of these illnesses that Yemen's public health is concerned about [1]. There are three main clinical manifestations of leishmaniasis that are endemic in various parts of the Yemen: mucocutaneous, visceral, and cutaneous. The most common types of leishmaniasis are cutaneous leishmaniasis (CL) produced by *Leishmania tropica*, which is endemic in the country's center and north, and CL caused by *L. major*, which is prevalent mostly in the country's south and east [2]. While MCL caused by *L. braziliensis* and visceral leishmaniasis produced by *L. infantum* are occasionally seen across the nation, they are more prevalent in the north [3, 4]. Different species of sandflies are responsible for the transmission of each of these forms: *Phlebotomus papatasi* is the vector for *L. major*, *Ph. sergenti* is the vector for *L. tropica* leishmaniasis, and *Ph. longicuspis* is the vector for *L. infantum*. Numerous geographic and bioclimatic conditions affect the diversity, abundance, and distribution of sandflies.To discover these elements and their effects on each species, particularly the vector species, entomological field investigations are therefore crucial. As the most infected focus of Anthroponitic cutaneous leishmaniasis in Yemen, our work is regarded as the first investigation on the variety of sandflies species in various biotopes of Dhamar Governorate (5,6,7). Its objectives are to analyze the species composition of sandflies in two different locations, identify the primary high-risk biotopes where vector species are present, and recommend effective vector control measures based on the behavioral diversity of sand flies and vectors in these settings.

Material and Methods

Study region

The study was carried out at Al-Hada, a rural municipality in northeast Yemen's Dhamar Governorate (14°66667N 44°16667"E). Two villages, Al-Ahsaa (14°2224N, 44°1665E) in the north and Al-Hmh (14°2213"N, 44°1678"W) in the south, were the sites of investigations. in 2023, from May to November.The average climate of Al-Hada is warm in the summer (annual mean maximum temperature of 10) and chilly in the winter (annual mean lowest temperature of 5). With 30 to 40 rainy days per year and an average annual rainfall of 34 mm at AL-

Ahsaa to 29 mm at Al-Hmh, the rainy season runs from Mars to June.We kept an eye out for the presence of sandflies in two villages that were situated between 2000 and 2320 meters above sea level.

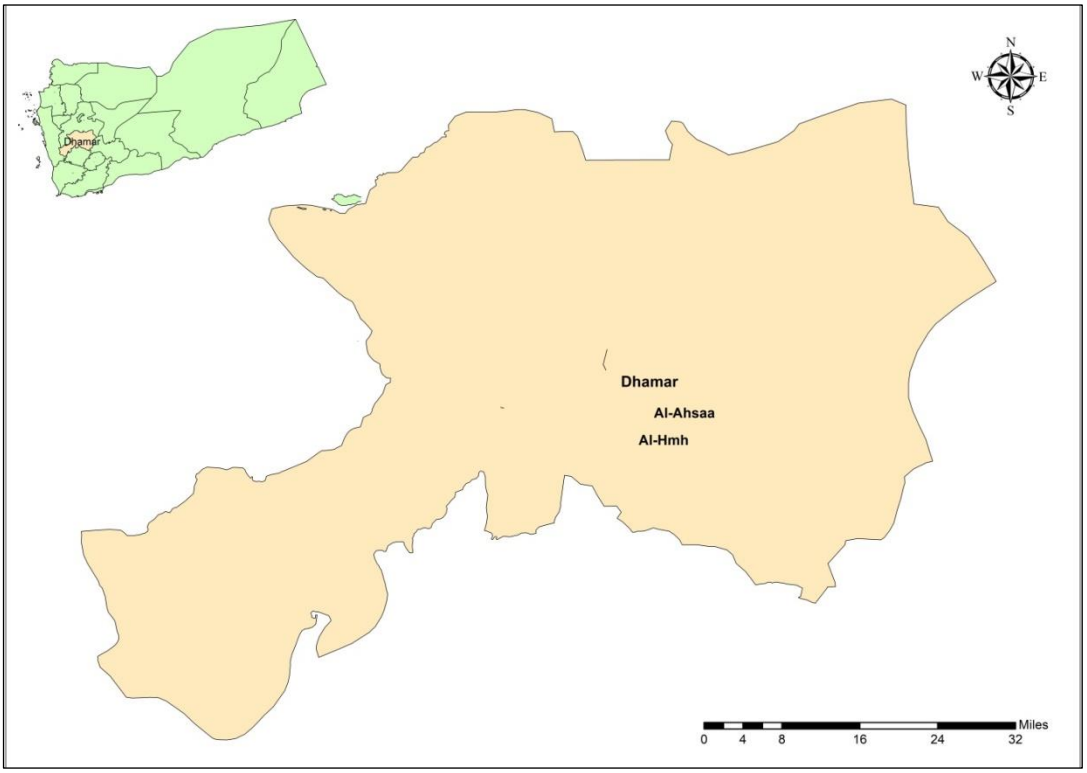

Figure 1. Map of Yemen's Dhamar Governorate illustrating sandflies gathering locations.

Sandflies collections and identifications

In the two villages under study, phlebotomine samples were gathered from May to November of 2023 utilizing (SPT) sticky paper traps. In each villages, ten randomly selected households had two SPT traps set up, one inside and the other outdoors, for one night from sunset to morning.

The specimens that were caught were tagged and placed into tubes containing 90% ethanol. Sandflies were using Marc-André solution (chloral hydrate/acetic acid) before species identification[8].The male genitalia, female spermathecae,

and/or pharyngeal morphology were used to verify each specimen's identity separately.Next, they were tallied and divided based on gender.

Data interpretation

The ecological indicators were used to process the data. They were computed in the manner described below:

• Specific richness (S): the quantity of species present in a certain area

• Number of specimens of species (x) / Total number of specimens x 100 was the formula used to compute relative abundance (pi).

• Degree of presence: C = n/N × 100, where N is the total number of survey locations and n is the number of locales where the species was found[9].

• For every species gathered for this investigation, the male/female sex ratio was also computed. In addition, to analyze the results, we used tables and visualizations along with descriptive statistics.

Result

fauna of phlebotomine species

In the two villages under study, 385 specimens were gathered throughout the trapping period. Five species from two genera were identified, with three Phlebotomus spp. (67,79%), *Ph. sergenti Parrot* (51,17%), *Ph. papatasi Scopoli* (12,47%), *Ph. alexandri Sinton* (4,16%), and Two Sergentomyia spp. (32,21%) being the most common species. In the Sergentomyia genus, *Se.taizi* (22,34%) was the most common species, closely followed by *Se. africana Newstead*. There was a relatively small percentage of (9,87%) (table 1). While most specimens (66,23%) were collected in the Al-Ahsaa locality between 0 and 2433 m, the majority of sandflies populations (33,77%) were collected in the Al-Hmh locality between 0 and 2390 m. *Ph. sergenti*, the primary vector of cutaneous leishmaniasis (CL), was collected at two villages, and its distribution demonstrated a very strong positive correlation with the Al Ahsaa locality (0 - 2317). The highest recorded concentrations of this species (140 total captures) were noted.Every elevation range was used to gather *Ph. papatasi* samples. A very high positive link was observed between the increase and its spread and the Al-Hmh area.The highest recorded

concentrations of this species (total catch: 27) were noted. *Ph. alexandri* was also discovered at all elevations higher than 2400 meters.

The percentage of gathered females was greater than the percentage of males (146♂ /239♀).The gender distribution differs depending on the species. For four species,*Ph. sergenti* (1:1.81), *Ph. papatasi* (1:0.26), *Se. taizi* (1:1.06), and *Se. africana* (1:0.44) ,it was in favor of the females; for the species,*Ph. alexandri* (1:0.28),it was in favor of the males (Table 1).

Table 1: lists the number (N), sex ratio (SR), and relative abundance (%) of the species of sandflies that were captured.

Species	Al -Hmh				AL- Ahsaa				Total		
	No. of collected sand flies			Fr %	No. of collected sand flies			Fr %	No. of collected sand flies(male /female)	Fr%	SR
	Male	Female	Total		Male	Female	Total				
Ph. papatasi	7	20	27	20.77	3	18	21	8.24	48	12.47	1:0.26
Ph. sergenti	22	35	57	43.85	47	93	140	54.90	197	51.17	1:1.81
Ph. alexandri	6	3	9	6.92	5	2	7	2.75	16	4.16	1:0.28
Se. taizi	19	8	27	20.77	20	39	59	23.14	86	22.34	1:1.06
Se. africana	4	6	10	7.69	13	15	28	10.98	38	9.87	1:0.44

Abundance and distribution of phlebotomine species

Regarding quantity, the Al-Ahsaa location had the greatest numbers of sandflies (66%) of all catches, followed by the Al-Hmh location (34%) (figure 1). In terms of the distribution of sandflies species among the villages, the AL-Hma and Al-Ahsaa locales 20,77%, 8,24%, and other *Ph. papatasi* specimens. The bulk of *Ph. alexandri* specimens (6,92%) were gathered at the Al-Hmh location, followed by Al-Ahsaa (2,75%). The majority of *Ph. sergenti* specimens were obtained in AL-Hmh (43,85%) and Al-Ahsaa (54,90%). A total of 124 specimens from the genus Sergentomyia were discovered. Of all the sandflies, *Se. taizi* had the highest relative abundance (22.34%), making it the most prevalent species of Sergentomyia. *Se. Africana* were gathered in AL-Hmh (10,98%, 7,69%) and AL-Ahsaa respectively . The distribution of species varied amongst the two villages. All villages give samples of *Ph. sergenti*, *Ph. alexandri*, and *Ph. papatasi*.

Sandflies seasonal fluctuations

The capture data for the three most prevalent species,*Ph. sergenti*, *Ph. papatasi*, and *Ph. Alexandri*,as well as the overall number of sandflies are displayed in Figures 2 and 3.

Sandflies were active during the summer months at both locations from May to November. May, June, and July were the months with the greatest abundance, and August, September, and October were the lowest. The total number of sandflies captured during the year revealed two peaks: one in late September/early October and one, more significant, in June/July. In the Al-Ahsaa locality, the seasonal abundance of adult *Ph. sergenti* showed a first peak in July, followed by a steady decline in sandfly numbers in September as the weather grew hotter, and finally a modest increase in late October to indicate a second peak that was obviously less significant than the first ,*Ph. sergenti* in the Al-Hmh region displayed a similar tendency, but with just one peak in the early part of June.
There was a significant difference in the weekly abundance of *Ph. alexandri* and *Ph. papatasi* between the two locations. In the Al-Ahsaa area, *Ph. papatasi* displayed a bimodal peak pattern, with one peak occurring in May and one in August.where as in the Al-Hmh locality, it displayed bimodal peaks from June to October. In the Al-Ahsaa locality, *Ph. alexandri* was less common and displayed bimodal peaks from July to October, which corresponded to the start of summer. A bimodal peak pattern with one peak in June and one in September was seen in the Al-Hmh locality.

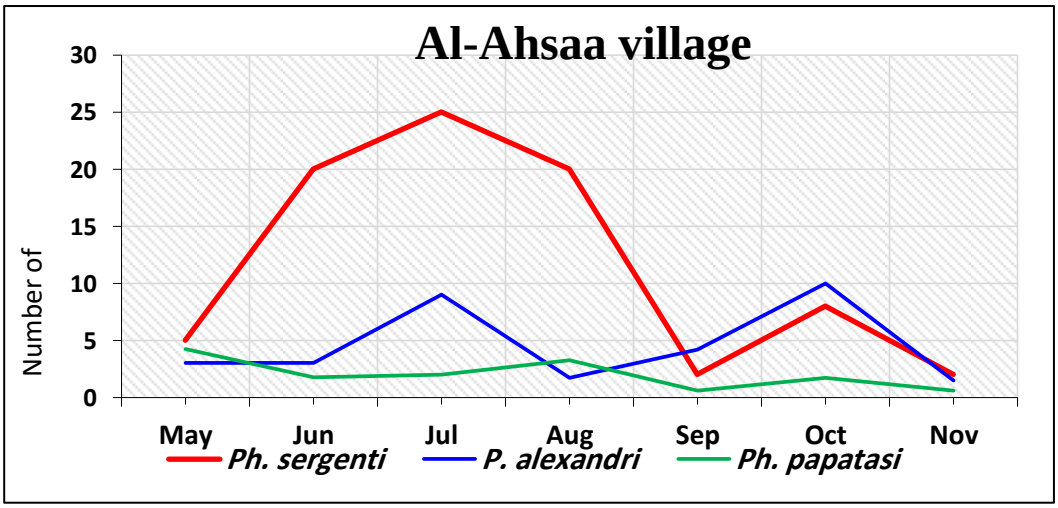

Figure 2: The Al-Ahsaa village's sandflies capture data

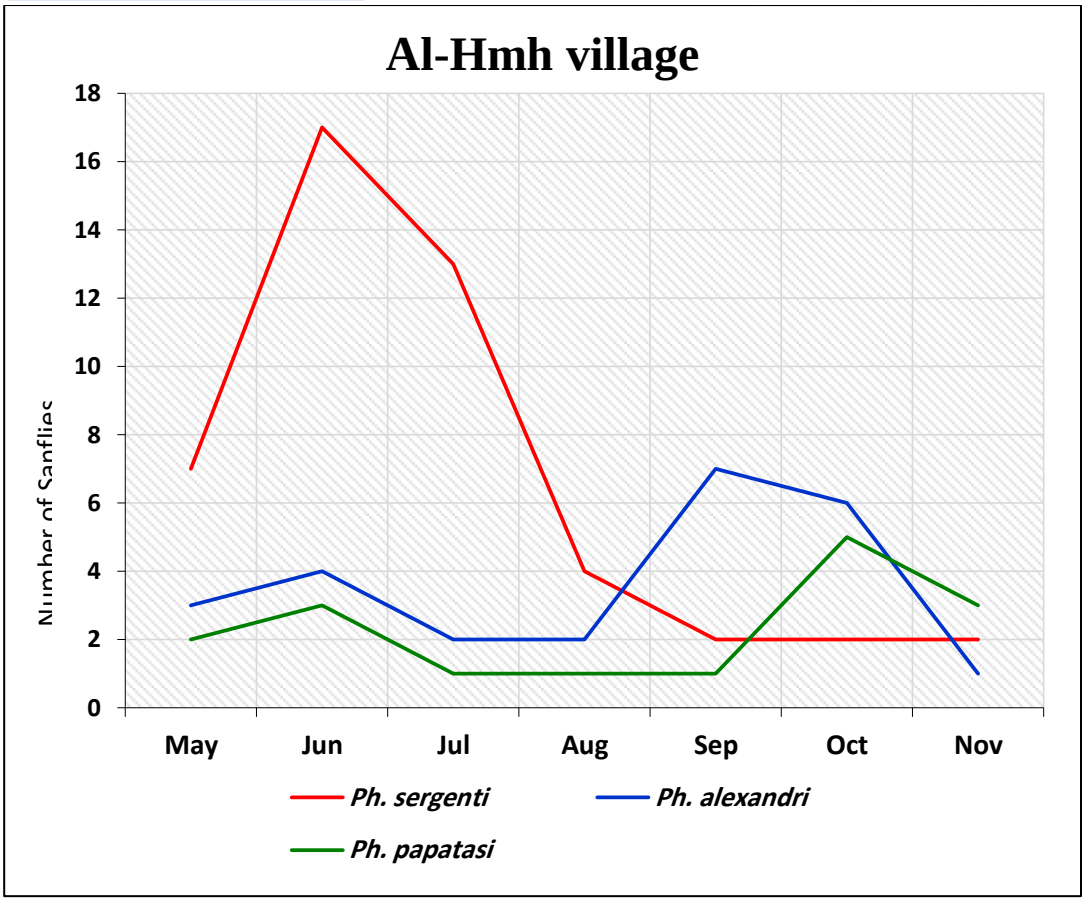

Figure 3: The sandflies records that were captured at Al-Hmh village

Discussion

In Dhamar, CL caused by *L. tropica* is a severe and growing public health issue. Two species of Sergentomyia (34,12%) and three species of Phlebotomus (65,88%) were found in the current study. Of them, *Ph. sergenti* is the most common (51,17% of the total catch) and is a major vector for *L. tropica*-caused cutaneous leishmaniasis in Yemen. It uses specific rodents as reservoir hosts to generate Anthropontic cutaneous leishmaniasis [10,11,12,13]. The significant vector of *L. major* is *Ph. papatasi*, accounting for 12.47% of the total catch [14]. The identified vector of *L. tropica* in Yemen is *Ph. sergenti* [15]. Although it was present, *Ph. alexandri* only made up 4.16% of the total. The fauna of the sandflies gathered for this study included only a small number of the remaining two species of Sergentomyia (*Se. tacizi* and *Se. africana*), which are known to be less common

in human contexts [15, 16]. *Ph. sergenti* adults were active from May to November, exhibiting a bimodal evolution in Al-Ahsaa and a single peak in Al-Hmh. There hasn't been much research done in Yemen on this species' population dynamics.*Ph. papatasi* sandflies were collected between May and November in the two locations that displayed a bimodal peak pattern in the Al-Hma locale; in Al-Ahsaa, there were only two peaks in the months of May through August, and one in June and one in October. The confirmed CL vector's significant potential risk of CL is indicated by its protracted activity period and notable density, which are cause for concern. primary transmission in the regions under study.

In Al-Ahsaa, *Phlebotomus alexandri* was a common species.It was seen from July to October, peaking in July near the start of summer. This species favors warmer habitats and areas with a high relative humidity content [26]. It is typically found in sylvatic biotopes and mountainous areas. A correlation between biodiversity and altitude has been found in earlier research carried out in the High Atlas Mountains [17, 18]. Guernaoui et al. (2006) explored the association between altitude and sandflies in Morocco's High Atlas Mountains. At 25 locations, sandflies were caught at various elevations (400–1400 m). It was shown that the density of each vector and the distribution of sandflies species may be influenced by height. *Ph. papatasi* was most abundant at 400–599 m and least abundant above 1199 m.These conclusions are not entirely supported by our data, which show a significant degree of diversity at an altitude of 2390 m asl in the Governorate of Dhamar. In the Taiz Governorate, Rioux et al. [16] also observed a significant degree of diversity at an elevation of 1500 m asl. They categorized the species according to their bioclimate and also mentioned the high degree of diversity in the northern zones. *Ph. sergenti*, *Ph. papatasi*, and *Se. taizi* were the three vector species that we described that were most frequently found in this investigation. These species are the most prevalent sand flies in Yemen, according to additional research [17, 18]. These species are easily gathered in and near human habitations and are known to be prevalent in anthropogenic situations. Nonetheless, some research [19,20] revealed that the seventh month of the year saw the highest frequency of activity for certain sandflies species. Our study's findings are consistent with those of the previously cited studies.Previous research has demonstrated that variations in elevation, which influences biotic (plant and animal resources) and abiotic (temperature, relative humidity, annual precipitation, resting places), are responsible for variations in biodiversity, richness, and evenness. As a

result, species composition is nearly identical in areas with comparable ecological conditions and vice versa. Compared to other biotopes, sylvatic habitats offer better living circumstances for various species of sand flies. This may be due to a lack of human interference and the existence of a variety of plant and animal species that serve as these insects' acceptable food sources. possibly as a result of the high. Ecological shifts and the migration of sandflies populations account for this unique presence. The insignificant outcome of can possibly be explained by the fact that this species is primarily found in low altitude stations, less than 1000 masl, whereas our trapping stations are high altitude (2317 m asl). According to our findings, diversity indices are higher when the environment is conducive to the survival of every species present there; otherwise, they are lower. The selection of our sampling locations, which appear to be highly diverse, helps to explain this outcome.

Conclusion

The results of this comprehensive analysis of the prevalence and seasonal patterns of *Ph. papatasi* and *Ph. sergenti*, the vectors of cutaneous leishmaniasis caused by *L. tropica* and *L. major* in Dhamar, provide essential data for planning apreventive measures. Control measures may be used to manage the disease's transmission if they are appropriately coordinated with case management and the implementation of appropriate reservoir control. The timing of the control operations should be scheduled twice a year during density peaks. Increasing public knowledge of disease preventive techniques is another requirement for an epidemic control program to be effective in preventing disease. Investigators' research on the distribution and behavior of vectors is essential. To provide decision-makers with the most up-to-date information, they must be carried out frequently in numerous locations.

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