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Scent Marking of Home Ranges in the Different Generations of the Siberian Musk Deer (Moschus moschiferus L. 1757); Meaning of Caudal Glands

Zaitsev V.A

ABSTRACT

In a key plot in the coniferous mountain forest of the Sikhote-Alin Biosphere Reserve, we studied the structure of the musk deer grouping, the distribution of scent marks by the excretion of the male caudal glands (MGC) in home ranges in winter seasons of 1977–1977 and 2003–2004. We used the method of tracking multi-days of individually identifiable, accustomed to the observer, musk deer specimens. The data indicate significant similarities in male movement, location of home ranges, activity cores, and main marking areas for generations of musk deer separated by a time interval of almost 30 years, which is typical under relatively stable environmental conditions. The features and correlations in the distribution of scent marks in the centers of activity of the male home ranges were determined. Neighboring males formed communication zones between home ranges, usually with an increased frequency of marking and often with a high scent marks density. These zones also have the meaning of "soft" barriers. However, there was no direct relationship between the indices of frequency and density of marks.

Keywords: the Siberian musk deer (*Moschus moschiferus*), caudal glands, marking, home range, structure, communication zones, heritability.

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Keywords: the Siberian musk deer (*Moschus moschiferus*), caudal glands, marking, home range, structure, communication zones, heritability.

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I. INTRODUCTION

Chemical communication, realized by odors, is of great importance for mammals, affects various vital functions. One of the main tasks of studying the communication functions is the ascertainment of its value in regulating the individual distribution relative to each other in spatial coordinates. The placement of scent marks in space is of great importance for animals, in particular, predatory, whose strategy of feeding is consistent with maintaining a certain home range ([3][22][13][17][18][2][38][29]; etc.). The study of the functions of the scent marking in ungulates ([28][7][8][9][10][6][36][12][1][5]; etc.) it is difficult often due to the specifics of ecological niches, a dynamic spatial and social organization of populations. A special complexity is the study of the results of the response of recipients to the marks, which actually determines the regulatory functions of the scent marking. However, the value of the marking can be understood by taking into account the totality of information about the movements of individuals, the marks frequency, behavioral and spatial aspects of marking and response of recipients to marks.

The musk deer has a distinction from other ungulates animals of the temperate climatic zone

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due of year-round individual territoriality, it marking the home ranges with specific scent marks all year [41] [27]. The many musk deer have been using compact forest areas all their lives (in the sense of “Lifetime Range” [14]), nevertheless, shifting the home ranges and changing their size in different of times periods [41][46].

We began the study of the scent marking in musk deer since 1975 [41]. The main task is to ascertainment the functions of marks in the regulation of social bonds and spatial distribution of individuals. In this article, we concentrate one's attention on the relationship between the frequency of marking by musk deer males with caudal glands and the markers density in different parts of their home ranges with the movements of males, the distribution of other individuals. For this, the results of the study are used in one of key plots in the Sikhote-Alin reserve (Far East, Russia) in 1976–1977 and 2003–2004. The results characterize the structure of the musk deer associations and the scent marks distribution in the period (January-March) after the rut (November-December), when the locomotor activity of male decreases, the marks distribution becomes more stable. In winter it is supported a communication system, which musk deer forms during the rutting period [41]. The tasks consist in determining the relationship between: 1) the structure of the grouping; 2) the marking frequency of the different parts of the home regions; 3) density and other indices of the marks distribution, it including after the time interval of 30 years.

II. MATERIALS AND METHODS

2.1 Presentation of the study area and researched species

The Sikhote-Alin State Biosphere zapovednik (reserve) (SABZ, 401,600 ha; IUCN category I; 136°20'; 45°02') and adjacent areas of the Central Sikhote-Alin have significant indicators of biological diversity [37]. Forests cover more than 95% of the reserve area. All means of hunting and chasing animals, a using vegetation have been banned for more than 50 years.

In the central part of the reserve in the river basin Serebryanka is our main key plot for the study of musk deer – "Zimoveyniy". The snow period lasts from the second half of November to the end of March-beginning of April. In January-February, temperatures down to -5°C– -15°C (up to -20°C) prevailed with the usual monsoon wind from the mainland to the Sea of Japan. The vegetation cover is dominated by cedar pine forests (*Pinus koraiensis*) of complex composition, multi-layer vertical and mosaic horizontal structure, with close crowns of forest stands of the upper tiers. Cedar pine forests are replaced by fir-spruce forests from absolute heights of 800–1100 m. The heights of the main ridge Podnebesny-Dalny reach 1222–1247 m a.s.l. On the slopes of southern exposures, cedar forests with oak (*Quercus mongolica*) are common, on the northern slopes cedar forests with Khingam fir (*Abies nephrolepis*), spruce (*Picea jezoensis*), cedar-larch (*Larix cajánderi*) associations, etc., on the bottom of the river valley there are cedar forests, poplar forests (*Populus maximowiczii*), willow forest (*Chosenia arbutifolia*). Fir, which is of great importance for ensuring the conditions for the musk deer existence [41], fills in many areas the lower and middle tree canopies of the forest, the lower and middle parts of the southern slopes, glens and forms the second tree layer.

The main habitats of musk deer are located in dark coniferous mountain forests, especially ripe and close to the stage of natural climax, which provide all the conditions for the existence of the species. These forests contain abundant arboreal fruticose lichens genera *Usnea, Evernia, Alectoria*, soft fir needles, leaves of rhododendrons (*Rhododendron sichotense*) and others, this are the main components of its nutrition, especially in winter. Thanks to the protection in the reserve, an increased animal number is maintained. The number of musk deer exceeded 3000 individuals [41] in the first period of research (1974–1983) in the reserve, its population density was more than 30 individuals per 10 km^2 in the most favorable fir-spruce forests and cedar pine forests with fir, larch, in the basin Serebryanka river – usually 11–24 musk deer. However, the musk deer population gradually decline since 1975–1980, mainly due to natural causes. In the second period (since 2003–2004), we counted in Zimoveyniy from 12–13 in 2004 to 3 musk deer per 10 km² in 2012. Outside the reserve, its population density is less. Density is affected by habitat transformation by tree felling, roads, hunting and poaching [43] [31].

2.2. Data collection

2.2.1. Key Plots, the "Zimoveyniy"

The methodology was based on snow tracking and visual observations of musk deer accustomed to the presence of an observer and their neighbors with photo and video recording, from 2011–2015 whish supplemented by radio tracking [41][19][20][46]). The studies were carried out in key plots at least 10–25 km² in the river basins of the eastern macroslope of the Sikhote-Alin ridge. We have created a network of intersecting pathways 0.5–0.6 km apart, with a total length of 35 km in Zimoveyniy. Of these, 9.5 km are marked every 20 m with scarlet paint. The main pathways run along the mountain foothills, streams, along the crests of the watersheds. Pathways and many landmarks are marked on the plans with the basis of aerial photographs in 1976–1979. From 2003-2004 we used satellite images, GPS and GPS-Glonas recorders. From the pathways, we approached the places of the previous musk deer snow tracking and continued to trail further, determining the location azimuths of the during radio tracking.

2.2.2. Tracking technique

The method of musk deer inurement, visual observations, snow tracking is described in detail in publications [41][46], popular on the website [44]. Musk deer, accustomed to us, allowed themselves to be observed from a distance of 1.5–10 m, it did not change their behavior and activity rhythm, retained this property of behavior all their lives, after long breaks. Each accustomed musk deer had special features of build, the location of spots on the fell and behavioral characteristics in relation to the observer. The intensive growth of canines in males up to the age of three years ensured the identification of several age classes: under yearlings, (0–1) year; the second – (1–2) years, the third year of life – (2–3); three years old and older (≥3). According to the shape of the head and spotting of the color, under yearlings of both sexes, females of the age of (1–2) years and older (≥2) were reliably identified. The age was determined exactly for the musk deer accustomed to an observer at the age of less than a year of life. Sex and age classes have special trace characters [45].

The tracking we carried out directly on the musk deer trails. The distances were measured with checked steps, by compasses, GPS recorder, with an orientation to known landmarks (landscape features, vegetation changes, fallen trees, etc.). A more accurate survey of the movement trajectories carried out with a surveying compass with the registration of changes in directions by natural components – the vectors ***V***a (according to the average from 1.3 m to 4.0 m at different transitions) ([41] [42] etc.). We noted encountered: scent marks, latrines (accumulations of several dunghill), beds, etc., as well as noticeable eats trail of lichen, needles, rhododendron, etc., and features of the trajectory. Part of this tracks were marked with bright numbers (total 1749 in 1976–2008). Thus, we determined the period between repeated visits to these points by musk deer, since neither the compass nor the GPS recorder provided such an opportunity. The length of the daily movement (for ≈24 hours) we determined by the trajectory of movement between successive meetings of an individual every day.

2.2.3. Organization of musk deer monitoring

Some neighbors of the accustomed musk deer also gradually got used to our usual presence in the key plot. We followed each musk deer continuously from 4–5 to 17 days, then took a break and often resumed tracking. From 2–3 to 5 neighboring individuals were usually tracked per day. In the interval between a tracking some musk deer, its emergence in the places of tracking a neighbor was established at the meeting of traces. After that we to tracked it up to the meeting. This made it determine more possible to accurately the overlap size and the number of visits to the home range of musk deer by neighbors. We regularly kept records of lichen (*Usnea, Evernia, Alectoria*) and other food of musk deer on permanent (11) and episodic plots of 400 m^2 and 900 m^2. The results show a sufficient abundance of musk deer food in the Zimoveiniy key plot [41][43].

2.3. Data processing

2.3.1. Tracking schemes

Data for the winter seasons 1976–1977 and 2003–2004 collected from January to the end of March–beginning of April. We conducted 140 tracking of daily movements and their fragments of 13 individuals in 1976 –1877, and 89 for 11 musk deer in 2003–2004. Tracking data (from GPS recorders and work schemes) was transported to an aerial and space image in NextQGIS or MapInfo. Then the trajectory, meeting points of scent marks, we corrected according to work schemes, next they converted into MapInfo 7.2. Spatial data analysis we carried out in MapInfo. On the schemes (Fig. 1, 3) it is possible to determine a similar course of trajectory movement after a long tracking break within no more than 70–100 m along the horizontal of the relief and 15–20 m along the vertical. In each season, we used our footprints of previous snow tracking for orientation.

2.3.2. The size of home ranges and the allocation of their zonal structures

The author adheres to the classical definition of the "home range" term [4], adjusted in relation to the time of study and ideas about the home range as a statistical dynamic system of movements. The latter has been shown when using snow tracking [41] [46], and radio and GPS satellite tracking ([25][16][26][23]; etc.). The outer contours of home ranges, of overlapping areas of neighboring musk deer on each other, are drawn along the trajectories of individuals bordering the areas, with smoothing at intervals of at least 50–100 m of their small changes in the path [46]. Such a method was used and when identifying a common center of activity, local activity cores or kernel ([4][15][39]; etc.), and zones with different the density of scent marks, beds. The cores are identified along dense groups of closed trajectories, usually at the locations of many beds. A common center of activity brings together local cores with tracks in between. This makes it possible to determine the contours taking into account the trajectories, which does not allow the selection of polygons by the radio and satellite methods of tracking. Episodic outings of musk deer, more often females, outside the home range were not taken into account. Marking frequency indices were used: the number of MGC marks, etc. per 0.1, 0.2 km or 1 km of tracking.

2.3.4. Marking patterns

Musk deer has several specific skin glands. Sokolov and Chernova (2001) generalized the results of their structure. All of these glands are involved in marking the home range. However, the complex of caudal glands: circumcaudal and supracaudal in males, circummanal in both sexes are of particular importance. Marking by glandular excretion of this complex has been studied both in wild and in captivity ([40][41], [33][27], etc.). Adult male leave two types of marks with caudal glands.

1) Smell spots (*MGC*), no more than of 2–4 cm in diameter, on objects that rise 30–70 cm above the ground or snow (stumps, branches, roots, stems of grass).
2) Dunghills – pellet group (*PG*), which during patrols can reach a mass of only 1.1–5 g and intensely smell of glandular excreta.

All musk deer also leave large heaps of excrement (more than 20–25 g) often in latrine (some more than 20–30 piles). The number of latrines and individual pellet hills in the habitat in any period reaches hundreds of pieces. Females and under yearlings usually scrape the substrate with their forelegs after defecation. Adult males leave separate small piles, usually in a "new" place, on path, rarely on the feces of other species. Often (≥63%) males do not scrape the substrate, especially in small piles, or make one or two scrapers. The pattern of marking objects in nature consists of:

1) approach to the scent mark; 2) its study, sniffing; 3) turning, raising or lowering on the

hind legs, applying the excreta of glands by rubbing from side to side or less often from top to bottom; 4) scrapers with one or alternately two front legs of the substrate towards the object of marking; 5) going away. Sometimes the musk deer licks off the old excreta of the conspecific with its tongue, also scrapes the bark of firs on the excretory spot with incisors. A variety of objects allows the musk deer to leave marks in the coniferous forest almost everywhere. *MGC* marks are clearly visible when tracking.

2.3.5. Patterns of behavior when musk deer male movements around the home range

Males combine usually several behavioral activities along the way, among which one usually dominates [41]. Foraging A] predominates in the fragments of way with active feeding and rest (according to the frequency of eating and resting places) with many turns, short steps (up to ≥25–35 cm) it is usually in the center of the home range. The pattern B] of active patroling distinguished by a more straightened trajectory, a long stride (up to 40–45 cm), sometimes trotting, a large number of scent marks, and rare food collection. Complex patrolling C] combines active foraging with scent marking. There are movement fragments in places rarely visited by musk deer D] with a low marking frequency. At the same time, males collect food (lichen thallome scraps, etc.) from the underlying surface, branches with different activity almost all the way.

2.3.6. Statistical Methods

Statistical calculations were carried out using Statistica 8, Statgraphics Plus. Nonparametric methods were used, since many samples are small. They were verified by Kolmogorov-Smirnov (*KS*) and Shapiro-Wilk (*SW-W*) tests. The difference in individual marking parameters of musk deer at different times and in different parts of the habitat was assessed using the Wilcoxon Matched Pairs Test (*W-test*), *ANOVA Friedman*. The text also uses the following designations: *Me* – median; *CV*, % – coefficient of variation; r_s is the Spearman correlation coefficient.

III. RESULTS

3.1. The structure of the musk deer observable grouping in the Zimoveyniy key plot in the seasons of 1977 and 2004 and Parameters of home ranges

In the Zimoveyniy key plot, the musk deer uses most usually the upper halves of the northern and northeastern slopes of the watersheds along their ridges, overgrown with cedar pine forests with abundant the Khingam fir, larch and other trees, as well as areas with a similar dense forest of the bottom of the river and streams valley. The activity of home ranges cores of males were located in a forest with abundant undergrowth, a "polewood" of the Khingam fir. Females and underyearlings settled in the forest with a windfall and coniferous regrowth.

3.1.2. In 1977

We determined the presence in January-March of 11 musk deer per 4.8 km² of tracking area: four males, five females of reproductive age (older than a year) and two more individuals (female and under yearlings) on the outskirts, which monitored only once. In February, in a cedar forest near the Zimoveiniy stream (between *4* and *6*; hereinafter, the numbers in the rectangles in Fig. 1, 2) settled on a part of the *M4* home range, a previously unknown female ("Martian") of age (1–2). By the beginning of March, it had gone to the upper reaches along the slope. Conflicts with it other musk deer were not noticed. *M4* ("Starik" – "Old-timer"), *M8juv* ("Myshka" – "Mouse"), *F1* ("Neulovimaya" – "Elusive"), *F2* ("Mila") were accustomed to the observer presence, *M5* (1-–2), *M6* (1–2) made it possible to follow from a distance of 20–30 m. External parameters of the main structural elements (cores, common center of activity) of the area used by musk deer during the tracking period shown in Table 1. For *M6*, the parameters are given until February 27, *F3* until February 21, 1977. The lynx (*Lynx lynx*) caught these animals on these dates. The areas of females significantly (from 26–27% to ≈100%) overlapped with areas of adult males. Three of females, then two and one lived within the home range *M4* and at least two lived within the area ($S >$ 1 km²) *M7*

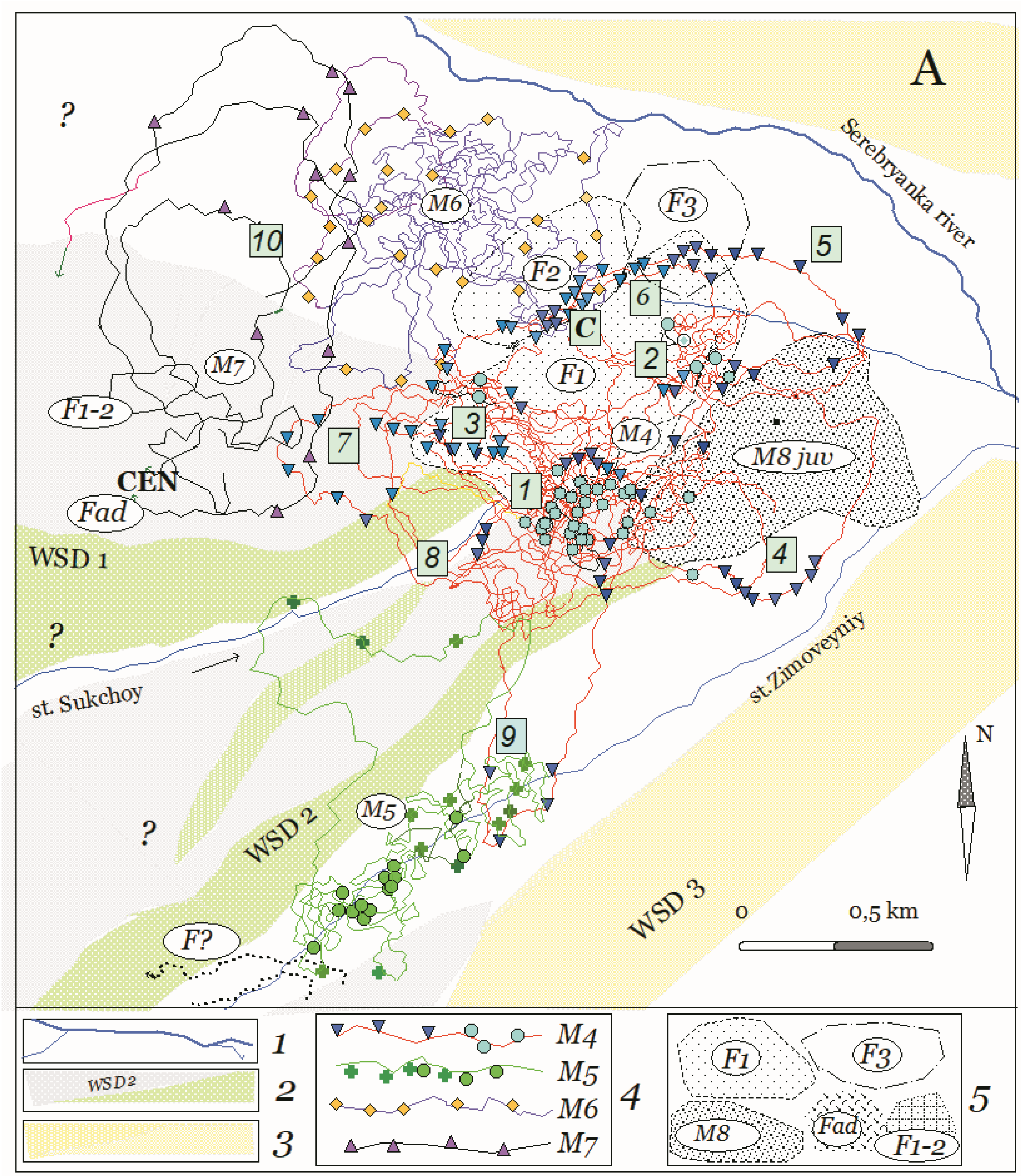
(> 2 year). The sizes of the *M7*, *F4*, and *F5* home ranges, which were observed fragmentarily, were not precisely determined. However, it was established that the center of activity of the *M7* was located in a cedar pine forest with fir along the crest of the WSH 1 watershed (Fig. 1).

Table 1: Parameters of musk deer home ranges on key plot Zimoveyniy in 01-03.1977

Musk deer, (age group)	Period, days*	Area, km^2	Perimeter, km	Length and Width, km	Centre, km^2	Number of the neighbors of same sex	Overlap (km^2) with musk deer of the same sex
M4 (>3)	24	1,54	5,42	1,80×1,25	0,56	4	0,27
M5 (1-2)	18	≥0,78	3,97	1,0×1,4	≥0,20	2	≥0,14
M6 (1-2)	14	0,66	3,22	1,2×0,93	0,30	2	0,22
M8juv (0-1)	25	0,30	2,26	0,83×0,62	0,23	1	0,26
F1 (>3)	19	0,34	2,51	1,10×0,49	0,20	2	0,053
F2 (2)	11	≥0,15	1,45	0,62×0,46	≥0,11	2	≈0,032
F3 (2)	10	>0,16	1,33	0,48×0,44	≥0,10	2	≈0,03

Note: * – number of tracking days.

The percentage of overlapping sites of neighboring males on the site *M4* in January-February was 18–20%. *M4* appeared just a few days later in the former center of activity of *M6* after the death of the latter. Until March 11, an overlap zone of sections *M4* and *M7* was formed, with an overlap area of 28-–30% of the home range area *M4*. In this season, we did not notice visits of neighboring males to the *M4* activity center, except for one passage of *M5* to the center margin, as well as a similar visit of *M4* to the *M5* activity center. The area percentage of activity centers reached 36% of the *M4* home range, 45–46% of *M6*, and 76–77% of *M8juv*.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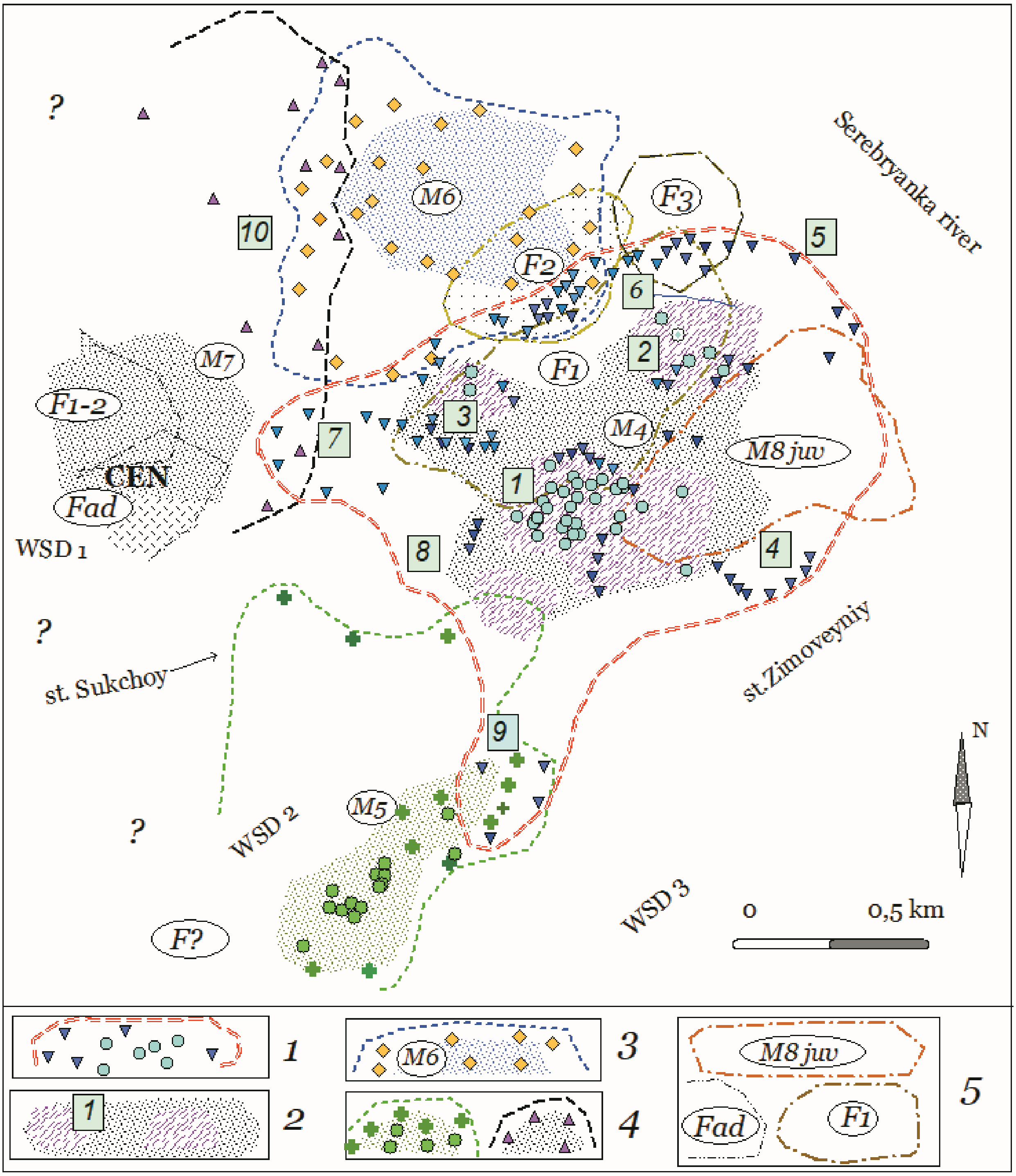


Fig. 1: Movements (Fig. A), contours of home ranges, the common center and local activity cores (B) of musk deer and the location of *MGC* marks and beds in the 1977 season, according to multi-day tracking data: in fig. A., legend: *1* – river and streams; *2* – southern and northern exposures of mountain slopes, WSH n – watersheds; *3* – valley cedar pine forests and secondary forest (yellow color) on mountain slopes; *4* – tracking trajectories of male musk deer, *MGC* marks and beds (circles); *5* – polygons for the female home ranges (individuals in Table 1 and in the text); in Figure B: *1* – contours, marks and beds of the *M4* home range in January-February 1977; *2* – center and local cores of *M4* activity; *3* -– contours, marks of *M6*; *4* – contours, centers, marks and beds of *M5* and *M7*; *5* – contours of the females and *M8juv* home ranges.

Overlap of home ranges females in phyllopatry association at point *6* (Fig. 1, 2) had lower values: for *F1* – 15%, *F2*– 21%, *F3* – 18–19%. The females occasionally ventured outside their normal ranges. *F1* in February made two exits from the valley to the slopes, also walked all night through the *M8juv* habitat, lay down twice, and then returned to its usual site. The movement of *F1* expanded after the death of *F3* and the departure of *F2* in the first ten days of March up the WSH 2 watershed and along the Zimoveiniy stream. *F1* has used many parts of the former sites of these females.

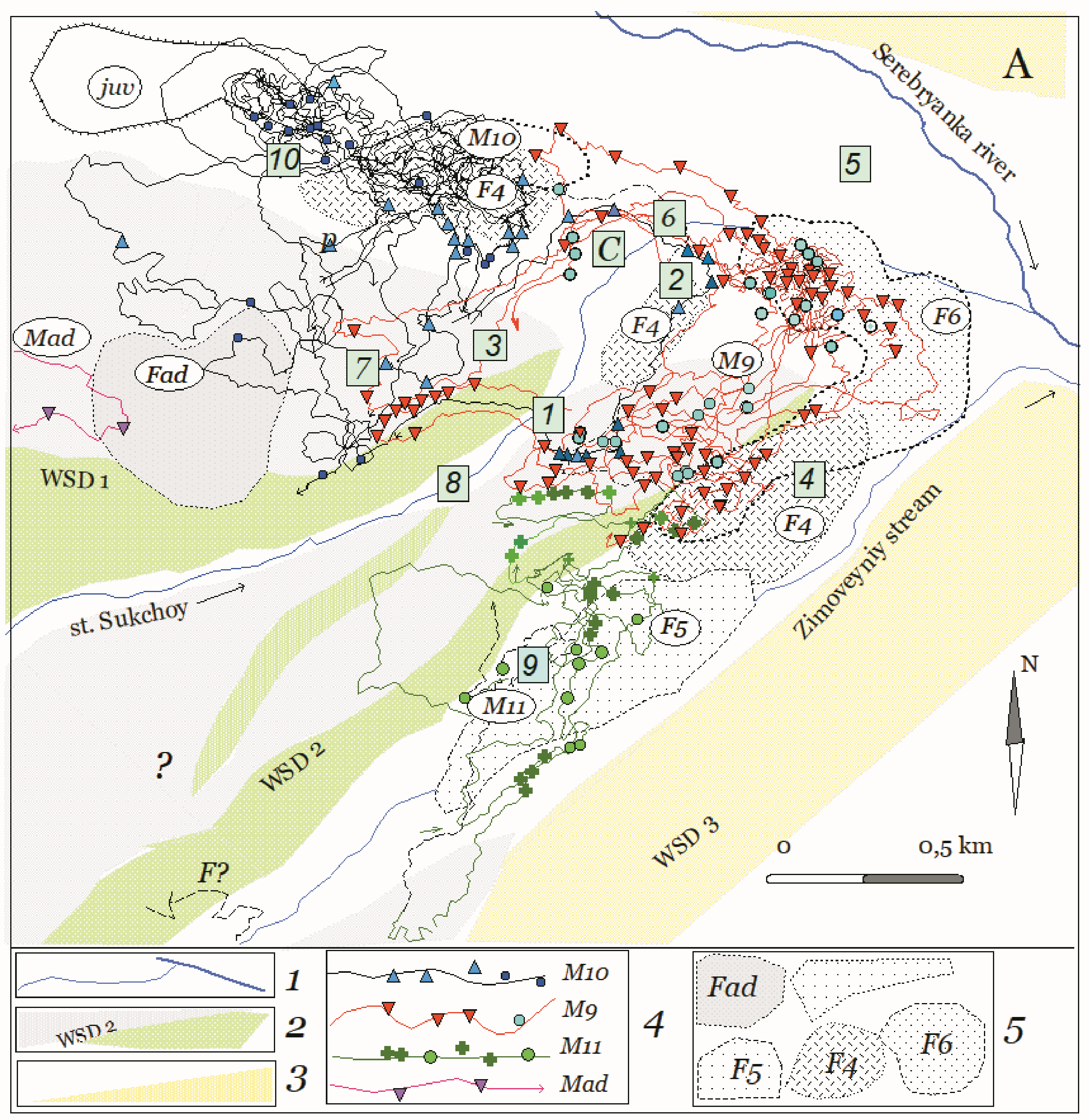
3.1.3. In 2004 г

In February, the snow depth reached 43–50 cm in the forest. In January-February, we determined the presence of 10 musk deer on 5.1 km² of the area surveyed by tracking. Among them, *M9* ("Iskatel" – "Fortune hunter") and *M10* ("Hero"), *F4* ("Beauty") are accustomed to our presence. Other traced individuals (Table 2) occasionally allowed themselves to be observed from distances of 20–35 m. The musk deer population density in this time was 3–1.4 times less than the average population density of this association in 1975–1982. At the beginning of the season in the dense forest of the river valley and Zimoveyniy stream, three females lived near the outskirts of home ranges *M9* and *M11* (Fig. 2). The overlap of their sites reached 23% for *F5*, 29% for *F6* and 50% for *F4*. However, the females stayed mainly in the places (6–15 ha) not overlaping by the neighbors visits. This phyllopatric females aggregation began to disintegrate in the first half of February, probably due to competition between them. However, the author noticed traces of only one pursuit by *F4* jumps of a younger *F6*, while tracking. *F4* did not fully use the vacated areas of the forest. At first, the female moved closer to the Sukhoy stream along the valley (area (0.04 km²; *F1* lived here in 1977), but a day later it went into the forest, where *F2* lived in 1977 (0.14 km²). Nearby was the underyearling home range, which was almost 50% overlapped by tracks of movements of *M10*.

Table 2: Parameters of musk deer home ranges in key plot Zimoveyniy in 01 -03.2004.

Musk deer, (age group)	Period, day	Area, km2	Perimeter, km	Length and Width, km.	Centre, km2	Number of the neighbors of same sex	Overlap (km²) with musk deer of the same sex
M9 (≥3)		1,35	5,47	1,75× 1,26	0,30	3	0,66
M10 (>4)		1,58	5,21	1,85×1,31	0,59	2 (3?	0,69
M11 (2-3)		>0,82	4,13	1,50×0,76	0,18	2 (?)	0,13+
F4 (>3)		0,18	1,8	0,78×0,41	0,13	2	0,09
F5 (3)		0,21	2,23	1,1×0,35	0,15	1	0,05
F6 (2)		>0,20	2,33	0,71×0,71	0,13	1	0,058

A significant overlap of home ranges was determined for males (Table 2): *M9* – 49%, *M10* – 43–44%, *M11* – at least 16% from the *M9* site. These percentages are even higher, since for the neighbor *Mad* on WSH 1 (Fig. 2) part of the area on the watersheds remained untracked. However, in these places, footprints of musk deer of different freshness were register during tracking.


A
Serebryanka river
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Zimoveyniy stream
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M11
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WSD 2
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WSD 3
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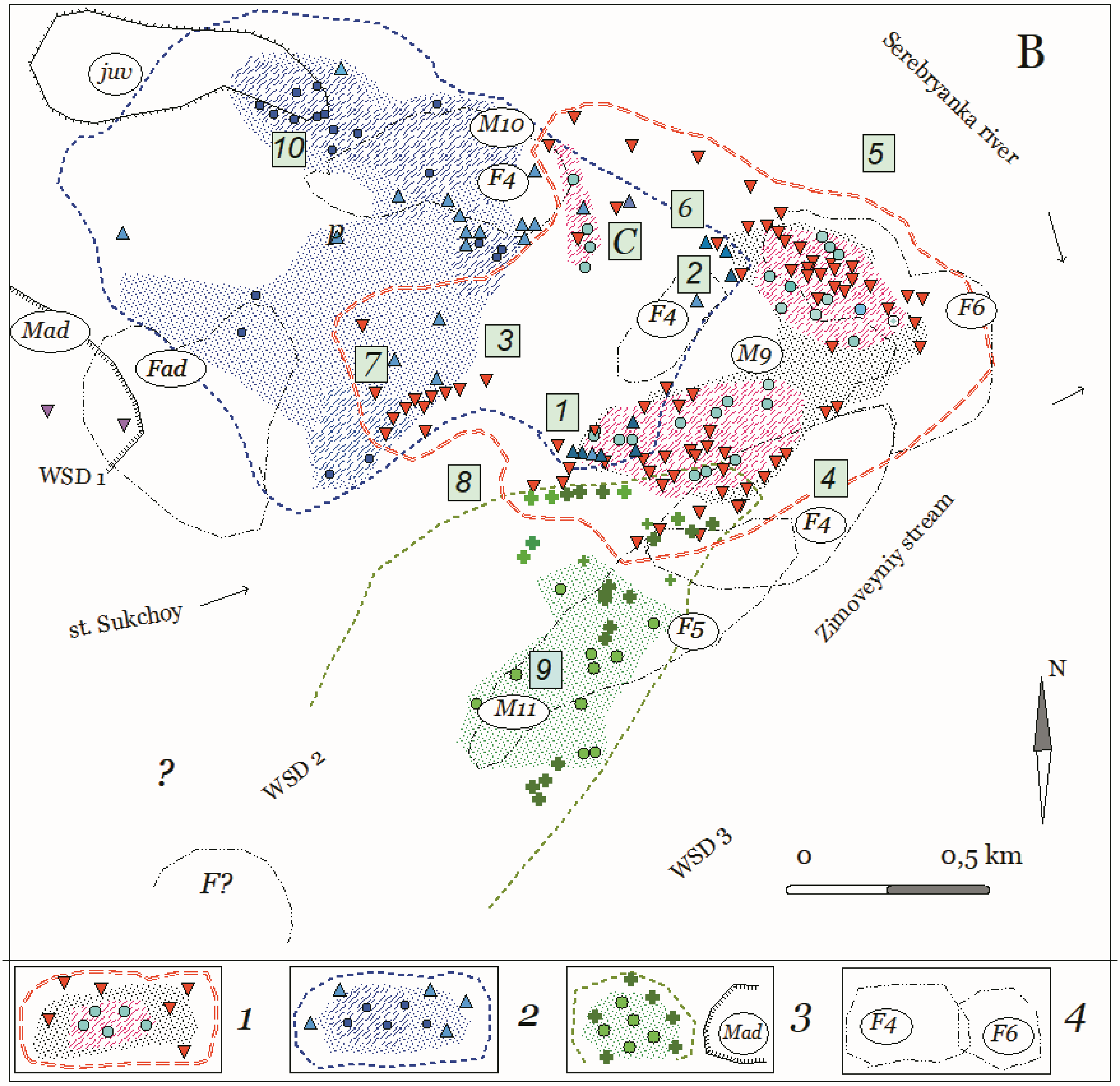

Fig. 2: Movements (Fig. A), contours of home ranges, centers and cores of activity (B) of musk deer and the location of MGC marks and beds in the 2004 season; in fig. A, the legend: *1–3* – designations in fig. 1.; *4* – tracking trajectories of male musk deer, *MGC* marks and beds (circles); *5* – female home ranges polygons; in legend of fig. B: *1* – contours, center and cores of the *M9* home range, marks and beds in January-February 1977; *2* – contours, the center of the *M10* home range, marks and beds; *3* – contour and center, marks of *M11*, contour of *Mad*; *4* – contours of females and underyearlings home ranges.

The home range size, areas of common centers of activity in males was 22–23% for *M9*, 37.3% for *M10*, and approximately 20–25% for *M11*. The general centers and, especially, the local cores of activity were located almost in the same places where centers and cores of males were located in 1977 (Fig. 1, 2). The difference from the situation in 1977 was small distances between the centers and the main local cores of neighboring males: only 150–350 m or less between *M9* and *M10*; 200–250 m between *M9* and *M11*. *M9* formed core ***C*** (Fig. 2B) almost synchronously with the movement of *F4* to neighboring areas. In March, *M10* delimiting the main place of presence of *F4* with *MGC* scent marks. At this time, we did not notice the movement of *M10* along the center of the *M9* home range (cores *1*, *2* in the rectangles and between them; Fig. 2). However, from the side of Zimoveiniy and WSH 2 traced two *M11* trajectories near the main core 1 of *M9*.

3.2.1. Frequency of MGC marking in activity centers and periphery of home ranges

The marking frequency (Tables 3, 4) differs significantly in the centers of activity and on the periphery of the home ranges of adult (>3–4 years old) males *M4* (1977), and *M10* (2004), as well as *M6* (1–2 year old in 1977) (Table 5). A male of the age class (1–2) *M5* (1977) had a similar frequency of marking the center of activity and the periphery under conditions of close location of the overlap zones of neighboring males to the center of *M5*. The difference slightly does not reach the p-value ($p < 0.05$) for *M11* (Table 5), the center of activity of which almost adjoined the home range of *M9* (Fig. 2A, B). The frequency of marking the periphery and the center of activity for *M9* (>3) had an insignificant difference. *M10* visited the center of activity of this male and its surroundings in January–February 2004 (Fig. 2A).

Table 3: Indices of the marking frequency with *MGC* scent marks (marks/0.2 km) of males followed by many days of tracking in January-March 1977.

Musk deer	Statistical index	Scent marks GC / 02 km in		
		Centre of Activity	Periphery	General
M4	*Mean*	0,23	0,82	0,48
	SD	0,619	1,214	0,984
	n	138	78	171
M5	*Mean*	0,20	0,45	0,30
	SD	0,459	0,631	0,547
	n	41	29	70
M6	*Mean*	0,22	0,28	0,24
	SD	0,422	0,461	0,435
	n	23	23	41

Table 4: Indices of the marking frequency with MGC scent marks (marks/0.2 km) of males followed by many days of tracking in January-March 2004.

Musk deer	Statistical index	Scent marks GC / 02 km in		
		Centre of Activity	Periphery	General
M9	*Mean*	0,51	0,79	0,62
	SD	0,775	1,125	0,929
	n	70	43	113
M10	*Mean*	0,12	0,59	0,28
	SD	0,379	0,931	0,658
	n	52	27	79
M11	*Mean*	0,39	0,89	0,56
	SD	0,941	1,079	0,969
	n	23	18	59

Table 5: Results of the assessment of differences (*W-test*) in the marking frequency in the center of activity and the periphery of male home ranges (according to Tables 3 and 4).

Statistical index	Male of Musk Deer					
	M4	*M5*	*M6*	*M9*	*M10*	*M11*
Z	3,718	0,338	2,628	1,150	2,934	1,804
p-value	0,0002	0,735	0,009	0,250	0,003	0,071
n	78	18	29	43	27	18

3.2.2. Frequency of marking with MGC marks in different zones of male home ranges

The results show that the frequency of *MGC* marks per 0.2 km of the way in 1977 varied somewhat in different parts of the male home ranges (Table 6). However, a significant variation in these indices (*CV* up to 194–320% with *n* up to 23–55) and a large proportion of null results allowed us to identify only a few major differences (Table 5). Comparison of data from 3 different cores of the *M4* home range showed insufficient difference between the samples in the overall continuum: *ANOVA Friedman*; $\chi^2 = 3.0$ (df = 3; p = 0.39), as in different parts of the periphery: $\chi^2 = 0.444$ (df = 4; p = 0.979). However, in the zone of active patrolling *5–7* (1.5 scent marks, *n* = 23, *SD* = 1.442) and between cores (0.62, *n* = 21, *SD* = 0.864), the difference is significant: *W-t test*, z = 2.22; *n* = 21; p = 0.026.

Table 6: Marking frequency (scent marks/0.2 km of tracking; in parentheses – *SD*) and density index (marks/ha) in different zones of male home ranges in January-March 1977

Iindices	Values of the frequency and density of marks in different zones of the home range							
	M4				*M6*			
	Core	Common Center	Periphery		Core	Common Center	Periphery	
			Whole area	Marking zones			Whole area	Marking zones
Number of *MGC*/0,2 km	0,23 (0,62)	0,33 (0,62)	0,82 (1,21)	1,52 (1,44)	0,20 (0,46)	0,45 (0,63)	0,23 (0,62)	0,33 (0,62)
Density of *MGC*/ha	0,68	0,58	0,55	1,8	0,50	0,43	0,39	0,64

In the common center and activity cores of *M4*, patterns of food gathering and resting A] prevailed over 82% of the total trajectories length (27.6 km). Only on some fragments of the way, the male left 2–3 marks per 0.2 km. The mark distribution in groups is also noticeable in other places, in particular, on trajectories along the *M8juv* area, where we observed one fragment of active marking B] in *4* (in Fig. 1). The male marked, with a slightly lower frequency, fragments of the way between cores *1*, *2*. He marked the periphery noticeably more often, especially the zones of active marking in the places of overlapping home ranges of *M4, M6*, and *M7* (Fig. 1, Table 6), with a total length along way 1, 6–1.7 km and a depth of up to 0.15–0.250 km. However, even before entering this zone from core *2,* the male began to actively marking (up to 3–4 scent marks per 0.2 km) on patterns B] (in *5* to *6* in Fig. 1) 700–800 m before overlapping with *M6*. It also marked actively after leaving the zone *7–6*. This zone is the inertial zone of the marking. This inertia is also observed in other places (in *3*, *7*, etc.; Fig. 1, 2).

In the snowy winter of 2004, many movements of the observed musk deer located in the valley and on the near slopes more compactly than in 1977. However, many features of the home ranges structure of predecessors were preserved (Figs. 1, 2). *M9*, which occupied a site similar in terms of the location of the kernels and part of the contour with the *M4* site (1977), marked the center of activity and the periphery relative evenly (Tables

4–7). However, in the overlap zone of the *M10* home range, the frequency increased significantly to 1.27 (n = 15; *SD* = 1.44) compared with the nuclear labeling (0.5; n = 24; *SD* = 0.771); *W-test*: z = 2.24; n = 15; p = 0.025, especially after *F4* moved here from Zimoveiniy stream. Each time when walking around this part of the home range, *M9* encountered fresh tracks of *F4*, walked along them (complex patrolling C], turning into pattern A]), several times it lay down near *F4* in a new nucleus in ***C*** (Fig. 2). This area was visited actively with marking and *M10*, to the home range which *F4* also moved. At the same time, *M9* marked the center of activity of its home range more intensively than the adultery *M10*: z = 2.84; n = 42; p = 0.005.

Table 7: Marking frequency (tags/0.2 km; *SD* in brackets) and index of marks density (marks/ha) in different zones of male home ranges in January-March 2004

Indices	Values of the frequency and density of marks in different zones of the home range							
	M9				*M10*			
	Core	Common Center	Periphery		Core	Common Center	Periphery	
			Whole area	Marking zones			Whole area	Marking zones
Number of *MGCs*/0.2 km	0,50 (0,77)	0,51 (0,78)	0,79 (1,12)	1,27 (1,44)	0,12 (0,38)	0,10 (0,36)	0,59 (0,93)	0,76 (0,99)
Density of *MGC*/ha	1,90	1,79	0,11	0,83	0,18	0,58	0,15	1,25

3.2.3. Density distribution of MGC scent marks in male home ranges

In key plot Zimoveiniy, aggregations of male trajectories are distinguished, uniting the cores of activities (between *1* and *2*, *1–3*, etc., Figs. 1A, 2A) and patrol (*4–9*) in the peripheral parts of home ranges. Adult males bypassed all the periphery of their territories in no less than 4–7 days (*M4* in 5–6 days), each time passing only a part of it. The next patrol usually took place in a few days. Only some males repeated visits to the same overlapping zone more frequently if the female's home range was located there (*M9* near *F4* home range in 2004).

In 1977 and 2004, we identified a similar arrangement of patrol trajectories in the overlapping of the male home ranges relative to relief and other landmarks (Figs. 1, 2). Only a slight shift of these zones was observed. The location of the main activity cores, the central system of movements that unite the local cores in a common center, was also preserved (1–2, 1–3). In 1977 and 2004, the trajectories of the central system, and especially patrol ways 5 and 6, lay along the outskirts of the female areas, between their territories. Males often did not enter the central parts of female home ranges. Since February 1977, *M4* also bypassed the main part of the *M8juv* area, which began to be marked with *MGC* marks since March. Conflicts of these musk deer at short distances from each other were not noticed. Conservatism in the schemata of ways location also determined the peculiarities of the males scent marks disposition.

There is no direct relationship between the marking frequency and the marks density (Tables 6, 7) for all males in different zones of their habitats: for *M4*, r = 0.86 (p = 0.13); *M9* – r = -0.65 (p = 0.35); *M10* – r = 0.78, p = 0.24, total for these males r = 0.35 (p = 0.26). For *M4*, M6 in 1977 and *M10* in 2004, the marks density in the marking zones was higher than in the activity core. At the same time, the ratio of marks densities in these zones is different for *M4* and *M6* (χ^2 = 5.16; df = 1; p = 0.02), for *M9* and *M10* (χ^2 = 20.09; df = 1; p < 0.001), as well as for *M4* and *M10* of different generations (χ^2 = 51.42; df = 1; p < 0.001). However, the difference is not significant for *M4* and *M9* living in the same place at different times (χ^2 = 2.40; p = 0.12), as well as for males of different age classes *M6* and *M10* (χ^2 = 2, 02; p = 0.12). The marks distributions in the males home ranges of different ages *M6* and *M9* also had similarities (χ^2 = 1.18; p = 0.28).

In 1977, we did not notice visits by neighboring males to the *M4* activity center, except for one visit to the *M5* margin, and the zones of active marking were distant from the main activity core. In the marking zone 5–7 (Fig. 1), the density of fresh marks in different places reached 1.42–2.8 per hectare, in the inertial zone 2/ha. This was different from the marks density in cores: *W-test*, z = 2.02; p = 0.043. Density indices differed in different activity cores by almost 1.5 times (from 0–0.69 marks to 1 per ha). *M4* left 16 marks in the 5–6 zone in just two patrols (1.65 km of way). In activity core 1, the male left five and four marks on only two the way fragments in places where old marks meet.

In 2004, the overlap zone between *M9* and *M10* reached 0.46 km^2. Patrol ways of males were located quite compactly almost in the same place where a similar zone stretched near *M4* in 1977 (Fig. 1, 2). *M9* had 0.83 *MGC* marks per ha, and in the inertial marking zone 5 had 1.67 scent marks, in the activity cores 1.69 (0.92–2) per hectare. Differences with mark densities in these parts of the home range are small (*W-test*, z = 1.75; p = 0.08). The increased marks density in the core of *M9* is due to the rare visits of the *M10*.

The concentration of fresh *MGC* markers in the *M9* activity core is associated with visiting the surroundings and marking by the *M11* by the end of March 2004. At a distance of up to 60 m from the *M11* trajectories, 11 marks were encountered, up to 130 m, – 18, and up to 300 m, another 7; r^2 = 0.923, p = 0.009. *M9* marked core activity mainly on pattern of complex patrolling C].

IV. DISCUSSION

The tracking methods for many days in key plot, in combination with visual observation of individually recognizable individuals, made it possible to accurately determine whether the marks belong to one or another musk deer male, accustomed to the observer. However, the full application of the method is possible in the snowy periods of the year. The study determined a significant similarity in the home ranges location, especially the main cores of activity (with the exception of their specific contours defined by motion trajectories), movement patterns of musk deer generations, separated by a time interval of almost 30 years. All this time, the grouping existed in stable conditions that are typical for coniferous forests, especially those close to the natural climax stage with sufficient food resources for musk deer [41]. The population density of the musk deer was in 2003–2004 on Zimoveiny, only 1.3–1.4 times less than in 1976–1977, the numbers of musk deer in the association are almost equal, and the sizes of home ranges of individuals of the corresponding sex and age groups are similar. The impact of the snowy winter of 2004 had a local effect. The musk deer is adapted to its usual movement in deep snow in coniferous forests [43].

The data (Fig. 1, 2; Tables 3–7) contain information about the encounter of only fresh marks during snow tracking. However, during the snow period, males leave more *MGC* marks in their home ranges, since we tracked only part of the musk deer movements. During the mating season (November-December), the intensity of marking in adult males (≥2–3 years old) reached 15–18 *MGC* marks per day, males traveled an average of 3.6 km with the prevalence of active patrolling B] on most of the way [41]. In January–March, the lengths of daily movements (to 1–3.5 km) and the scent marks number (3–8) per day decreased. Young males (1–2) left up to 4–5 marks per day in November–December, and 1–2 marks in January–March. Total, in November-December, adult males left from 750 to more than 1000 marks in their home ranges, in January-February – from 250 to more than 700; young males, respectively, about 200–300 and 90–180. After a period of active marking in November–December, males usually renewed their previous marks, the encounters number with which is much higher (>75–90%) than with the marks of their neighbors [41]. Meanwhile, the smell of *MGC* persists for a long time. We felt it 1–1.5 months after marking. Nevertheless, males renewed some marks 4–6 times in 1.5–2 weeks, and in some places of key importance for the movement organization, 5–7 marks were located in limited areas (100–200 m^2). Such activity of marking, which seems to be excessive, is probably associated with possible rapid changes in the musk deer groupings, such as the death of a neighbor, with the maintenance of territorial status and scent background by males.

The results indicate a significant relationship between the frequency of *MGC* marking and the distribution of scent marks in the male musk deer home ranges with the movements of neighboring males, the distribution of their marks, and the social situation in the musk deer grouping in different time. The movements of adult males (≥2–3 years) are coordinated, moreover, with the distribution of females, which leads to an indirect connection between the distribution of marking zones and the location of females' territories. However, the distribution of marks (Figs. 1, 2) and indices of their density (Tables 4–7) in home ranges indicate a relationship between *MGC* marking, primarily with the movements of males, with their visits to each other's home ranges, with the proximity of the main activity centers and local cores of neighbors.

The frequency of *MGC* marking is usually higher in zones of active marking at the periphery of home range than in the cores of activity, especially in adult males (Tables 3–7), but not always. There was no direct relationship between the marking frequency and marks density by the end of the tracking period ($p > 0.05$). According to the ratio of mark density indices in cores and in marking zones, two main variants in the location of markers are distinguished:

a) active marking zones are distant from the main activity core, neighboring males do not visit the activity core of the resident, males often visit the marking zones on the periphery;
b) some local cores almost adjoins the area of overlap with the home ranges of neighbors, neighboring males visit the main cores with marking.

In variant b), the scent mark density in the cores visited by neighbors was even higher than in the infrequently visited peripheral marking zones (Table 7, in *M9*), the marking frequencies of the common center of activity and the periphery did not differ much (Table 5). Alternative b) includes data of the marks distribution in the home range of the male (2–3 years old) in our other key area [46]: 54.1% of *MGC* marks were located in the common center and activity cores of this male during frequent visits to his territory by neighbors. The male formed a modular structure near the places where neighbors penetrated into the center of activity, which ensured the vital activity of the individual and the protection of the territory. Elements of the modular structure can also be notice for males on Zimoveiniy, near local cores (for *M4*, *M10*) and the female habitats.

Scent marks have dispersal over the entire area of males from the age of >1 year, especially during the mating season [40] [41]). However, the density of their distribution has different values in different parts of home ranges. Males mark after the mating season with greater frequency, mainly certain zones. These include areas visited by other males. Among them, in specific episodes, a vast zone *5–7* stands out (Fig. 1, 2) in the place of overlapping areas of male neighbors of successive generations. The location of this belt has changed only slightly since 1977. By the 2000 two of its sections are detached: the lower one (*5–6*) in the place of active B] and complex C] patrolling of *M9* and *M10*, and the upper on the mountain slope (near *7*; Fig.2), which was preserved in the place of the *M4* and *Mad* confrontation in 1977. Other zones are also maintain their approximate localization according to changes in the male movements.

Peters and Mech [24] were among the first to propose a graphical grid-and-nodal model, according to which the density of scent marks in the wolf (*Canis lupus*) increases in the border zones between the home ranges of neighboring packs. However, wolves also actively mark the environs of the den, but in a different way [2]. The location of marks in places where competitors are likely to appear is also characteristic of other predatory animals: the coyote (*Canis latrans*) [3], the African lion (*Panthera leo*) [17][18], and the cheetah (*Acinonyx jubatus*) [13]; the tiger (P. tigris) [32], leopard (*P. pardus*) [29], etc. The inertial marking phenomena that we observed in the musk deer (the inertial marking belt in 5 and others; Figs. 1, 2) violate the strict relationship between the distributions of scent marks and neighboring individuals. Musk deer males marking actively, starting bypassing belt 5–6, almost a kilometer before visiting the overlapping area with neighboring males. However, all the years there was no regular presence of males from the side of the river, where this zone is located in the forest. The activity (motion, marking) of males increased spontaneously during patrolling due to the corresponding motivation (reconnaissance, individualization of the territory, aggression). The inertial marking zones persisted for as long as well the marking zones in the overlay area. The phenomenon of inertial marking additionally indicates an excessive amount of scent marking means. In general, redundant marking contradicts, on the one hand, the principle of saving and reducing costs (which is suppose by some authors: [8][11][2]. But on the other hand, it is effective not only in creating soft "barriers", hindrances between plots of neighbors only on a part of the periphery, but it is also optimal for the individualization of the all territory by a resident. Male musk deer are able to distinguish their *MGC* marks from those of their neighbors. This has been shown both in natural conditions [41] and in captivity [27]. In the natural environment, the influence of encounters with smell marks of neighbors on the change in the movement trajectories of the recipients was also observed. Thus, *MGC* marking has diverse communicative functions; it is involved in the regulation of the dynamics and stabilization of the musk deer distribution. Such a response is observed in cheetah [13].

This conclusion adds to the hypothesis by Gosling [7] [10]. that residents mark their home ranges with scent to give recipients a means of evaluating when comparing the scent of individuals upon meeting with the mark scent. Resident musk deer neighbors are familiar with each other, but they have a small number of contacts when they meet most of the year [41] [46]. The excreta of the caudal complex glands contains various chemicals [34] [35] and they is able to indicate to the recipient several parameters of the donor. This is consistent with the concept of broad communicative properties of marking, which is also suggested by Macdonald [18] – "connection marking") for predators, by Matyushkin [21] for the Amur tiger (*Panthera tigris altaica*), this is consistent with the concept of mediated communication [30] and hypothesis by Gosling [7] [11].

Scent marking is one of the means, mechanisms for regulating the spatial distribution of individuals, however, effective. Attention is drawn to the rare visit and then avoidance of *M4* to the main site of the *M8juv* (1977) even before the young male began marking his home range with sparse *MGC* marks from mid-March. Males also did not form local nuclei in their home ranges in the places where other under yearlings and females are usually present. Thus, the very distribution of musk deer individuals is based on a certain behavior stereotype, which determines their adaptive dispersal according to environmental conditions, however, with the preservation of a single association. Marking arrange in this case spatial and social relations between individuals. This is facilitated by the maintenance for a long time, the inheritance of such elements of the structure of the used space as the main marking zones. With this continuity is probably due to the similarity (χ^2; $p > 0.05$) of the distribution of mark density indices in different parts of the home ranges of different generations males occupying habitats in the same places: adult males *M4* and *M9*, different age classes *M6* and *M10*.

V. CONCLUSION

The paper provides for the first time detailed information on the marking in musk deer males by the excretion of the caudal glands (*MGC*) in different parts of their home ranges in connection with the movements and marking by neighboring males, with location of females and underyearlings home ranges. The tracking methods makes it possible to determine exactly the belonging of the marks to one or another musk deer, accustomed to the observer and individually identifiable. The data indicate a significant similarity in the home ranges location, the system of movements, in the activity cores distribution and the main marking zones for musk

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deer generations, separated by a time interval of almost 30 years. This conservatism corresponds to rather stable conditions created by dark coniferous forest. Marking with *MGC* is part of a general stereotype of behavior that determines the adaptive dispersal of individuals in an association according to environmental conditions. This is an effective means of stabilization and dynamics of the group structure, regulation of the distribution of individuals, especially males, relative to each other, including the main patterns of bypassing their home ranges for a long time. The variety of scent marking communicative properties are revealed in the creation of communication zones between the home ranges of neighboring males, which also have the value of barriers, and in the individualization of the residents home ranges. Some redundancy in the means of marking (the number of marks, inertial marking phenomena) is probably associated with possible rapid changes in groupings, individualization, and the maintenance by males of a certain territorial status.

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Ethic

In the study, not a single musk deer died due to our fault. We did not influence the distribution and normal movements of the musk deer in home ranges.

Conflict of Interests

No conflicts of interest

BIBLIOGRAPHIC REFERENCES

1. Adams, C.A., Bowyer, R. T., Rowell, J.E., Hauer W.E. , Jenks J.A. (2001). Scent marking by male caribou: an experimental test of rubbing behavior. Rangifer; 21 (1): 21–27.
2. Barja, I., de Miguel, F.J., Bárcena, F. (2005). Faecal marking behaviour of Iberian wolf in different zones of their territory. Folia Zool.; 54(1–2): 21–29.
3. Barrette, C., Messier, F. (1980). Scent marking in free-ranging coyotes, *Canis latrans*. Anim. Behav.; 28: 814-819. doi:10.1016 /S0003-3472(80) 80141-2
4. Burt, W.H. (1943). Territoriality and home range concepts as applied to mammals. Journal of Mammalogy; 24 (3): 346–352.
5. Carranza, J, Mateos-Quesada, P. (2001). Habitat modification when scent marking: shrub clearance by roe deer bucks. Oecologia; 126: 231–238. doi 10.1007/s004420000511
6. Green, M.J.D. (1987). Scent marking in the Hymalayan musk deer (*Moschus chrysogaster*). J. Zool.; 1B (4): 721–737.
7. Gosling, L.M. (1980) Defence guild of savannah ungulates as a context for scent communication. Symposium Zool. London: 45: 195-212.
8. Gosling, L. M. (1981). Demarkation in a gerenuk territory: an economic approach. Zeitschrift für Tierpsychologie; 56: 305–322.
9. Gosling, L. M. (1985). The even toed ungulates: order Artiodactyla. Sources, behavioral context, and function of chemical signals. R. E. Brown & D. W. MacDonald (eds.). Social odors in mammals, Oxford Univ. Press, Oxford, U.K.: 560-618.
10. Gosling, L.M. (1987). Scent marking in an antelope lek territory. Anim. Behav., 35: 620–622, doi:10.1016/S0003-3472(87)80298-1.
11. Gosling, L.M. (1990). Scent marking by resource holders: alternative mechanisms for advertising the costs of competition. In: Macdonald D.W., Muller-Schwarze D., Natynczuk S.E. (eds); Chemical signals in vertebrates 5. Oxford University Press, Oxford: 315–328.

12. Danilkin, A., (1996). Behavioral ecology of Siberian and European roe deer. Chapman and Hall, London.
13. Eaton, R. L. (1973). The World's Cats. V. 1. Winston, Ore.: World Wildlife Safari.
14. Jewell, P.A. (1966). The concept of home range in mammals. Exploration and territory in mammals. Symposium of Zool. Soc. London; (18): 85–109.
15. Kaufmann, J.H. (1983). On the definition and functions of dominance and territoriality. Biol. Rev. Cambridge Phil. Soc.; 58 (1): 1–20.
16. Kie, J.G., Matthiopoulos, J., Fieberg, J., Powell, R.A., Cagnacci, F., Mitchell, M.S., Gaillard, J.M., Moorcroft, P.R. (2010). The home-range concept: are traditional estimators still relevant with modern telemetry technology? Phil. Trans. R. Soc. B.; 365: 2221–2231. doi:10.1098/rstb.2010.0093
17. Macdonald, D.W. (1980). Patterns of scent marking with urine and faeces amongst carnivore communities. Symposium Zool. Soc. London; 45: 107–139.
18. Macdonald, D.W. (1985). The Carnivore: Order Carnivora. In: Brown R.E., Macdonald D.W. (eds.). Social odours in Mammals. Clarendon Press, Oxford: 619–722.
19. Maksimova, D.A., Seredkin, I.V., Zaitsev, V.A., Mikell, D.G. (2014). Home range and daily movements of musk deer in Sikhote-Alin. Areals, migrations and other movements of wild animals. Vladivostok: Reya: 175–180. [In Russian]
20. Maksimova, D.A., Seredkin, I.V., Zaitsev, V.A., Mikell, D.G. (2015). Habitat of a young male musk deer in the Sikhote-Alin Reserve. Proceedings of the XV meeting of geographers of Siberia and the Far East. Irkutsk: publishing house of the Institute of Geography. V.B. Sochava. SB RAS: 424–426 [In Russian]
21. Matyushkin, E.N. (2000). Traces and the method of snow tracking in the study of large predatory mammals. Zoologichesky Journal; 79 (4): 412–420. [In Russian]
22. Mills, M.G.L., Gorman, M.L. and Mills, M.E.J. (1980). The scent marking behaviour of the brown hyaena, *Hyaena brunnea*, in the Southern Kalahar. South African J. Zool.; 15: 240–248.
23. Moorcroft, P.R., Barnett, A. (2008). Mechanistic home range models and resource selection analysis: a reconciliation and unification. Ecology; 89(4): 1112–1119. doi: 10.1890/06-1985.1
24. Peters, R.P., Mech, L.D. (1975). Scent-marking in wolves. *Amer. Scient. 63: 628–637.*
25. Powell, R.A. (2000). Animal home ranges and territories and home range estimators. Research Techniques in Animal Ecology (Pearl M.C., ed.). N.-Y.: Columbia Univer. Press: 66–110.
26. Powell, R.A., Mitchell, M.*S.* (2012). What is a home range? J. of Mammalogy; 93: 948–958. doi: 10.1644/11-MAMM-S-177.1
27. Prikhodko V.I. (2003). Musk deer. Origin, systematics, ecology, behavior and communication. Panov E.N. (ed). Moscow: GEOS. [In Russian]
28. Ralls, K. (1971). Mammalian scent marking. Science; 171: 443–449. doiI: 10.1126/science .171.3970.443
29. Rafiq, K., Jordan, N.R., Meloro, C., Wilson, A.M., Hayward, M.W., Wich, S.A., McNutt, J.W. (2020). Scent-marking strategies of a solitary carnivore: boundary and road scent marking in the leopard. Animal Behaviour; 161 (3): 115–126. Doi: 10.1016 j.anbehav.2019.12.016
30. Rozhnov, V.V. (2011). Mediated chemo communication in the social behavior of mammals. Zakharov A.A. (ed.). Moscow: Association of Scientific Publications KMK. [In Russian].
31. Slaght, J.C., Milakovsky, D., Maksimova, D.A., Seryodkin, I.V., Zaitsev, V.F., Panichev, A.M., Miquelle, D.G. (2017). Anthropogenic influences on the distribution of a Vulnerable coniferous forest specialist: habitat selection by the Siberian musk deer *Moschus moschiferus*. Oryx; 5(1): 174–180. doi.org/10.1017/S0030605316001617.
32. Smith, J.L.D., McDougal, C., Miquelle, D. (1989) Scent marking in free-ranging tigers, *Panthera tigris*. Anim Behav.; 37: 1–10. doi.org/10.1016/ 0003-3472(89)90001-8

33. Sokolov, V.E., Prikhodko, V.I., Smirin, V.M., (1980, 1981). Poses and expressive movements in the behavior of the musk deer (*Moschus moschiferus* L.). Message 1, 2. Zoological journal; 1980. 69 (12): 1875–1884; 1981. 60(10): 1553–1561. [In Russian]
34. Sokolov, V.E., Kagan, M.Z., Vasilyeva, V.S., Prikhodko, V.I., Zinkevich, E.P. (1986). Main components of the musk deer caudate gland secretion. Chemical communication of animals. Moscow: Science: 302–310. [In Russian]
35. Sokolov, V.E., Chernova, O.F. (2001). Skin glands of mammals. Bolshakov V.M. (ed). Moscow: GEOS. [In Russian].
36. Sun, L., Xiao, B., Dai, N. (1994). Scent marking behaviour in the male Chinese water deer. Acta Theriologica; 39 (2): 177–184.
37. The plant and animal world of the Sikhote-Alinsky zapovednik (2006). 2nd edition. A.A. Astafyev (ed.). Vladivostok: Publishing House of Primpoligraphcomplex. [In Russian].
38. Vogt, K., Zimmermann, Fr., Kölliker, M., Breitenmoser, U. (2014). Scent-marking behaviour and social dynamics in a wild population of Eurasian lynx *Lynx lynx*. Behavioural Processes; 106: 98–106. · doi: 10.1016/j.beproc.2014.04.017
39. Worton, B.J. (1989). Kernel Methods for Estimating the Utilization Distribution in Home-Range Studies. Ecology; 70 (1): 164–168. doi:10.2307/1938423
40. Zaitsev, V.A. (1985). Scent Marking behavior of the Sikhote-Alin musk deer. Bulletin of the Moscow Society of Natural Scientists, Biology Branch; 90 (6): 51–62. [In Russian]
41. Zaitsev, V.A. (1991). The Musk deer of the Sikhote-Alin. Ecology and behavior. Baskin L.M., Filonov K.P. (eds). Moscow: Science. [In Russian]
42. Zaitsev, V.A. (2002). Vector systems and rhythms in movement and orientation of moose (*Alces alces* L.) and other mammals (Mammallia), Journal of General Biology; 63 (4): 335–350. [In Russian]
43. Zaitsev, V.A. (2006) Musk Deer: Ecology, Population Dynamics, Perspective for Conservation. Biodiversity Conservation Center Press, Moscow, Russia. [In Russian]
44. Zaitsev, V.A. (2022). The Musk deer. Training a saber-toothed animal. Website "Kedr": https://kedr.media/stories/kabarga-priucheni e-sablezubogo-zverya-2455
45. Zaitsev, V.A., Zaitseva, V.K., 1982. Traces of musk deer. Hunting and hunting husbandry; 5: 18–19. [In Russian]
46. Zaitsev, V., Maksimova, D., Smirnov, Y., Belotelov, N. (2021). Home Range Use by a Male Siberian Musk Deer (*Moschus moschiferus* L.) in Central Sikhote-Alin. Biology Bulletin; 48(9): 1631–1649. doi: 10.1134/S1062359021090247

Supreme Theory of Everything: It is Time to Discuss Hubble's Law

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ABSTRACT

The Hubble constant, the Doppler effect, and redshift are the key factors for understanding the Universe. The Hubble constant is a linear approximation of a very short interval in 1-2 Mpc of universe-scale. The Supreme Theory of Everything indicates this constant varies permanently and confirms that there is no need to search for the Hubble constant. The Hubble constant doesn't find anywhere. So, I call the Hubble constant the Hubble Flow. Contemporary cosmology can observe more than 14000 Mpc of distance from Earth. Astronomers have the beautiful possibility to follow Hubble Flow, which opens the mystery of the Universe. We need to find its physical basis. We don't also know the age of the Universe as a consequence of the flawed Hubble constant. The research aims to present the possibility of using the open hysteresis instead of the Hubble constant for the determination of the structure of the universe.

Keywords: Hubble constant, Hubble flow, open hysteresis in Hubble flow, flawed age of universe.

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I. INTRODUCTION

Since the beginning of the 1900s, we have transformed our view of the Universe. We learned that our galaxy is just one of many, that galaxies are racing away from each other, and that the universe's expansion is accelerating. These discoveries depended on an important finding made by Henrietta Leavitt, an American astronomer. [1]

In 1929, Edwin Hubble announced that almost all galaxies appeared to be moving away from us. [2][3][4][5] The velocity of a galaxy could be expressed mathematically as

$$v = H \cdot d \quad [3] \qquad (1)$$

Where v is the galaxy's radial outward velocity, d is the galaxy's distance from Earth, and H is the constant of proportionality called the Hubble constant. [6]

Today some theories have indeed become very complicated, and some have been too simple. But the fundamental ideas aren't that complex. Does the Hubble constant have this very simple relationship? And is the calculation of the age of the Universe so easy? The exact value of the Hubble constant is still somewhat uncertain but is generally believed to be around 65 kilometers per second for every megaparsec in the distance. [6][7]

The Hubble law is in functional studies. [8-12] The first measurement of H_0 from WMAP, in 2003, was 72 ± 5. Further results from WMAP were slightly lower: 73 in 2007, 72 in 2009, and 70 in 2011. No problem, though: the error for the SH0ES and WMAP measurements still overlapped in the 72-to-73 range. The most recent result from SH0ES at that time showed a Hubble constant of 74 ± 2, and WMAP's final result showed a Hubble constant of 70 ± 2. [8]

Indeed, one method's results would begin to trend toward the other's as methodology and technology improved-perhaps as soon as the first data were released from the Planck Space Observatory, the European Space Agency's successor to WMAP. That release came in 2014: 67.4 ± 1.4. The error ranges no longer overlapped—not even close. [10] The proportionality between recession velocity

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and distance in the Hubble Law is called the Hubble constant [9] (it looks like the Planck constant [13]), or more appropriately the Hubble parameter we have a history of revising it. In recent years the value of the Hubble parameters has been considerably refined, and the current value given by the WMAO mission is 71 km/s per second. Measurements using a variety of techniques find the Hubble constant to be about 70 to 76 kilometers per second for every megaparsec of distance (Mpc, about 3.26 million light-years). So, an object one Mpc away will move away from us at 70-76 km/s, an object two Mpc will move away at 140-152 km/s, and so on. [1][14]

The fact that the Hubble expansion rate of the Universe changes over time teaches us that the expansion of the Universe isn't a constant phenomenon. In fact, by measuring how that rate changes over time, we can learn what our Universe is made from: this was precisely how was first discovered dark energy. [15] [16]

Entitling his paper "Sorry, Astronomy Fans, The Hubble Constant Isn't A Constant At All Starts With A Bang," Ethan Siegel wrote that if you measure the slope of that line, you get a value, colloquially known as the Hubble constant, still, it isn't a constant at all, as it changes over time. Here's the science behind why. [17] Astronomers have reached a fundamental impasse in their understanding of the Universe: they cannot agree on how fast it is flying apart. And unless a reasonable explanation can be found for their differing estimates, they may be forced to completely rethink their ideas about time and space. Only new physics can now account for the cosmic conundrum they have uncovered, many believe. [18]

"Over the decades, these surprises have included the discovery of dark matter – believed to be made up of as yet undetected particles – whose extra gravitational pull explains why galaxies do not fly apart. In addition, astronomers have also discovered the existence of dark energy, which is accelerating the rate at which the cosmos is expanding. [18]

"Those two discoveries were remarkable enough," adds Riess who won his Nobel for his involvement in the discovery of dark energy. "But now we are facing the fact there may be a third phenomenon that we had overlooked – though we haven't got a clue yet what it might be." [18]

"Changing the Hubble constant from 67.4 to 73.5 would mean it must have been flying apart faster than previously supposed and so must be younger than its currently accepted age of 13.8bn years," says Mortlock. [18]

A Kavli Institute for Theoretical Physics workshop in July 2019 directed attention to the Hubble constant discrepancy. New results showed that it does not appear to depend on the use of any one method, team, or source. Proposed solutions focused on the pre-recombination era. [19]

This paper is a summary review of a KITP-UCSB workshop convened to bring together both experimental and theoretical researchers in the field to review and assess the current state of affairs and identify promising next steps for the resolution of this issue. [20][21]

The model is well established from decades of research and its Hubble constant prediction is supported by Planck's results, however, measurements indicate the universe is expanding faster than expected. This conflict has been growing more perplexing in recent years. [1][22]

"The Hubble constant discrepancy has been increasing, raising the possibility that we may be missing something interesting in our understanding of the universe," said SH0ES team lead Adam Riess at the Johns Hopkins University and Space Telescope Science Institute in Baltimore. [22]

So, either something is wrong with our various measurement techniques or something is wrong with our theoretical model of how the universe evolves. [1][23]

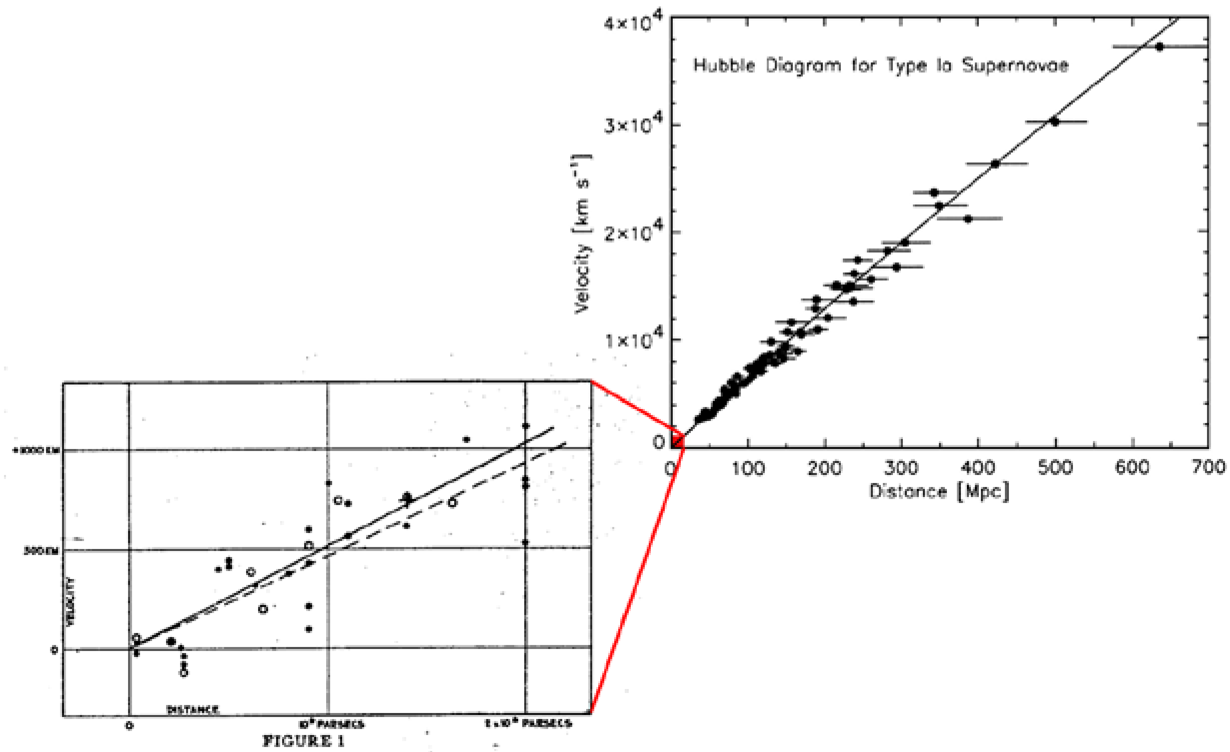
If you measure the slope of that line, you get a value, colloquially known as the Hubble constant. But it isn't a constant at all, as it changes over time. Hubble measurements suggest a faster expansion rate in the modern universe than expected, based on how the universe appeared more than 13 billion years ago. These measurements of the early Universe come from the European Space Agency's Planck satellite. This discrepancy has been identified in scientific papers over the last several years, still, it has been unclear whether differences in measurement techniques are to blame or whether the difference could result from unlucky measurements. [24]

These most precise Hubble measurements to date bolster the idea that new physics may be needed to explain the mismatch. [24]

"This mismatch has been growing and has now reached a point that is impossible to dismiss as a fluke. This disparity could not plausibly occur just by chance." [1][25][26]

Cosmologists have been struggling to understand an apparent tension in their measurements of the present-day expansion rate of the Universe, known as the Hubble constant. [27][28][29]

One alternative to the Hubble recession law is the tired-light hypothesis proposed initially by Zwicky. [30][31] Despite periodic re-examination of the concept, tired light has not been supported by observational tests and remains a fringe topic in astrophysics. [32]



Measurement of the Hubble constant then and now

Figure 1: "How Far We've Come" [33] in the study of the Hubble constant

We've come a long way in our understanding of the Universe. While Hubble is given credit for the initial discovery of the distance-redshift relation, later astronomers continued to take measurements of the distance of galaxies and their redshifts.

You can see this in the upper right of the Figure above, which plots a more modern graph of the relation. Hubble's original data spans the small red square in the lower-left corner of the Figure. Then in 1998, Purlmutter, Schmidt, and Riess used observations of very distant galaxies to show that the Universe was not just expanding but accelerating. [33].

The recent study strengthens the case that new theories may be needed to explain the forces that have shaped the cosmos. [24].

Either way, the Hubble constant puzzle indicates something is missing from our picture of the universe. [1][24]

And that was all it short review is about recent scientific research on the Hubble constant.

II. NEW SOLUTION FOR HUBBLE PROBLEM

2.1 Hubble Flow

Hubble's law must yield a great deal of much more information about the Universe. But it conflicts with the observations and research above talked. This contradiction is not just in minor details but is very fundamental. Hubble's law couldn't be formulated perfectly because the Hubble constant (H) is a linear relationship between the distance and velocity of the receding celestial object on a small scale (1-2 Mpc). The Hubble law was almost valid in nearby galaxies (700 Mpc) (Figure 2a and Figure 2b). But it is not constant for distant galaxies lying more than 700 Mpc. Today we can observe 14260 Mpc or 46.5 Gly in radius [34]. I introduce that the diameter of the whole Universe is approximately 60000 Mpc, which equals 195.7 billion light years. [35] Of course, at that time Hubble law was a revolutionary scientific discovery. At that time, it was. Even now, not only Hubble's law (same as Einstein's photoelectric effect [13]) but many phenomena haven't been explained by classical physics because they are not linear, but cyclical. As seen today, Hubble's law cannot be accurately determined without the apparent hysteresis of magnetism. Because of this, we carefully handle the 100-year-old theory of Hubble from another point of view in this chapter.

Does the problem of Hubble's constant direct us to new physics? Or require a new consideration of an old unsolved law? Both versions maybe. I think that the reason for Hubble's problem is the unsolved old physical phenomenon of hysteresis, which has been a struggle for scientists. At first, I solved the problem to open hysteresis, then used it for solving the Hubble problem, and finally considered its results for different levels, from quantum mechanics to cosmological phenomena. It was proved to be correct and rational. [35][37-43].

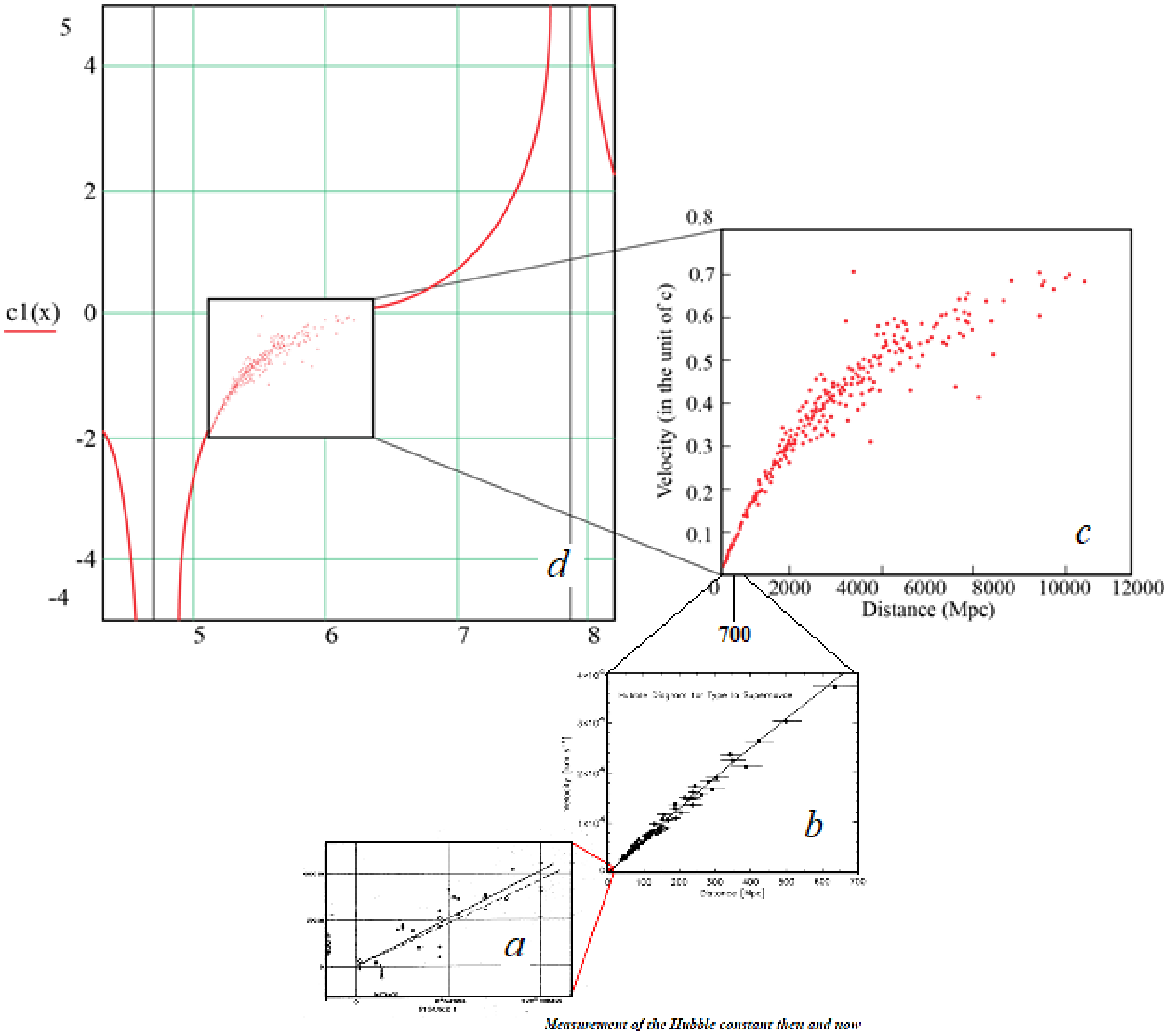


Figure 2: How Far We've Gone Now in Universe-Scale

Figure 2 is processed from Figure 1 by Brain Koberlein [33] and from a paper by Ulaanbaatar T., [35] The horizontal axis is not scaled in Figure 2d because of the circle scale but it says a lot.

The Hubble constant is seemingly different in Figure 2c [36] and Figure 2d [35]. For this reason, we called it the Hubble Flow [35].

In this paper, I wouldn't like to copy and insert the formula extraction of the open hysteresis published [41][42] and examples to use it.

The Hubble Flow (*H(x)*) is described by the following formula of the open hysteresis of the electromagnetism [13][35][37-43] (Figure 2d):

$$H(x) = \frac{0.7 \cdot sin\ (x)}{|\ cos\ (x)\ \ |} \quad (2)$$

Where *x* is the distance unit in a circular scale.

According to the Supreme Theory of Everything, the graph of Hubble Flow shown in red in Figure 2d shows only the whole structure of the Universe.

2.2 Structure of the Universe

The understanding of the universe depends on the key factor "Hubble flow". The curve in Figure 2d is a quarter of a full illustration in the Universe-scale.

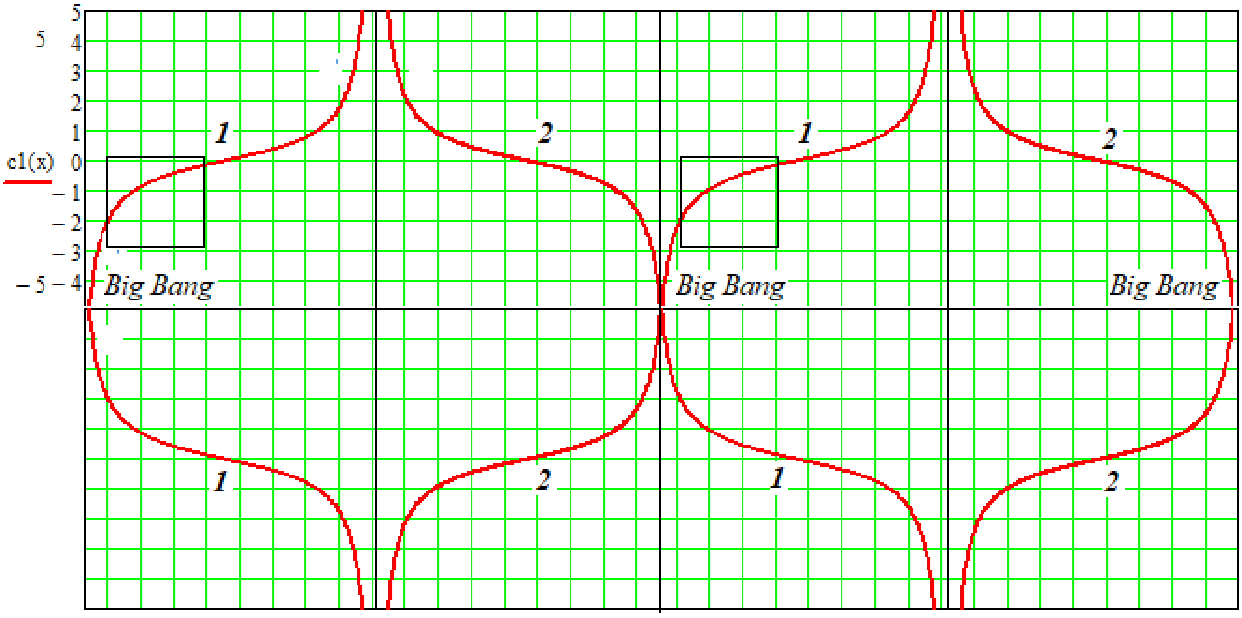


Figure 3: Universe structure as a geometric rotation form [35]
(1 denotes Big Expansion: Accelerating-Slowing-Accelerating,
2 represents Big Crunch: Intensive Slowing-Slowing-Intensive Slowing)

It is the large-scale structure of the universe. And parallel universes have the same designs I think [35] [44].

2.3 The Age of the Universe is Flawed

According to the Hubble law

$$v = H \cdot d$$

$$H(t) = \frac{\frac{\Delta d(t)}{\Delta t}}{d(t)} \qquad [45]$$

Where $d(t)$ is the dimensionless scale factor for the expanding Universe, $d(t_0) = 1$ is the scale factor $set = 1$ at present.

The scale factor R for a given observed object in the expanding Universe relative to $R_0 = 1$ at present may be implied from the z parameter expression of the redshift. [9]
The Hubble parameter has the dimensions of inverse time, so a Hubble time t_H may be obtained by inverting the present value of the Hubble parameter. [46]

$$H_0 = 71\frac{\frac{km}{sec}}{Mpc} = 2.3 \cdot 10^{-18} sec^{-1}$$

$$t_H = \frac{1}{2.3 \cdot 10^{-18} sec^{-1}} = 13.8 \cdot 10^{9}\ years$$

It is seemingly so uncomplicated. Unfortunately, H_0 cannot be constant. Consequently, the age of the Universe is changed.

The title of Ethan Siegel's article is "If The Universe Is 13.8 Billion Years Old, How Can We See 46 Billion Light Years Away?". [47]

III. CONCLUSION

We summarize that:

- We cannot find any constant of Hubble anywhere. It changes by the angle of a circle.
- We can call the Hubble Constant the Hubble Flow, which is the result of the open hysteresis of everything.
- The cause for the Hubble flow is the circular structure of the Universe.
- The presently accepted age of the Universe is not 13.8 Billion years. More research is needed to determine the exact age of the universe.

REFERENCES

1. Discrepancies in the Hubble Constant Have Vexed Astronomers – NASA's Roman Space - SciTechDaily -Telescope Could Help Resolve the Puzzle, NASA'S Goddard Space Flight Center, 2021 https://scitechdaily.com/discrepancies-in-the-hubble-constant-have-vexed-astronomers-nasas-roman-space-telescope-could-help-resolve-the-puzzle/
2. Hubble, E. (1929). "A relation between distance and radial velocity among extra-galactic nebulae". *Proceedings of the National Academy of Sciences*. 15 (3): 168–73. Bibcode: 1929PNAS...15..168H. doi:10.1073/pnas.15.3.168. PMC 522427. PMID 16577160.
3. Redshift and Hubble's Law - NASA https://starchild.gsfc.nasa.gov/docs/StarChild/questions/redshift.html
4. Emad Iskander, Douglas Scott & Martin White, The Hubble Expansion, https://www.astro.ubc.ca/people/scott/hubble.html
5. P. J. E. Peebles, the Standard Cosmological Modelhttps://ned.ipac.caltech.edu/level5/Peebles1 / frames.html
6. What distance method did Edwin Hubble use to determine the ... - Socratic https://socratic.org/questions/wh at-distance-method-did-edwin-hubble-use-to-determine-thedistance-to-local-gal
7. Hubble Constant, National Aeronautics and Space Administration, Goddard Space Flight Center,https://lambda.gsfc.nasa.gov/education/graphic_history/hubb_const.html
8. Richard Panek, How a Dispute over a Single Number Became a Cosmological Crisis, https://www.scientificamerican.com/article/how-a-dispute-over-a-single-number-became-a-cosmological-crisis/
9. Hubble law and the expanding universe - GSU http://hyperphysics.phyastr.gsu.edu/hbase/Astro/hubble.html
10. C. L. Bennett D. Larson, J. L. Weiland, Show all 21 authors, E. L. Wright, (2012) Nine-Year Wilkinson Microwave Anisotropy Probe (WMAP) Observations: Final Maps and Results, The Astrophysical Journal Supplement Series 208(2), DOI: 10.1088/0067-0049/208/2/20
11. Dan Scolnic, New Measurements of the Hubble Constant, The National Science Foundation, University of Chicago, The Kavli Foundation, https://indico.cern.ch/event/615891/contributions/2643252/attachments/1507549/2349644/tevpa_scolnic.pdf
12. Adam G. Riess, Lucas Macri, and others, A redetermination of the Hubble constant with the Hubble Space Telescope from a differential distance ladder, The Astrophysical Journal, 699:539–563, 2009 July 1 doi:10.1088/0004-637X/699/1/539
13. Ulaanbaatar Tardad, Supreme Theory of Everything: A New Quantum Concept of the Photoelectric Effect. London Journals of Research in Science: Natural and Formal, Volume 22 | Issue 14 | Compilation 1.0, 1-12, 2022.
14. Probing the Hubble Constant with NASA's Roman Space Telescope, Nancy Grace Roman space telescope, Goddard Space Flight Center, https://roman.gsfc.nasa.gov/feature_hubble_constant.html
15. Mystery of Universe's Expansion Rate: Hubble Data Shows That "Something Weird" Is Going On, Astronomy, Astrophysics, Hubble Space Telescope NASA Popular Space Telescope Science Institute, 2022.
16. Hubble constant, NASA https://epxkve.holztreppen.info.pl/hubble-constant-nasa.html
17. Ethan Siegel, Sorry, Astronomy Fans, The Hubble Constant Isn't A Constant At All Starts With A Bang, Contributor Group, 2019 https://www.forbes.com/sites/startswithabang/2019/08/02/sorry-astronomy-fans-the-hubble-constant-isnt-a-constant-at-all/?sh=7f40b4299d59
18. Robin McKie, The Hubble constant: a mystery that keeps getting bigger https://www.theguardian.com/science/2019/nov/02/hubble-constant-mystery-that-keeps-getting-bigger-estimate-rate-expansion-universe-cosmology-cepheid
19. Licia Verde, Tommaso Treu, Adam G. Riess, Tensions between the Early and late Universe, Nature Astronomy 3(10), 2019, DOI: 10.1038/s41550-019-0902-0.https://www.researchgate.

net/publication/336109393_Tensions_between_the_early_and_late_Universe

20. Eleonora Di Valentino [2011.00246], A combined analysis of the H0 late time direct measurements and the impact on the Dark Energy sector. https://arxiv.org/abs/ 2011.00246https://arxiv.org/pdf/2011.00246.pdf
21. Adam Riess – New determination of the Hubble constant with Gaia EDR3, Further Evidence of Excess Expansion, https://www.youtube.com/watch?app=desktop&t=2061&v=8RPoPsvd60M&feature=youtu.be
22. NASA's Goddard Space Flight Center, Discrepancies in the Hubble Constant Have Vexed Astronomers – NASA's Roman Space Telescope Could Help Resolve the Puzzle, Astronomy and Astrophysics, 2021, https://scitechdaily.com/discrepancies-in-the-hubble-constant-have-vexed-astronomers-nasas-roman-space-telescope-could-help-resolve-the-puzzle/
23. Hubble constant mismatch no fluke; new physics may be needed, Hubble Space Telescope Science institute, https://astronomynow.com/2019/04/27/hubble-constant-mismatch-no-fluke-new-physics-may-be-needed/
24. Mystery of the universe's expansion rate widens with new Hubble data https://phys.org/news/2019-04-hubble-universe-faster.html
25. Wilfred H. Sorrell, Misconceptions about the Hubble recession law, Astrophys Space Sci (2009) 323: 205–211 DOI 10.1007/s10509-009-0057-zhttps://files.core.ac.uk/pdf/2612/81847289.pdf
26. Overduin, James Martin; Wesson, Paul S. (2008). *The light/dark universe: light from galaxies, dark matter, and dark energy*. World Scientific Publishing. p. 10. ISBN 978-981-283-441-6.https://briankoberlein.com/post/how-far-weve-come/
27. Is the Hubble constant not...Constant? - 邮件群发|自建邮局 https://www.jszsoft.net/2022/10/29/ is-the-hubble- constant not constant-2/
28. Hubble constant mismatch no fluke; new physics may be needed, 27 April 2019 Astronomy Now, https://astronomynow.com/2019/04/27/hubble-constant-mismatch-no-fluke-new-physics-may-be-needed/
29. Donna Weaver / Ray Villard, Adam Riess, Claire Andreoli (2019), Mystery of the Universe's expansion rate widens with new Hubble data, https://www.nasa.gov/ feature/goddard/2019/mystery-of-the-universe-s-expansion-rate-widens-with-new-hubble-data
30. Proc. Nat. Acad. Sci. 15:773, 1929.
31. Wilfred H. Sorrell, Misconceptions about the Hubble recession law, Astrophys Space Sci (2009) 323: 205–211 DOI 10.1007/s10509-009-0057-z https://files.core.ac.uk/pdf/ 2612/81847289.pdf
32. Overduin, James Martin; Wesson, Paul S. (2008). *The light/dark universe: light from galaxies, dark matter, and dark energy*. World Scientific Publishing. p. 10. ISBN 978-981-283-441-6.
33. Brian Koberlein, How Far We've Come, 10 October 2013. vhttps://briankoberlein.com/post/how-far-weve-come/
34. The observable universe, https://en.wikipedia.org/wiki/Observable_universe
35. Ulaanbaatar, T., Supreme Theory of Everything: Whole Universe in a Simple Formula, London Journal of Research in Science: Natural and Formal, Volume 20 | Issue 5 | Compilation 1.0, p. 73-90.
36. Universe expansion by velocity and distance relation https://i.stack.imgur.com/7bl6l.png
37. Ulaanbaatar Tarzad, Supreme Theory of Everything, 4th International Conference on Astrophysics and Particle Physics, December 03-05, Holiday Inn Chicago O'Hare, Chicago, USA, 2018.
38. Ulaanbaatar T., Supreme theory of everything, J. Astrophys. Aerospace Technol. 2018. Volume 6, DOI 10 4172/2329-6542-C7-035.
39. Ulaanbaatar Tarzad, Supreme Theory of Everything, Advances in Theoretical & Computational Physics, Volume 2, Issue 2, 1-6, doi.org/10.33140/ATCP.02.02.05
40. Ulaanbaatar Tarzad, Jargalan Narmandakh, Batgerel Baltin & Sangaa Deleg, Supreme Theory of everything: A New Possibility to Open the Hysteresis, London Journal of Research in Computer Science and Technology Volume 21 | Issue 1 | Compilation 1.0, 2021

41. Ulaanbaatar Tarzad, Formula Extraction in Supreme Theory of Everything, Advances in Theoretical & Computational Physics, Volume 2 | Issue 4 | 1 of 3, doi.org/10.33 140/ ATCP.02.04.01
42. Ulaanbaatar Tarzad, Supreme Theory of Everything: Geometric Methods for the Complex Analysis, Journal of Current Trends in Physics Research and Applications, App 2(1): 1-7, 2021
43. Ulaanbaatar Tardad, Supreme Theory of Everything: Special Theory of Relativity Was Lost from the Beginning, Journal of Applied Mathematics and Physics > Vol.10 No.12, December 2022 DOI: 10.4236/jamp. 2022.1012244
44. Model of expanding Universe, https://www. spacetelescope.org/images/opo0109g/.
45. Hubble Parameter, http://hyperphysics.phy-astr.gsu.edu/hbase/Astro/hubble.html.
46. Ethan Siegel (2018), If The Universe Is 13.8 Billion Years Old, How Can We See 46 Billion Light Years Away? https://medium.com/ starts-with-a-bang/if-the-universe-is-13-8-billi on-years-old-how-can-we-see-46-billion-light-years-away-db45212a1cd3
47. Ethan Siegel (2018), If The Universe Is 13.8 Billion Years Old, How Can We See 46 Billion Light Years Away? https://medium.com/ starts-with-a-bang/if-the-universe-is-13-8-billi on-years-old-how-can-we-see-46-billion-light-years-away-db45212a1cd3.

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Efficacy of Different Soil Amendments and Bio-Agents against *Fusarium Oxysporum* f. sp. *lentis in Vitro & in Vivo*

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ABSTRACT

Five organic amendments were evaluated against wilt of lentil which were found more or less effective. Maximum disease control (42.85%) found in neem cake followed by mustard cake (38.23%), parthenium (32.90%), linseed cake (28.57%) and sawdust was least in reducing wilt (23.66%) in 2016-17. Similar results were also observed in the year 2017-18.Inhibitory effect of bioagents was tested against Fusarium oxysporum f. sp. lentis in vitro. Maximum (65.94%) mycelial growth was inhibited by Pseudomonas fluorescens followed by Bacillus subtilis (62.23%), T. viride (39.62%)and T. virense (39.22%).T. harzianum was found least effective inhibition of mycelia growth (35.65%) in dual plate technique. All five bio-agents evaluated against F. o. f. sp. lentis in vitro were also tested in vivo conditions, where they also were found effective in wilt management. Maximum disease control (42.10%) was recorded with P. fluorescens@ 10 g/kg seed followed by Bacillus subtilis (38.27%) @ 10 g/kg seed, T. viride (32.70%) @ 4 g/kg seed and T. virens (32.80%) @ 4 g/kg seed . T. harzianum was least effective in reducing wilt incidence (30.40%) @ 4 g/kg seed in 2016-17. Similar results were also observed in the year 2017-18. Disease incidence was maximum at 90 days after sowing as compared to 60 and 30 days after sowing in both the years.

Keywords: isolation, disease incidence, percentage disease control and bio-agents.

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Keywords: isolation, disease incidence, percentage disease control and bio-agents.

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I. INTRODUCTION

Food legumes are well-known part of diets worldwide and play an important and diverse role in the farming systems. Lentil (*Lens culinaris Medikus*.) is most important pulse crop grown in India, which suffers economic losses due to wilt complex. Legumes are also known as cost effective and an ideal crops for reducing poverty, improving human health, nutrition, and enhancing ecosystem resilience(Akibode and Maredia 2011). Lentil is cultivated as a rain fed crop in all India about 1.34 million ha area with 1.02MT production and 759 kg/ha productivity (Abraham, 2015). In India lentil is predominantly grown in the North, particularly in Uttar Pradesh, Madhya Pradesh, Bihar and West Bengal. In Uttar Pradesh, it is grown in 620.000 lakh/ha area with 452.000lakh tones production and 732.0 kg/ha productivity (Ahmad, *et al.,* 2018). They are low in fat, low in sodium, cholesterol free, and are an excellent source of both soluble and insoluble fibre, complex carbohydrates and vitamins (Market Outlook Report, 2010). Fusarium wilt disease is a widespread in almost every country where lentil is grown (Dikshit *et al.,* 2016). Sometime, this disease can cause complete failure of the crop, especially in a warm spring and dry and hot summer. Fusarium wilt is severe on lentil mainly grown on residual moisture in the highlands dominated with vertisols. *Fusarium oxysporum f sp. lentis* is an important soil borne fungus with limited host range (Sharfuddin *et al.,* 2012). It produces three types of spores; oval or kidney shaped micro conidia; thin walled, multicellular (4-6 cells) macro conidia with a definite foot cell and a pointed apical cell, and chlamydospores formed singly in macro conidia, terminal or intercalary in the hyphae. In recent years, *Trichoderma* species have confirmed as effective biocontrol agents against Fusarium disease, caused by *Fusarium oxysporum* (Akrami *et al.,* 2011; Kashem *et al.,* 2016; Khaliquzzaman *et al.,* 2016). This wilt pathogen. This wilt pathogen survives in the soil as chlamydospores that can remain viable for several years (Erskine and Bayaa, 1996) and is capable of colonizing residues and roots of most crops grown in rotation with lentil. The incidence of the wilt disease is increasing, causing substantial lentil yield losses. Yield losses due to lentil wilt reported by various workers, 50- 78 per cent yield loss under natural conditions at Madhya Pradesh by Khare *et al.* (1979 a, b) and Agrawal *et al.* (1991), upto 50 per cent at Madhya Pradesh by Khare, (1980and 1991), 67 per cent wilt incidence reported by Vasudeva and Srinivasan (1952) at New Delhi, 25 to 50 per cent at Budelkhand region of Uttar Pradesh (Anonymous, 1999), 12 per cent at North west Syria (Bayaa *et al.,* 1986 and 1994), 13.2 per cent at South Syria (El-Ahmed and Mouselli., 1986 and 1987) and 70 per cent at Czechoslovakia (Bojdova and Siskny, 1990).

There is much said about the role of organic amendments in modification of physical, chemical and biological environment of soil through addition of decomposable organic matter. It improves the structure, texture, aeration and water holding capacity of soil and improves the development of root system. The biological environment also changes, due to intense microbial activities in the soil which is helpful for developing more antagonistic micro- organisms.

II. MATERIALS AND METHODS

2.1 Isolation of Fusarium oxysporum f.sp. lentis

Small pieces of infected root 1–2 mm dimension from the advancing margin of the spot, adjacent to healthy portions were cut with blade, washed well in distilled water to remove dust adhered to the infected pieces. Pieces were dipped in 0.1per cent mercuric chloride solution for 30 seconds and finally washed well in three changes of sterilized distilled water. The bits were then transferred to PDA medium in Petri plates with the help of inoculating needle under aseptic condition and incubated at 28 ± 10c. Pure culture was done by transfer of a pinch of mycelium on sterilized Potato Dextrose Agar medium in Petri plates and incubated in BOD.

2.2 Effect of different soil amendments in net house condition

Soil were collected and sterilized in autoclave, filled (3Kg /pot) in earthen pots separately. Neem cake (2.77 gm./kg soil), mustard cake(2.53 gm./kg soil), linseed oil cake(2.28 gm./kg soil), sawdust(1.64gm./kg soil) and *Parthenium* compost (5 gm./kg soil) were mixed individually in the sterilized soil filled pots, two weeks prior to sowing. Control pots were filled with soil without adding amendments. The seeds of wilt susceptible variety of lentil (L 9-12) were sown in each pot (15 seed per pot) where finally 10 plants will be maintained. The experiment was conducted in CRD with three replications. First appearance of disease, disease incidence and per cent disease control were observed 30 and 60 days after sowing. Per cent disease incidence and per cent disease control were calculated by using following formula.

$$\text{Percent diseaseincidence} = \frac{\text{Number of infected plants}}{\text{Total number of plants}} \text{ x } 100$$

$$\text{Percent diseae control} = \frac{C - T}{C} \text{ x}100$$

Where,

C = Per cent disease incidence of control pots

T = Per cent disease incidence in treated pots

Efficacy of different bio-agents against F. oxysporum f.sp. lentis in vitro

Table 1: List of bio-agents used for dual culture technique

S. No.	Name of bio-agents
1.	*Trichoderma viride*
2.	*Trichoderma harzianum*
3.	*Trichoderma virens*
4	*Bacillus subtilis*
5	*Pseudomonas fluorescens*

Five bio-agents were used *viz*., *Trichoderma viride*, *Trichoderma harzianum, Trichoderma virens, Bacillus subtilis* and *Pseudomonas fluorescens* which were obtained from the Department of Plant Pathology, NDUA&T, Kumarganj, Ayodhya (U.P.).The antagonistic potential of *Trichoderma virdae, Trichoderma harzianum Trichoderma virense, Bacillus subtilis*. and *Pseudomonas fluorescens* against *F. oxysporum* f. sp. *lentis* was assessed in dual culture technique. Measuring radial growth of the *F. oxysporum* f.sp. *lentis* as well as that of bio-agents. The mycelia disc of 3 mm diameter from the margin of 7 day old culture of bio-agents and *F. oxysporum* f.sp. *lentis* were placed on solid PDA in paired combination at distance of 2.5 cm from each other in three replications. Control set was made by inoculating

F. oxysporum f.sp. *lentis* singly on the medium. Dual Petri dishes were incubated at 28 °C in BOD incubator and the extent of interaction was observed by measuring area covered in dual culture and in the control at 4 and 7 days of incubation. The per cent inhibition of the interacting fungi was calculated as follows:

% inhibition of radial growth (PIRG) $=(R_1-R_2)/R_1 \times 100$
Where, R_1- radial growth of pathogen as control.
R_2-radial growth of pathogen in dual culture experiments with antagonists
(Sharfuddin and Chaudary, 2012).

Efficacy of different bio-agents against *Fusarium* wilt *in vivo*

Table-2: List of bio-agents used

Treatment	Name of bio-agents
1.	Seed treatment with *Trichoderma harzianum*@ 4 g/kg seed
2.	Seed treatment with *Trichoderma viride*@4 g/ kg seed
3.	Seed treatment with *Trichoderma virens* @4g /kg seed
4	Seed treatment with *Bacillus* subtilis @ 10 g/kg seed
5	Seed treatment with *Pseudomonas* fluoresens@10g /kg seed.
6	*Control*

Soil was collected and sterilized in autoclave, filled (3Kg/ pot) in earthen pots separately. Seed treated with bio-agents as per treatment mentioned above. Control pots were filled with soil without adding bio-agent. The seeds of susceptible variety of lentil (L 9-12) were sown in each pot (15 seed per pot) where finally 10 plants were maintained. The experiment was conducted in CRD with three replications. First appearance of disease, disease incidence and per cent disease control were observed 30 and 60 days after sowing. Per cent disease incidence and per cent disease control were calculated by using following formula.

$$\text{Percent diseaseincidence} = \frac{\text{Number of infected plants}}{\text{Total number of plants}} \text{ x } 100$$

$$\text{Percent diseae control} = \frac{C - T}{C} \text{ x}100$$

Where,

C = Per cent disease incidence of control pots

T = Per cent disease incidence in treated pots

III. RESULTS

3.1 Efficacy of different soil amendment on disease incidence

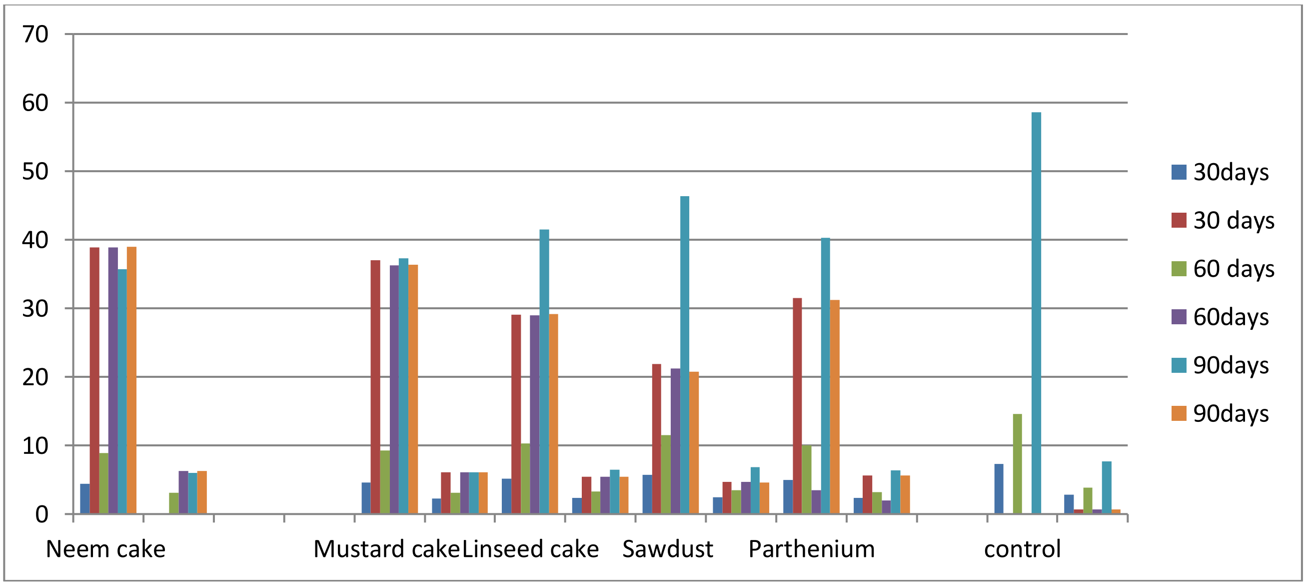
It is evident from the data that all five organic amendments tested reduced wilt incidence of lentil significantly over check and minimum disease incidence was recorded in Neem oil cake (31.71%) @ 2.77 gm./kg soil followed by mustard cake (34.29%)@ 2.53 gm./kg soil, parthenium compost (37.55%) @5 gm./kg soil, linseed cake (39.63%) @2.28 gm./kg soil and sawdust (42.33%) @1.64gm./kg soil and as compared to control (55.44%). Neem oil cake was found significantly superior over all other treatments except mustard cake after 90 days, maximum disease control (42.80%) was found in neem cake followed by mustard cake (38.14%), parthenium (32.81%), linseed cake (28.51%) and sawdust was least effective in reducing wilt (23.66%) in 2016- 17 (Table-3 and Fig. 1).

Table 3: Efficacy of organic amendment against *F. oxysporum* f. sp. *lentis* on disease incidence and per cent disease control *in vivo* at 30 days, 60 days and 90 days after sowing 2016-17

Treatment	Disease incidence	%Disease control	Disease incidence	% Disease control	Disease incidence	% Disease control
	30 days	30 days	60 days	60 days	90 days	90 days
Neem oil cake @ 2.77 gm/kg soil	3.96 (2.11)	42.85 (6.58)	7.92 (2.90)	42.85 (6.58)	31.71 (5.67)	42.80 (6.57)
Mustard cake @ 2.53 gm./kg soil	4.28 (2.18)	38.23 (6.21)	8.57 (3.01)	38.16 (6.21)	34.29 (5.89)	38.14 (6.21)
Linseed cake@2.28 gm./ kg soil	4.95 (2.33)	28.57 (5.39)	9.90 (3.22)	28.57 (5.38)	39.63 (6.33)	28.51 (5.38)
Sawdust @ 1.64 gm./ kg soil	5.29 (2.41)	23.66 (4.91)	10.58 (3.33)	23.66 (4.91)	42.33 (6.54)	23.64 (4.91)

Parthenium@5 gm./kg soil	4.65 (2.27)	32.90 (5.77)	9.31 (3.13)	32.82 (5.77)	37.55 (6.14)	32.81 (5.76)
Control	6.93 (2.72)	0.00 (0.71)	13.86 (3.78)	0.00 (0.71)	55.44 (7.47)	0.00 (0.071)
SEM±	0.069	0.179	0.101	0.166	0.210	0.179
CD (0.05%)	0.211	0.552	0.312	0.510	0.646	0.553
CV	5.084	6.295	5.426	5.821	5.728	6.313

* Figure in parenthesis is root transformed value



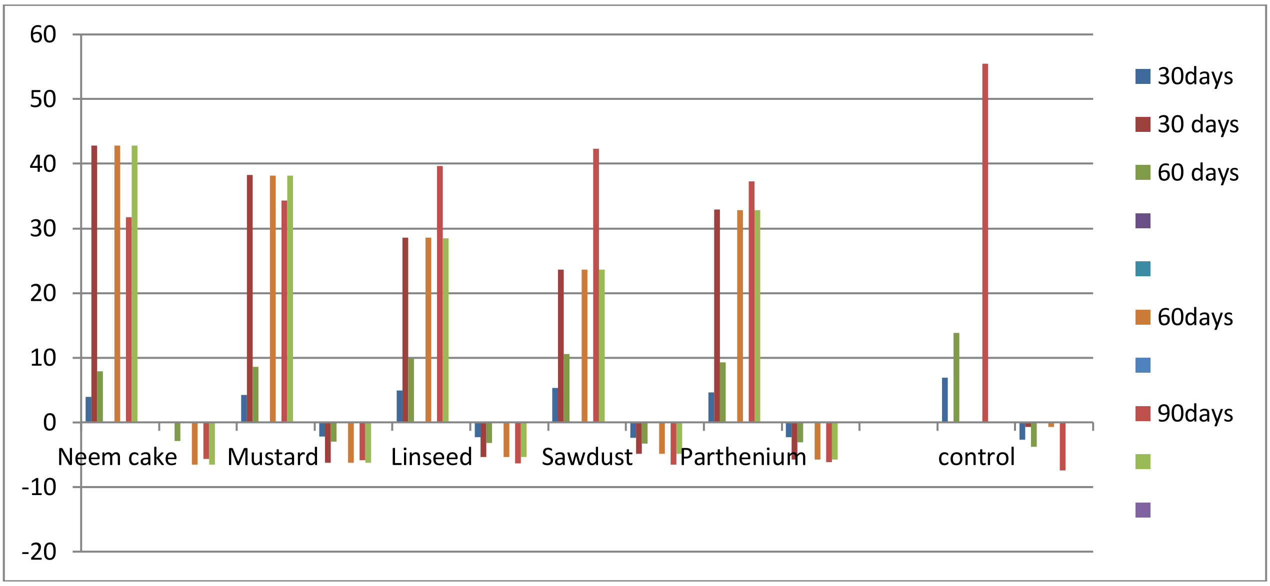
Similar results were also observed in the year 2017-18, Neem oil cake was found significantly superior over all other treatments. Minimum disease incidence was recorded in Neem cake (35.71%) followed by mustard cake (37.26%) parthenium compost (40.25%), linseed cake (41.48%) and sawdust (46.38%) as compared to control (58.55%). Maximum disease control was obtained in neem cake (39.00%) followed by mustard cake(36.36%), parthenium (31.25%) and linseed cake (29.15%). sawdust was least effective in reducing wilt (20.78 %) (Table 4 and Fig. 2).

Table 4: Efficacy of organic amendment against *F. oxysporum* f. sp. *lentis* on disease incidence and per cent disease control *in vivo* at 30 days, 60 days and 90 days after sowing 2017-18

Treatment	Disease incidence	%Disease control	Disease incidence	%Disease control	Disease incidence	%Disease control
	30 days	30 days	60 days	60 days	90 days	90 days
Neemcake@ 2.77 gm/kg soil	4.46 (2.23)	38.90 (6.27)	8.92 (3.06)	38.90 (6.27)	35.71 (6.01)	39.00 (6.28)
Mustardcake@ 2.53 gm./ kg soil	4.60 (2.26)	36.98 (6.12)	9.31 (3.13)	36.23 (6.06)	37.26 (6.14)	36.36 (6.07)
Linseed cake @2.28 gm./ kg soil	5.18 (2.38)	29.04 (5.43)	10.31 (3.29)	28.97 (5.43)	41.48 (6.47)	29.15 (5.44)

Sawdust @ 1.64 gm./ kg soil	5.70 (2.49)	21.91 (4.73)	11.50 (3.46)	21.23 (4.66)	46.38 (6.84)	20.78 (4.61)
Parthenium@5 gm./kg soil	5.00 (2.34)	31.50 (5.65)	10.00 (3.24)	3.50 (2.00)	40.25 (6.38)	31.25 (5.63)
Control	7.30 (2.79)	0.00 (0.71)	14.60 (3.88)	0.00 (0.71)	58.55 (7.67)	0.00 (0.71)
SEM±	0.074	0.158	0.107	0.147	0.219	0.157
CD	0.229	0.485	0.331	0.452	0.674	0.482
CV	5.333	5.663	5.562	6.074	5.752	5.662

* Figure in parenthesis is root transformed value



Disease incidence was maximum at 90 days after sowing as compared to 60 and 30 days after sowing in both the years (Plate 1).

Plate 1: Efficacy of soil treatment with various organic amendments on wilt of lentil

3.2 Efficacy of different bio-agents against F. oxysporum f. sp. lentis in vitro

Effect of bioagents was tested against inhibition of mycelial growth of *Fusarium oxysporum* f. sp. *Lentis*. Maximum(65.94%) mycelial growth was inhibited by *Pseudomonas fluorescens* followed by *Bacillus subtilis* (62.23%), *T. viride* (39.62%) and *T. virens* (39.22%). *T. harzianum* was found least effective in inhibiting mycelia growth (35.65%) in dual plate technique. (Table5, Fig. 3 and Plate 2).

Table 5: Efficacy of bio-agents against *F. oxysporum* f. sp. *lentis* on radial growth and growth inhibition using dual culture technique after 7 days incubation

Fungal antagonist	Inhibition (%) in 7 days Mycelial growth (mm)
T harzianum	35.65 (32.08 mm)
T. viride	39.62 (35.65 mm)
T. virens	39.22 (35.29 mm)
P. fluorescens	65.94 (59.34 mm)
Bacillus subtilis	62.23 (56.00 mm)

3.3 Efficacy of different bio-agents against Fusarium wilt of lentil in vivo

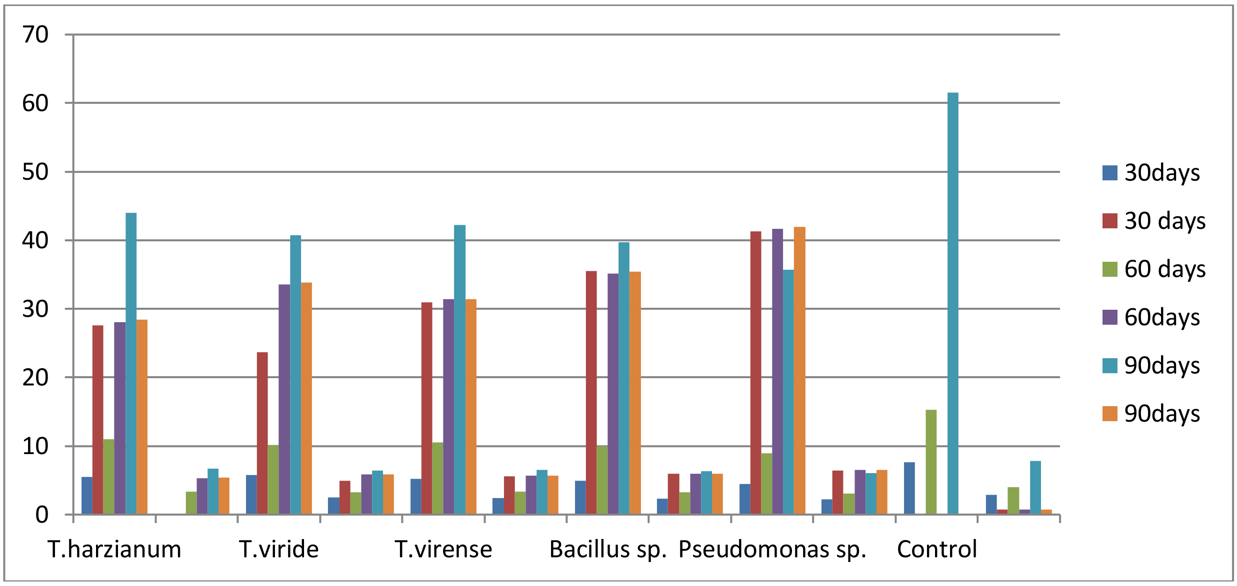
It is evident from the data (table-12) that seed treatment of all five bio-agents reduced wilt incidence of Fusarium wilt significantly over check. Minimum disease incidence (33.31%) was recorded with *Pseudomonas fluorescens* @ 10 g/kg seed , followed by *Bacillus subtilis* (35.50%) @ 10 g/kg seed, *T.vd* (38.70%) @ 4 g/kg seed, *T.vs.*(39.20%) @ 4 g/kg seed and *T.h.*-(40.10%) @ 4 g/kg seed, all bio-agents were significantly superior over control against Fusarium wilt. Maximum disease control (40.06%) was recorded with *Pseudomonas fluorescens* @ 10 g/kg seed followed by *Bacillus subtilis* (38.26%) @ 10 g/kg seed, *T. viride* (32.69%) @ 4 g/kg seed and *T. virens* (31.81%) @ 4 g/kg seed. *T. harzianum* was least effective in reducing wilt incidence (30.26%) @ 4 g/kg seed in 2016-17 (Fig. 3).

Table 5: Efficacy of bio-agents against *F. oxysporum* f. sp. *lentis* on disease incidence and disease reduction *in vivo* at 30 days 60 days and 90 days after sowing 2016-17.

Treatment	Disease incidence	% Disease control	Disease incidence	%Disease control	Disease incidence	% Disease control
	30 days	30 days	60 days	60 days	90 days	90 days
T. harzianum (T_1) @ 4 g/kg seed	5.00 (2.34)	29.57 (5.48)	10.00 (3.24)	30.40 (5.55)	40.10 (6.36)	30.26 (5.54)
T. viride (T_2) @ 4 g/kg seed	4.80 (2.30)	32.39 (5.73)	9.67 (3.19)	32.70 (5.76)	38.70 (6.25)	32.69 (5.75)
T.virens(T3) @ 4 g/kg seed	4.90 (2.32)	30.98 (5.61)	9.80 (3.20)	32.80(5.76)	39.20 (6.30)	31.82 (5.68)

Bacillus Subtilis (T4)@ 10 g/kg seed	4.40 (2.21)	38.02 (6.20)	8.87 (3.06)	38.27 (6.22)	35.50 (6.00)	38.26 (6.22)
Pseudomonas fluorescens (T5)@ 10 g/kg seed	4.16 (2.16)	41.40 (6.46)	8.32 (2.97)	42.10 (6.52)	33.31 (5.81)	40.06 (6.36)
Control	7.10 (2.75)	0.00 (0.71)	14.37 (3.85)	0.00 (0.71)	57.50 (7.61)	0.00 (0.71)
SEM±	0.072	0.176	0.103	0.165	0.214	0.176
CD(>0.05)	0.223	0.542	0.319	0.508	0.661	0.543
CV	5.343	6.055	5.511	5.608	5.815	6.055

* Figure in parenthesis is root transformed value

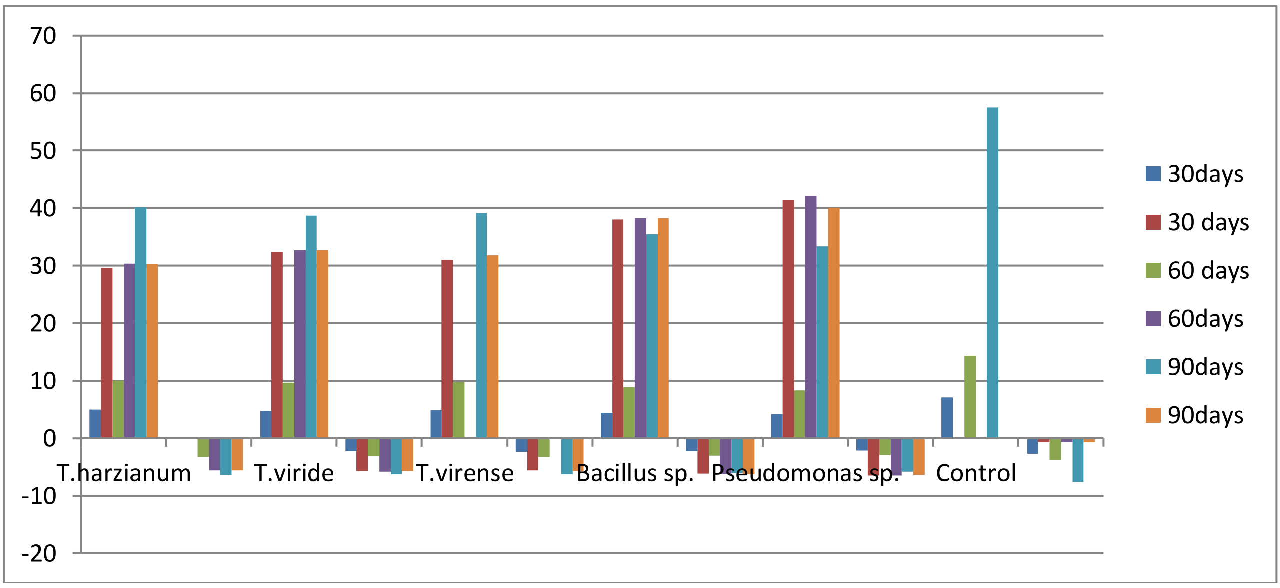


Similar results were also observed in the year 2017-18. Minimum disease incidence was recorded in *Pseudomonas fluorescens* (35.70%) @ 10 g/kg seed followed by *Bacillus subtilis* (39.70%) @ 4g /kg seed, *T. viride* (40.70%) 4g /kg seed, *T. virens* (42.20%) @ 4g /kg seed and *T. harzianum* (44%) @ 4g/kg seed as compare to control (61.50%). Maximum disease control (41.95%) was found in *Pseudomonas fluorescens* followed by *Bacillus subtilis* (35.44%), *T. viride* (33.82%) and *T. virens* (31.38%). *T. harzianum* was least effective in reducing wilt incidence (28.45%) (Table 6) (Plate 2 and Fig. 4).

Table 6: Efficacy of bio-agents against *F. oxysporum* f. sp. *lentis* on disease incidence and disease reduction *in vivo* at 30 days 60 days and 90 days after sowing 2017-18

Treatment	Disease incidence	%Disease control	Disease incidence	%Disease control	Disease incidence	%Disease control
	30 days	30 days	60 days	60 days	90 days	90 days
T. harzianum (T_1) @ 4 g/kg seed	5.50 (2.45)	27.63 (5.30)	11.00 (3.39)	28.10 (5.34)	44.00 (6.67)	28.45 (5.38)
T. viride (T2) @ 4 g/kg seed	5.80 (2.51)	23.68 (4.91)	10.17 (3.26)	33.52 (5.83)	40.70 (6.42)	33.82 (5.86)
T. virens (T3) @ 4 g/kg seed	5.25 (2.40)	30.92 (5.60)	10.50 (3.32)	31.37 (5.64)	42.20 (6.53)	31.38 (5.64)
Bacillus subtilis	4.90	35.52	9.92	35.16	39.70	35.44
(T4) @ 10 g/kg seed	(2.32)	(5.99)	(3.22)	(5.96)	(6.33)	(5.99)
Pseudomonas fluorescens (T5) @ 10 g/kg seed	4.46 (2.22)	41.31 (6.46)	8.92 (3.07)	41.64 (6.48)	35.70 (6.01)	41.95 (6.51)
Control	7.60 (2.84)	0.00 (0.71)	15.30 (3.97)	0.00 (0.71)	61.50 (7.86)	0.00 (0.71)
SEM±	0.074	0.167	0.108	0.173	0.218	0.171
CD(>0.05)	0.229	0.515	0.333	0.534	0.671	0.526
CV	5.243	5.997	5.561	6.008	5.686	5.896

* Figure in parenthesis is root transformed value



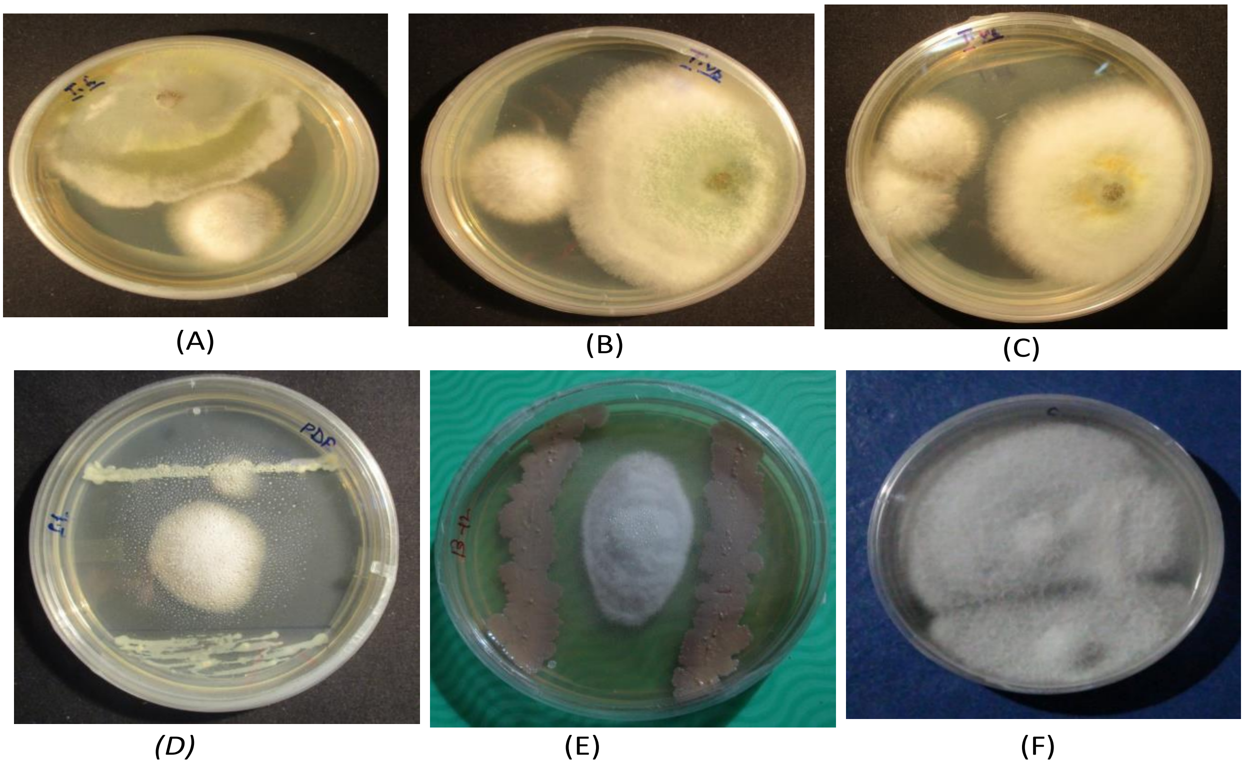


Plate 2: Inhibition of mycelial growth of *F. oxysporum* f. sp. *lentis* by different bio-agent on dual plate assay (a) *T. harzianum (*b) *T. virens* © *T. viride* (d) *Pseudomonas fluorescens*(e) *B. subtilis* (f) *F. oxysporum* f. sp. *lentis* (control)

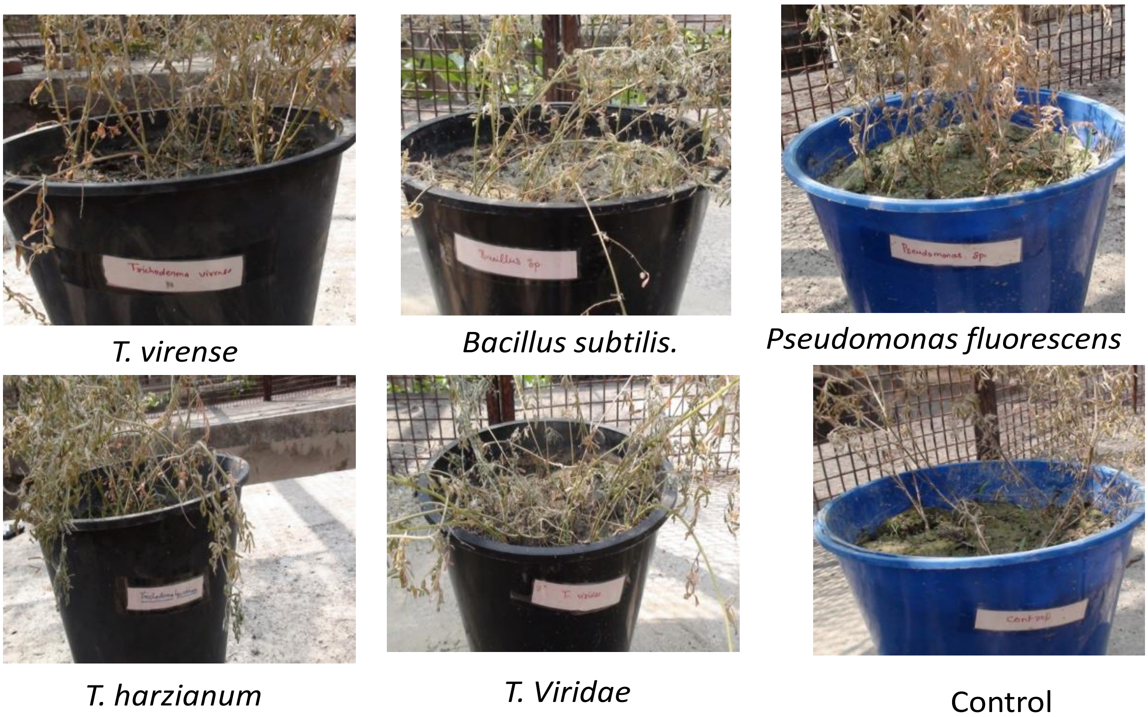


Plate 2: Effect of Antagonists on wilt disease

Disease incidence was maximum at 90 days after sowing as compared to 60 and 30 days after sowing in both the years.

IV. DISCUSSION

4.1 Efficacy of different soil amendments on disease incidence

Five organic amendments were evaluated against wilt of lentil which were found more or less effective. Minimum disease incidence was recorded in neem oil cake (31.71%) @ 2.77 gm./kg soil followed by mustard cake (34.29%)@ 2.53 gm./kg soil, Parthenium compost (37.55%) @5 gm./kg soil, linseed cake (39.63%) @2.28 gm./kg soil and sawdust (42.33%) @1.64gm./kg soil and as compared to control (55.44%). Neem oil cake has found significantly superior over all other treatments except mustard at 90 days. Maximum disease control (42.85%) found in neem cake followed by mustard cake (38.23%), parthenium (32.90%), linseed cake (28.57%) and sawdust was least effective in reducing wilt control (23.66%) in 2016- 17.

4.2 Efficacy of different bio-agents against Fusarium oxysporum f. sp. lentis in vitro and in vivo

Inhibitory effect of bioagents were tested against *Fusarium oxysporum* f. sp. *lentis in vitro*. Maximum(65.94%) mycelial growth was inhibited by *Pseudomonas fluorescens* followed by *Bacillus subtilis* (62.23%), *T. viride* (39.62%)and *T. virens* (39.22%).*T. harzianum* was found least effective in the inhibition of mycelia growth (35.65%) in dual plate technique.

All five bio-agents evaluated against *F. oxysporum* f. sp. *lentis in vitro* were also tested *in vivo* conditions, where they were also effective in wilt management. Minimum disease incidence (33.31%) was recorded with *Pseudomonas fluorescens* @ 10 g/kg seed , followed by *Bacillus subtilis* (35.50%) @ 10 g/kg seed, *T. viride* (38.70%) @ 4 g/kg seed, *T. virens* 39.20%) @ 4 g/kg seed and *T. harzianum* (40.10%) @ 4 g/kg seed, all bio-agents are significantly superior over control against Fusarium wilt. Maximum disease control (42.10%)was recorded with *Pseudomonas fluorescens* @ 10 g/kg seed followed by *Bacillus* (38.27%) @ 10 g/kg seed , *T. viride* (32.70%) @ 4 g/kg seed and *T. virens* (32.80%) @ 4 g/kg seed . *T. harzianum* was least effective in reducing wilt incidence (30.40%) @ 4 g/kg seed in 2016-17. Similar results were also observed in the year 2017-18. Disease incidence was maximum at 90 days after sowing as compared to 60 and 30 days after sowing in both the years.

V. CONCLUSIONS

Five organic amendments were evaluated against wilt of lentil which were found more or less effective. Maximum disease control (42.85%) found in neem cake followed by mustard cake (38.23%), parthenium (32.90%), linseed cake (28.57%) and sawdust was least effective in reducing wilt control (23.66%) in 2016- 17.

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Conflict of Interest

The authors declare that they have no conflict of interest.

REFERENCES

1. Abraham, R. (2015). Lentil (*Lens Culinaris Medikus*) Current Status and Future Prospect of Production in Ethiopia. Adv. Plants Agric Res2 (2): 00040.
2. Agarwal, S. C., Singh, K. and Lal, S. S. (1993). Plant protection of lentils in India. In: Erskin, W. and Saxena, M. C. (eds). pp. 147-165.
3. Anonymous (2014-15). Project Coordinator's Report (Rabi). All India Coordinated Research Project on MULLARP. IIPR, Kanpur. 1. 19-22 pp.
4. Bayaa, B., Erskine W, (1994). Diseases of lentils. In: The Pathology of Food and Pasture Legumes (pp. 423-471).
5. Bayaa, B., Erskine, W. and Khoury, L. (1986). Survey of wilt damage on lentils in north "vest Syria. Arab J. Pl, Protec. 4(2): 118-119.
6. Bojdova, J. and Sinsky, T. (1990). Species spectrum of the Fusarium genus on lentil in Czechoslovakia. LENS Newsletter 17(2): 29-31
7. EI-Ahmad, M. and Mouselli, N. (1986). Lentil wilt in south Syria. Arab J. PI. Pro tee. 4(1): 30.
8. EI-Ahmad, M. and Mouselli, N. (1987a). Wilt and root rot of lentil (Lens culinaris). LENS Newsletter, 14: 10-14.
9. EI-Ahmad, M. and Mouselli, N. (1987b). Wilt and root rot of lentil LENS Newsletter, 14(1-2): 31-37.
10. Khare, M. N. (1980). Wilt of lentil. Technical Bulletin. Jabalpur, India: Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, M.P. India, 155.
11. Khare, M. N. (1991) . Lentil diseases variety spedal reference to seed quality. Indian J. Mycol. Pl. Patho1. 21 (I): 1-13.
12. Khare, M.N., Agrawal, S.C. and Jain, A.C. (1979 a). Diseases of lentil. Indian Phytopathol .. 21: 455
13. Khushboo Dubey, S.K. Singh, (2018). Efficacy of different soil amendments on disease incidence wilt of lentil. International Journal of Chemical Studies 2018; 6 (5): 72-74
14. Khushboo Dubey, S.K. Singh, (2021). Efficacy of different bio-agents against Fusarium oxysporum f. sp. lentis in vitro and in vivo condition. Journal of Agricultural Science & Engineering Innovation (JASEI) U.S. ISSN 2694 -4812 Vol. 2, No. 1, 2021.
15. Khushboo Dubey, S.K. Singh, (2021). Integrated Disease Management wilt of lentil caused by Fusarium oxysporum F. Sp. Lentis. Int. J. Sci. Res. in Biological Sciences. 8, (2) pp.41-48.
16. Sharfuddin, C. and Mohanka, R. (2012). In vitro antagonism of indigenous Trichoderma isolates against phytopathogen causing wilt of Lentil. Int J L Sci. Phar. Res.. 2: 195-202.
17. Vasudeva, R.S. and Srinivasan, K.V. (1952). Studies on the wiltdisease of lentil (Lens esculenta Moench). IndianPhytopath. 5(1): 23-32

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ABSTRACT

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The work was oriented to analyze the behavior through simulation processes of urban environmental pollution in rest areas caused by non-ionizing electromagnetic waves produced by wireless technologies. The mixed methodology and the hypothetical-deductive approach allowed structuring the research process in four phases of documentation, practice, processing and simulation model. The sampling and data collection in the sites defined in terms of electric and magnetic field strength, power density and exposure time made it possible to determine that the polluting effects analyzed are closely linked to the type and number of emission sources, distance to the sources, spatial location and construction materials, as aspects that, alt[hough not under the direct control of human beings, can be reduced by means of the adequate use of wireless technology devices and the correct definition of construction materials.

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I. INTRODUCTION

Since its beginnings, mankind has had the enormous need to communicate, interrelate and transmit knowledge, that is, to provide information and reproduce it from one to another; starting from primitive phonemes, cave paintings or writings on stone, thanks to creativity and its systematic application in innovation processes, significant progress has been made in scientific development (Espitia et al., 2021), so that technological innovation has become an essential component of human nature that can provide welfare conditions (Castellanos et al., 2019).

Urban environments increasingly welcome technological developments that help the planning process and improve the quality of life of human beings, and advances in global positioning systems for development (Puentes et al., 2019), the use of artificial intelligence and automatic learning to improve security and defense parameters (Gutiérrez-Portela et al., 2021), support for military forces (Espitia et al., 2021) and even their application to general (Paredes-Chacín et al., 2020) and specific educational processes (Cuevas and Díaz, 2020), are proof of this.

Nowadays, all information is available to anyone in just a few hundredths of a second with the click of a button or the touch of a touch screen, all thanks to what is called "connectivity". However, despite the rapid technological development, connectivity was difficult to achieve, as urban communities and cities were immersed in a sea of antennas and equipment that, due to their novelty and indiscriminate location, visibly affected the urban landscape.

Over the years, and gradually, the equipment that allows connectivity became part of the urban landscape, in addition to having the advantage of not requiring extensive cabling or fixed points of

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support in each street, and considering that the attention has been mostly focused on how the concentration of industrial processes negatively affects human health (Zafra- Mejía et al., 2020) and (Eslava-Pedraza et al., 2021), without addressing in detail the impact of connectivity on environmental pollution caused by connectivity.

Wireless technologies, specifically cellular telephony as a product, once its functionality was proven, was made available to the general population, being the pioneers in the Nordic countries despite its high costs at the beginning. The phenomenon of having a communication device without any type of wired connection, portable, similar in use to conventional telephone sets, soon became a success; but it did not stop there, parallel and almost as members of a single gestation, cellular telephony eventually expanded its services and included in its platform the use of another prodigious technological advance such as the Internet. A successful merger was born from that moment and turned the cellular equipment into a multi-equipment that serves as musical equipment, recorder, camera, television, tablet, alarm clock, telephone and remote control, because today through applications and internet connection any user can control the TV, air conditioner or refrigerator among others at long distance.

International organizations and governments were not oblivious to the charm of the services offered by cellular telephony and the Internet, and soon began massification programs reaching the point that today and according to statistics there are more cellular devices in use than people on the planet (UIT, 2016) hey would also be inserted into the economy and would create their own space, hence today we hear in the jargon of finance terms such as "digital economy", "e-commerce", "online store" or "virtual shopping" among others (CEPAL, 2013).

In everyday life, more and more people are dependent on connectivity and therefore on technology that generates non-ionizing electromagnetic waves. Some devices that generate electromagnetic waves are acquired voluntarily and others are assigned and provided by service companies for a better operation of their networks and products. Therefore, the proliferation of electromagnetic wave generating devices is evident and the increase of environmental pollution by these are increasing in the environment.

Studies of environmental contamination by electromagnetic waves have usually focused on studying, analyzing, measuring and issuing recommendations regarding exposure limits to high voltage lines, radio communication stations and recently cell phone base stations (Recommendations to limit exposure to electric, magnetic and electromagnetic fields (up to 300 GHz) (ICNIRP, 1998), but very little interest has been shown in establishing specific recommendations for exposure limits to non-ionizing electromagnetic waves produced by wireless technologies such as those emitted by cellular telephony or Internet or WIFI equipment. Epidemiological scientific studies that normally study the possible effects of the waves produced by cell phone equipment use as a dosimetric magnitude the Specific Absorption Rate (SAR) which is defined as the ratio of energy absorbed over time per unit mass of exposed body tissue (Quintana and Sepúlveda, 2013) or in simpler terms studies the thermal effect of the waves produced by cell phone equipment in the head and more specifically in the human brain, However, over time scientists have asked whether the aforementioned waves not only produce a thermal effect, but whether they can affect the human body without the need for an immediate physical response, which has led to study the possible relationship between the physics of non-ionizing waves and their biological effect on the human being.

Unfortunately, the systems work with only one measurement parameter such as Electric Field Strength (V/m), leaving aside the other three parameters such as Magnetic Field Strength (A/m), Magnetic Flux Density (μT) and Power Density (W/M2).

The massive presence of electromagnetic radiation emission sources has generated a type of almost imperceptible and immaterial pollution called "electromagnetic pollution" or "electropollution" (Gallego Serna, 2011). Electromagnetic pollution (term recognized by the WHO in 1981) is caused by the emission of electromagnetic radiation originated by electrical and electronic devices (Méndez, 2008) and has the characteristic of propagating in a vacuum, presenting three phenomena when it collides with an object: being transmitted through the object, being reflected or being absorbed.

Scientific communities, research groups and ordinary people are increasingly raising questions about the possible risks resulting from continuous and massive exposure to non-ionizing electromagnetic waves, to such an extent that the World Health Organization (WHO) through the International Agency for Research on Cancer (IARC) has categorized radiofrequency electromagnetic fields as group 2B, defined as "possibly carcinogenic to humans" (IARC, 2013). Unfortunately, the results of the different studies have been varied and contradictory, which has led political communities such as the European Union to take regulatory measures, while many nations are only governed by international regulations or, as in the case of Colombia, only have regulations to regulate the ICT sector and the use of the radioelectric spectrum (Congreso de la República de Colombia, 2019) and (ANE, 2020), but from an approach that is subject to international determinations, which are considered permissive due to the low restriction values they handle.

Electromagnetic waves have three propagation mechanisms: reflection, diffraction and scattering. Reflection occurs when an electromagnetic wave hits a surface of much larger dimensions than the wavelength of the signal and whose properties are different from the previous medium.

Diffraction occurs when the path of the wave is obstructed by objects that have sharp corners and edges; when the wave hits the object, secondary waves are produced that are assumed as new wave fronts propagating even in the space behind the object. The naturalization of diffraction at high frequencies depends on the geometry of the obstacle, amplitude, phase and polarization of the wave.

The scattering mechanism occurs when the wave is obstructed by objects whose dimensions are much smaller than the wavelength, or when there is a high number of objects per unit volume in the propagation medium. It can also occur due to rough surfaces or irregularities in the communication channel. Objects such as lamps, poles, trees, furniture cause dispersion producing either increase or decrease of the signal (Castellanos y Talero, 2005).

Indoor propagation is that which occurs in an enclosed environment. In general, it is affected by the same mechanisms of outdoor propagation, although much more marked. In indoor environments, the distances are short, predominantly multipath propagation and there is a greater susceptibility to variations caused by doors, windows, furniture, people, among others (Castellanos y Talero, 2005).

Multipath propagation in wireless communications often means that there is no line of sight between the transmitter and the receiver, so the transmitted signal must follow indirect paths.

When multiple signals arrive at the receiver through different paths in an indoor environment, two types of interference can occur: constructive interference and destructive interference. Constructive interference occurs when the vector sum of the signals produces an increase in the amplitude of the received signal. Destructive interference occurs when the vector sum of the signals produces a decrease in the received signal at the receiver.

Another phenomenon that occurs when handling multipath propagation is fading, which occurs when the receiving antenna does not pick up a single clean signal, receiving multiple replicas that upon reaching the antenna give a resulting signal that may have a different value in amplitude and phase, depending on the intensity and relative propagation time of the waves and the bandwidth of the transmitted signal.

Indoor propagation in the framework of this study corresponds to wifi routers and mobile cellular telephony equipment.

II. METHODOLOGY

The mixed methodological approach (Hernández Sampieri, 2014) is represented in the harmonious combination of quantitative and qualitative aspects; in addition, the hypothetical deductive approach that permeates most of the research process is complemented with an inductive approach represented in the possibility of applying the results obtained in multiple and varied contexts. The methodology employed allowed the research to be structured in four phases: documentation, practice, processing and, finally, simulation model.

III. RESULTS

3.1 Documentation

This phase consisted of a search for similar studies and research projects in international, national and regional organizations and institutions.

The first studies on the health effects of Non-Ionizing Electromagnetic Radiation (NIR) began in the 1960s (Méndez et al., 2008), by means of which it was verified that some physiological responses resulting from radiation could be beneficial, as in physiotherapy, or, in other cases, harmful to health; But it was not until 1992 in Montreal (Canada), during the Eighth International Congress of the International Radiation Protection Association (IRPA), that a new independent scientific organization was established, the International Commission for Non-Ionizing Radiation Protection (ICNIRP), whose functions are to investigate the hazards that may be associated with different forms of NIR, to develop international recommendations on exposure limits for NIR, and to address all aspects of NIR protection against known adverse health effects (Hernández et al., 2008).

The international scientific community debates year after year in different scenarios, what would be the levels and conditions of radiation that can be considered as innocuous, but so far there is no definitive final conclusion. For this reason, the WHO recommends the adoption of preventive measures on this issue, which is why several countries have adopted laws and guidelines on NIR and preventive health. Thus, countries such as Austria and Switzerland have NIR laws that contemplate much lower irradiation levels than those recommended by the ICNIRP, since this commission does not take into account preventive measures for long-term radiation (Méndez et al., 2008).

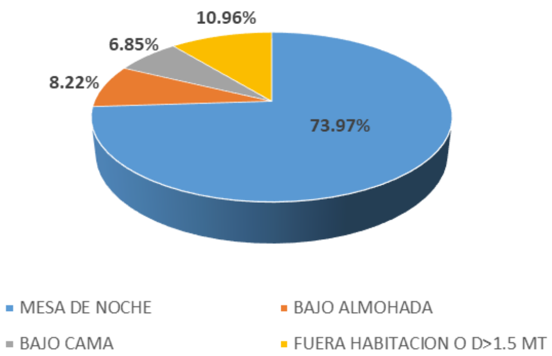
The concern about the dizzying growth of cellular and wifi equipment is not for less, since there are currently more cellular equipment subscribers than people on the planet, to the point that in countries or administrative regions such as Hong Kong 234 subscriptions/100 inhabitants, Bahrain 217 subscriptions/100 inhabitants, United Arab Emirates 204 subscriptions/100 inhabitants or in more representative countries in terms of demographics China 97 subscriptions/100 inhabi-tants, India 87 subscriptions/100 inhabi- tants and United States 127 subscriptions/ 100 inhabitants among others (Banco Mundial, 2016).

The degree of inclusion of wireless technologies (Wi-Fi and mobile telephony) has reached such an extent that international organizations such as the Organization for Economic Cooperation and Development (OECD), the Economic Commission for Latin America and the Caribbean (ECLAC), the World Bank and the ITU, among others, have included ICT or Internet connectivity indicators in their economic studies (Isoglio, 2021), (Banco Mundial, 2010), (UIT, 2015) and (UIT, 2018), correlating them directly with the degree of development of nations and clearly visualizing the gap between developed and developing countries.

3.2 Practice

The procedural development of the research project is of a mixed nature, which allows the combination of quantitative aspects with qualitative tools for the collection and analysis of information, represented in measurements and surveys, respectively. In accordance with the project's frame of reference, previous results on the impact of wireless technologies in free spaces (Barrera Monsalve and J. Mosquera, Téllez, 2018) were taken into account to take measurements in living spaces (rooms) at night. Since the characteristics were so accurate, it was logical that the type of sampling was "non-random" since all the homeowners were not willing to allow the operator of the measuring equipment to enter.

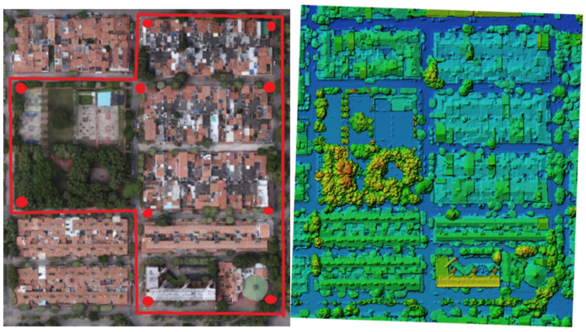
The first stage established in the qualitative method corresponded to a survey, which was carried out in the Los Pinos neighborhood of the city of Cúcuta, in order to find out where people placed the cell phone equipment while resting or sleeping at night. The survey was conducted with a population of 73 people, establishing as a result that 73.97% of people place the cell phone on the night table next to the bed, 8.22% under the pillow, 6.85% under the bed and only 10.96% leave the equipment more than 1.5 meters away from the bed or outside the room; that is, 89.04% of those surveyed leave the cell phone equipment less than 30 centimeters from their head. Additionally, it was established that none of the respondents have the wifi equipment in the room.



Source: (Barrera, 2018).

Figure 1: Location of cellular equipment during sleeping or resting hours.

The measurements taken in other similar outdoor projects show that the results are usually much lower than the values recommended by international organizations and national legislation, so the project was not a comparison of "recommended values" versus "indoor values", but rather "outdoor values versus "indoor values" of a single study area. The selected sector was the Los Pinos neighborhood in the city of Cúcuta, because it is a densely populated area, it is a residential neighborhood, its topography is flat, the housing has a typical design and most of them have not suffered alterations in their distribution and materials, the date of construction is similar and it has a cell phone base station of a service operator within the study area, This allows us to provide more information about electromagnetic wave pollution from wireless technologies identified in the home, such as cellular telephony, wifi broadband equipment and waves coming from other services with similar characteristics but outdoors. Additionally, points were taken in areas of urban extension of the city. It should be noted that the measurement was of immission due to the contribution of all radiofrequency sources whose fields are present in the place at a height of 1.50 meters.



Source: (Barrera, 2018)

Figure 2: Aerial delimitation photograph (a) and altimetry photograph of Los Pinos neighborhood, Cúcuta (b).

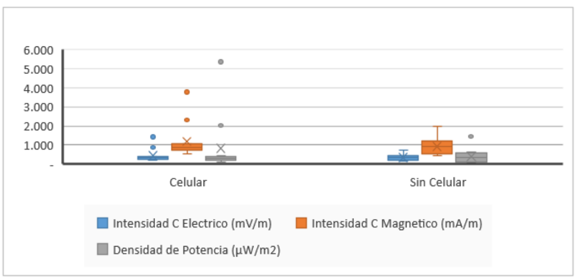
The next stage of the project consisted of taking measurements corresponding to Electric Field Strength (V/m), Magnetic Field Strength (A/m) and Power Density (W/m2) during a period of 6 minutes, using the RF intensity meter CEM EXTECH INSTRUMENTS Model 480846 frequency scale from 10 MHz to 8GHz. During the data collection process, all measurement points were georeferenced.

Source: (Barrera, 2018).

Figure 3: EMF RF intensity measuring equipment

3.3 Processing

The third phase corresponded to the processing of the information collected and in its development box and whisker diagrams were used to compare the three measured variables such as electric field strength (V/m), magnetic field strength (A/m) and power density (W/m2).

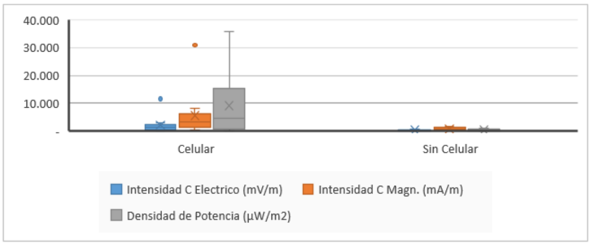


Source: (Barrera, 2018).

Figure 4: Electromagnetic Contamination Variation in Living Space in the Los Pinos Neighborhood Indoor Measurement

As can be seen in Figure 4, the measurements obtained at the sampling points in the Los Pinos neighborhood showed a decrease in electromagnetic wave contamination when cellular equipment was not included.

Figure 5 shows the results of the measurements taken in neighborhoods on the outskirts of the city of Cúcuta, which allowed us to identify the increase in electromagnetic wave contamination when cellular equipment was included.



Source: (Barrera, 2018)

Figure 5: Electromagnetic Contamination Variation in Habitable Space Neighborhoods periphery Indoor Measurement.

As can be seen, the graphs presented above show opposite behaviors, since the variables studied increase or decrease depending on the inclusion or not of cellular telephone equipment.

3.4 Simulation model

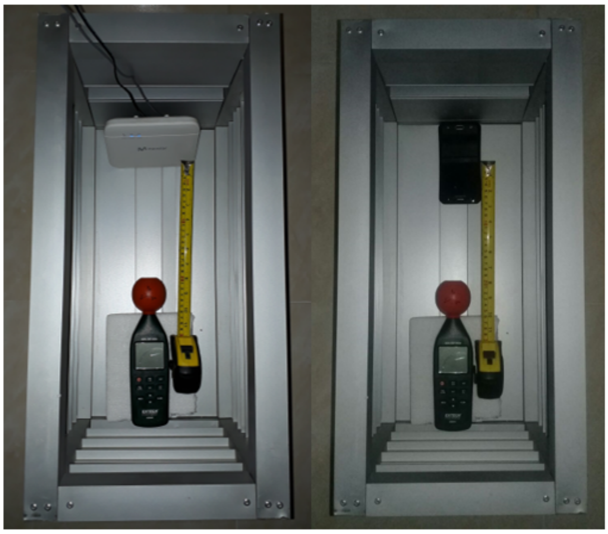
The fourth phase of the project corresponds to the design of a simulation model, which consisted of using boxes with a base of 0.30 x 0.60 centimeters and a height of 0.30 centimeters in 5 different materials. The dimensions of the boxes were established based on the information obtained in the survey, which showed that most people rest with the cell phone equipment at 30 centimeters or less from the head, a measure that was established as the width of the base; the longest measure of the base was established at 60 centimeters to allow locating inside the boxes both the EMF RF intensity measuring equipment and the emission sources, either the wifi equipment or the cell phone equipment.

The time determined for taking measurements is 6 minutes, which corresponds to the time worked during the previous stages of measurement and as established by the IUT-T K.61 recommendation and the Colombian legislation.

Source. (Barrera, 2018).

Figure 6: Photograph of simulation model boxes made of clay, metal, aluminum, melanin and icopor.

Measurements were taken without restriction and in each of the materials using two pieces of equipment. In the case of the cellular telephony equipment, the SAMSUNG J5 PRIME was used, which has average SAR values both in the manufacturing company and in the market (0.713 W/kg for the USA); the broadband or wifi equipment used was an Askey model RTV9015VW. As with the field measurements, these were performed indoors at one of the points that presented the least interference at night.

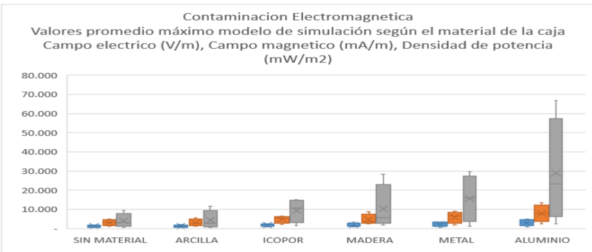


Source. Barrera, 2018).

Figure 7: Photograph of aluminum box with measuring equipment and a. Broadband or wifi equipment, b. Cellular telephone equipment. Broadband or wifi equipment, b. cellular telephony equipment.

3.5 Final results

The analysis of the study shows that environmental contamination by non-ionizing electromagnetic waves from wireless technologies is largely influenced by the construction materials used in the space and the distance to the source.



Source: (Barrera, 2018).

Figure 8: Electromagnetic Contamination Variation in Building Material Living Space. Indoor measurement.

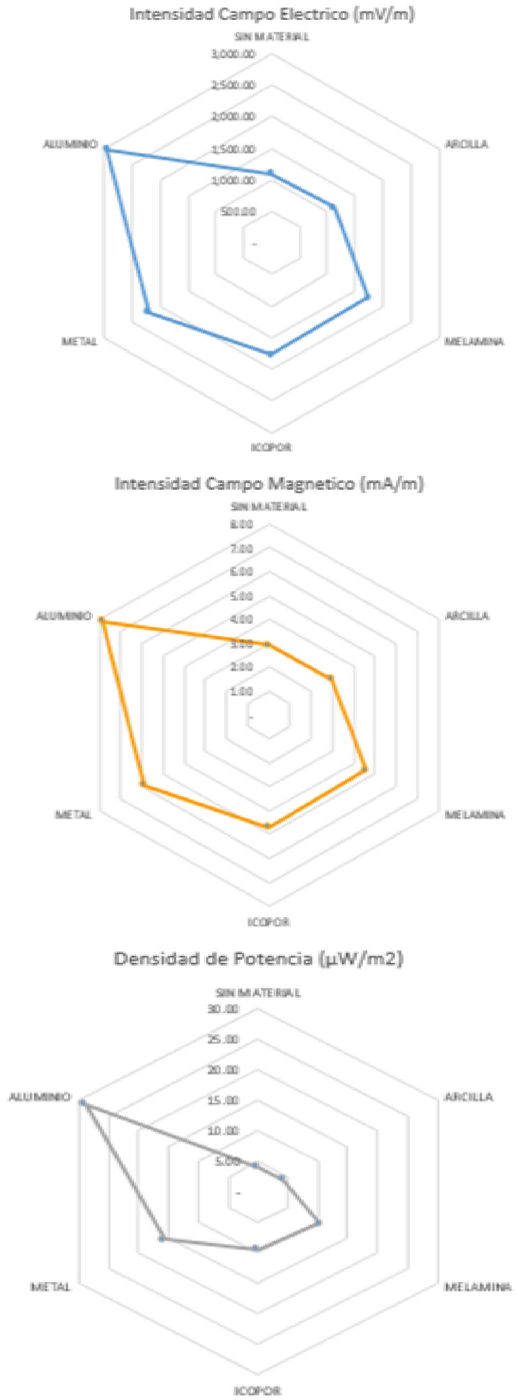
As shown in graph 8, when the space was confined, the values of electric field (V/m), magnetic field (mA/m) and power density (mW/m2) increased, the latter being the highest with the proposed simulation model. All the materials worked differently, the normal one being the one that reflects the behavior of the environmental contamination corresponding to "no material". The metal box (representing metal carpentry in the living space) works as a Faraday Cage protecting from the emitting source; the clay box (representing masonry in the living space) is shown as the second highest blocking to electromagnetic pollution and; finally, the icopor boxes (representing light construction in the living space) and the melanin (representing furniture and architectural finishes in melanin in the living space) show a higher percentage of affectation by electromagnetic pollution. Finally, the aluminum box (represents aluminum carpentry in the living space) worked as an antenna or an amplifier equipment of the waves and therefore of the electromagnetic pollution.

The results obtained for Electromagnetic Contamination, Variation in Living Space in the Los Pinos Indoor Measurement Neighborhood, shown in Figure 4, show the interference phenomenon that affects the results due to radiation resulting from the contribution of all the radiofrequency sources whose fields are present in the area. It is important to keep in mind that it is feasible to reduce EMF in homes through a series of precautionary measures as established by (Álvarez-Ovallos et al., 2014) and (Tomitsch and Dechant, 2015), but in the case of Los Pinos Indoor Measurement it is an interference phenomenon and not a space free of electromagnetic contamination by non-ionizing electromagnetic waves resulting from wireless technologies. The results obtained for Electromagnetic Contamination Variation in Habitable Space in Peripheral Neighborhoods Indoor Measurement can be considered normal because when the cell phone is less than 30 centimeters away from the RF EMF intensity measuring equipment, the contamination increases.

IV. DISCUSSION

The proposed simulation model presents the results corresponding to the six restriction media proposed, establishing that there are materials that amplify the value of the electromagnetic waves under study in a constant way for Electric Field (V/m), Magnetic Field (mA/m), and in some cases presenting exponential increases such as the case of Power Density (W/m2) in the scenario corresponding to Aluminum.

The scenario corresponding to the Aluminum box shows that there are materials that can amplify values of non-ionizing electromagnetic waves, thus presenting an increase in one of the Electromagnetic Contamination indicators.



Source: (Barrera, 2018)

Figure 9: Radial graph of maximum average values of the simulation model Electric field (mV/m), Magnetic field (mA/m), and Power density (µW/m2).

V. CONCLUSIONS

The estimation of environmental pollution by non-ionizing electromagnetic waves produced by wireless technologies in living spaces is closely linked to the type of emission sources, number of sources, distance to the sources, location of the space under study and construction materials that confine the site.

The discrimination of non-ionizing electromagnetic wave producing devices produced by wireless technologies in residential rest areas should be based on the source and type of non-ionizing electromagnetic wave generated. Indoor emission devices correspond to cellular telephony equipment (mobile broadband) and wifi equipment (fixed broadband).

The establishment of the magnitudes of the parameters of non-ionizing electromagnetic waves in living spaces of rest is linked to a series of variables that in most cases the inhabitant cannot establish or control, but through the implementation of the culture of the correct use of wireless technology devices and the correct architectural design and use of suitable materials of the living space either outdoor or indoor source through visual inspections, electromagnetic pollution can be reduced.

Environmental contamination by electromagnetic waves in indoor spaces varies significantly depending on the spatial configuration, architectural arrangement, construction materials used, type of source and distance of the subject to the source, with aluminum being the material with the highest amplification values and clay-based materials those with the lowest values and therefore the least contamination with indoor sources.

REFERENCES

1. A. A. Espitia, J A. Agudelo & T. Ramírez, T. Percepciones sobre innovaciones tecnológicas en el Ejército colombiano. Revista Logos Ciencia & Tecnología, vol. 13, no. 2, pp. 85-102, 2021. Doi: https://doi.org/10.22335/rlct.v13i2.1408
2. J. Castellanos, J. R. Carreño, y W. Hofacker, "Tecnología y bienestar," Rev. UIS Ing., vol. 18, no. 1, pp. 237-242, 2019. Doi: 10.18273/ revuin.v18n1-2019021
3. M. Puentes, D. Rueda, R. Ramos, C. Barrios, "Planificación de posicionamiento satelital multiconstelación en entornos urbanos," Rev. UIS Ing., vol. 18, no. 3, pp. 59-66, 2019. Doi: 10.18273/revuin.v18n3-201900
4. F. Gutiérrez-Portela, F. Almenárez-Mendoza, L. Calderón-Benavides, E. Romero-Riaño, "Security perspective of wireless sensor networks," Rev. UIS Ing., vol. 20, no. 3, pp. 189-202, 2021, Doi: 10.18273/revuin.v20n3-2021014
5. A. J. Paredes-Chacín, A. Inciarte Gonzáles, y D. Walles-Peñaloza. Educación superior e investigación en Latinoamérica transición al uso de tecnologías digitales por Covid-19. Revista de ciencias sociales, vol. 26, no. 3, pp. 98-117, 2020. Doi: https://doi.org/10.31876/rcs.v26i3.33236
6. A. Cuevas y J. Díaz. La historia de la matemática un factor imprescindible en la elaboración de una propuesta didáctica. El caso del concepto de función. El Cálculo y su Enseñanza, no. 5, pp. 165-179, 2014.
7. C. A. Zafra- Mejía, J. P. Rodríguez-Miranda & H. A. Rondón-Quintana. The relationship between atmospheric condition and human mortality associated with coarse particulate matter in Bogotá (Colombia). Revista Logos Ciencia & Tecnología, vol. 12, no. 3, pp. 57-68, 2020. Doi: https://doi.org/10.22335/rlct.v12i3.1237
8. J. E. Eslava-Pedraza, F. A. Martínez-Sarmiento, A. J., Soto-Vergel, E. J. Vera-Rozo, & D. Guevara-Ibarra. Generación de mapas de contaminación por material particulado mediante sistemas embebidos: caso de estudio en Cúcuta (Colombia). Revista Logos Ciencia & Tecnología, vol. 13, no. 3, pp. 86-97, 2021. Doi: https://doi.org/10.22335/ rlct.v13i3.1433
9. Unión internacional de telecomunicaciones (UIT). 2016. www.itu.int/es/mediacentre/Pages/2016-PR30.aspx.
10. CEPAL. Economía digital para el cambio estructural y la igualdad. Comisión Económica para América Latina y el Caribe, 16 p., 2013.
11. Comisión Internacional para la Protección Contra la Radiaciones No Ionizantes (ICNIRP). Recomendaciones para limitar la exposición a campos eléctricos, magnéticos y electromagnéticos (hasta 300 GHz). 28 p., 1998.
12. A. Quintana y O. Sepúlveda. Niveles de radiación de campo electromagnético presentes

en las antenas WIFI Omnidireccionales. 40, 2013.
13. L. M. Gallego Serna. Lineamientos para le gestión del riesgo de las áreas urbanas expuestas a las radiaciones electromagnéticas emitidas por las estaciones base de telefonía móvil estudio de caso: Municipio de Cartago Valle. 17 p., 2011.
14. Agencia Internacional para la Investigación sobre el Cáncer (IARC). Monografías sobre la evaluación de los riesgos carcinogénicos para humanos, 112, 2013.
15. Ley 1978 de 2019. Por la cual se moderniza el Sector de las Tecnologías de la Información y las Comunicaciones - TIC, se distribuyen competencias, se crea un Regulador Único y se dictan otras disposiciones. Congreso de la República de Colombia. https://www.funcionpublica.gov.co/eva/gestornormativo/norma.php?i=98210
16. Resolución 000134 de 2020. Por la cual se reglamenta el artículo 35 de la Ley 1978 de 2019. Agencia Nacional del espectro (ANE). 4 p., 2020.
17. E. Castellanos Díaz, y J. B. Talero Niño. Análisis de propagación electromagnética en espacios cerrados: Herramienta software en Matlab para predicción y simulación. 17-71, 2005.
18. R. Hernández Sampieri. Metodología de la investigación. Sexta Edición. Editorial Mc Graw Hill Education. 540 p., 2014.
19. N. R. Méndez, R. M. Méndez, y G. Cobiça. Contaminación Electromagnética Salud e Internet. Rio de Janeiro: Instituto Nacional de Metrologia, Normalização e Qualidade Industrial (INMETRO), 2, 2008.
20. L. J. Hernández, F. Quiroga, K. Medina y L. M. Guerrero. Proyecto Ondas Electromagnéticas. Hospital Fontibón Empresa Social del Estado, 6 p., 2008.
21. Banco Mundial. SIR-AFI. DataBank. 2016. https://datos.bancomundial.org/indicator/IT.NET.BBND.P2?end=2016&start=2016&view=map.
22. A. Isoglio. La economía basada en el conocimiento: discusiones conceptuales sobre los cambios ocurridos a escala global desde la década de 1970. investigación & desarrollo, vol. 29, no. 2, pp. 169-195, 2021. Doi: https://dx.doi.org/10. 14482/indes.29.2.330
23. Banco Mundial. Science, Technology and Innovation Capacity Building Partnerships for Sustainable Development, 2010.
24. Unión internacional de telecomunicaciones (UIT). Base de datos de la UIT sobre indicadores mundiales de las telecomunicaciones/TIC. 2015. https://itu-news.itu.int/es/3780-Telefonos-moviles-ya-son-casi-7000-millones-br-Tenemos-casi-todos-un-telefono.note.aspx.
25. Unión internacional de telecomunicaciones (UIT). IUT-T K.61 "Directrices sobre la medición y la predicción numérica de los campos electromagnéticos para comprobar que las instalaciones de telecomunicaciones cumplen los límites de exposición de las personas". 9-15, 2018.
26. O. Barrera Monsalve y J. Mosquera, Téllez. Contaminación ambiental por ondas electromagnéticas no ionizantes producto de tecnologías inalámbricas en ambientes al aire libre. Mutis, vol. 8, no. 2, pp. 57-72, 2018. DoiI: http://dx.doi.org/10.21789/22561498.1404.
27. O. Barrera. "Contaminación Ambiental por Ondas Electromagnéticas No Ionizantes producto de tecnologías inalámbricas en espacios habitables de descanso", trabajo de maestría, Univ. de Pamplona, 2018.
28. A. Álvarez-Ovallos, E. Amado-González, y A. Quijano-Parra, A. Estudio del efecto de los campos electromagnéticos sobre la producción de biomasa en Saccharomyces cervisiae variedad Rhône. Bistua: Revista de la Facultad de Ciencias Básicas., vol. 12, no. 2, pp. 14-23, 2014.
29. J. Tomitsch & E. Dechant, E. Exposure to Electromagnetic Fields in Households Trends From 2006 to 2012. Bioelectromagnetics, no. 36, pp. 77-85, 2015.

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