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Record of intramural mite Liponyssoides Muris Hirst, 1913 (Acari: Mesostigmata: Dermanyssidae) on host swiss albino mice Mus musculus from, India

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Abstract
This study has been carried out to investigate the mites present in Swiss mice rearing cage and observed the impact of changes in meteorological parameters such as humidity, temperature, and rainfall on the mite population during the monsoon, winter, and summer season. Fortnightly collection and examination of the husk of Swiss albino mice rearing house for one year from 1st June 2018 to 31st May 2019 have been attempted from an educational complex, at Loni, District Ahmednagar, Maharashtra. A total 176 specimens of mites have been collected, screened, and classified into one genus of parasitic mites, *Liponyssoides muris* Hirst, 1913 (Mesostigmata: Dermanyssidae). This interesting study reported the first record of *Liponyssoides muris* from India except for Madras for the first time as a parasite of Swiss albino mice *Mus musculus***.**

Keywords: investigate, impact, meteorological parameter, fortnightly

Introduction
Laboratory experimental animals like mice, rats, etc. have been used in biomedical research for various aims. From the 20th-century laboratory mice and rats, etc. have been started to use as experimental models in biomedical research [1] The intramural ecosystem in animal houses will provide suitable habitat to this Acari fauna so that they can survive and flourish. Having a proper well maintained hygienic conditions in these animal houses, despite this these animals have been seen to be infected by ectoparasites like mites.
Different meteorological parameters like temperature, humidity, rainfall, etc., play an important role in maintaining mite populations in their respective habitat. Temperature is one of the most important meteorological parameters which is directly related to the amount of moisture, the atmosphere can hold. Humidity is the amount of water vapour, the gaseous state of water in the air, and relative humidity represents a percentage of water vapour in the air which is relative to humidity maximum amount of water vapour, that changes when the air temperature of the atmosphere changes. During summer conditions as the air temperature increases, relative humidity decreases. When temperature decreases, the relative humidity increases [3
At present, the study of mites associated with laboratory mice, rats, and other small rodents in India and other countries is less attended. Hirst 1913 & 1914, first time reported the *Liponyssoides muris* and other parasitic mites found on *Mus rattus*, *Mus norvegicus*, and *Arvicanihis niloticus* in Egypt, later from Madras, India on *Mus rattus* and from Ceylon, Colombo on *Mus rattus*, from Arabia on the rat species. Similarly, it was reported on *Rattus rattus*, from Leopoldville, Belgian Congo [13, on different rodents from Thailand [2, on *Funambulus pennanti* Northern Palm Squirrel from Nepal [14, on murine rodent from Rangoon, Burma [18, on the Asian house rat, *Rattus tanezumi* from Yunnan Province, China [8, on *Rattus rattus* from Mangrove forests of Qeshm Island, Iran [4

Materials and Methods
The husk has been collected from mice rearing cages at an educational complex from Loni, Rahata tehsil, District-Ahmednagar, Maharashtra, India. Two rearing cages were screened from the mice house every time, in which two mice of the same age and size were present in each cage. For each sampling single alternative cage has been selected. Husk samples include bottom corn beat husk were present in the cage. The husk samples from the mice rearing house have been regularly collected fortnightly during morning time (9.00 AM) manually in clean and labeled sterilized sampling bottles. Mites have also been collected from four corners of the cage and rearing stands by brushing the cage dust with a smooth camel brush. The sample has been examined by taking husk which was spread uniformly in a clean and sterile Petri dish and observed under a Stereo binocular dissecting research microscope with illumination.
The influence of environmental parameters on the population of *Liponyssoides muris* has been determined by carrying out the correlation coefficient analysis with the help of SPSS software. The meteorological data on maximum temperature, minimum temperature, maximum relative humidity, minimum relative humidity, rainfall was measured during the study using mini temperature humidity meter HD-303 and averaged for simple correlation analysis.

Isolation, Clearing, and Mounting
Mites have been separated from the husk by using a simple pickup method [9 The mites were picked up from the sample by using a fine needle, moistened in 4% lactic acid. Ingested blood in the mites has been removed by minute puncturing. Isolated mites have been made clear and transparent by keeping them in 4% lactic acid for 2–3 days. The clearing period depends on the thickness of the cuticles of mites. When cleared, mites were mounted in such a way that the ventral side facing up on a clean slide at a center in a drop of melted glycerin jelly, and a clean cover slip was placed on the mite with sufficient pressure from above so that all

body parts get extended. Slides were dried at N.T.P and preserved as permanent slides for further studies.

Photographs and Identification
The photographs and measurements of specimens were taken using a Leica trinocular research microscope with an attached camera. For SEM analysis, mites were cleaned and cleared in washing for 15 min in 0.05 % HCI or 4% lactic acid. They were then dehydrated by washing for 10 min in a graded series of ethanol alcohols (40 %, 50 %, 60 %, 70 %, 80 %, and 90 %) and finally by 3 x 15 min washes in absolute alcohol [5, 15] The mite has been identified following the description, and diagrams of Hirst, 1913 & 1914 and other authentic literature.

Result and Discussion
Total 176 specimens of single species of mite have been collected and studied during this study from an educational complex, at Loni, Rahata tehsil, District-Ahmednagar Maharashtra, revealed *Liponyssoides muris* mite species for the first time from India except for Madras, which is found in parasitic association with laboratory Swiss mice. Recently the genera *Dermanyssus muris* included in the genus *Liponyssoides* of the family Dermanyssidae [16, 17] This species is found to feed on the blood of mice and recorded in colonies on corners of rearing cages. Although environmental parameters in the animal house were maintained at a constant range by an air conditioner, the impact of extramural and intramural environmental parameters on the population of *Liponyssoides muris* in three different seasons i.e. monsoon, winter, and summer is observed and studied during this study. The high population load of *Liponyssoides muris* has been recorded during monsoon when humidity is increased and the temperature is moderate followed by winter and summer. A large number of gravid females and eggs have also been obtained during the monsoon. From this observation, it is very clear that increased humidity during monsoon is found favourable for an increase in the mite population and plays a determental role in the population dynamics of mites during different seasons.

Taxonomic Account
Order: Mesostigmata Canestrini
Family: Dermanyssidae Kolenati

***Liponyssoides muris* Hirst, 1913**
Dermanyssus (Liponyssoides) *muris* Hirst, Bull. ENT. Res., 1913, 4(2):120.
Dermanyssus muris Hirst, Bull. ENT. Res., 1914, 5(3): 216.

Specimens examined
57 females, 41 males, 40 protonymph, and 38 deutonymph from Swiss albino mice *Mus musculus* rearing cage, at Loni, 19.57ºN, 74.46 º E, Ahmednagar district, Maharashtra, India.

Distribution
Previously, *Liponyssoides muris* has been recorded from Egypt, Arabia, Ceylon, and Foemosa, (Madras) India (Hirst, 1913 &1914), from Leopoldville, Belgian Congo (Lavoipierre 1946), from Thailand (Domrow, 1963), from Rangoon, Burma (Telford *et al*. 1980), from Yunnan Province, China (Huang *et al*. 2013), from Mangrove forests of Qeshm Island, Iran (Eslami *et al*. 2018).

Remark
This species has never been described since the first original description by Hirst, 1913 & 1914 on *Mus rattus* from Egypt. The species is recorded here for the first time from India except Madras (No any literature available) on host Swiss albino mice *Mus musculus* in the laboratory.

External Morphology
The color of freshly collected mites was red or white depending on when recently blood meal has been taken. Life cycle consists of four developmental stages i.e. egg, protonymph, deutonymph, and adult. Male specimens (Fig. 7) are smaller than female specimen, adult gravid female mite (Fig. 2) attains a length and width of about 1539.20 × 1327.93 µm and male 961.07×702.07 µm.
Gnathosoma of female (Fig. 3) measures 305.10 × 195.18 µm in length and width, pedipalp with five segments, chelicera long, fused and whip like in almost all stages except male, female chelicera measures about 439.64 µm in length.
Idiosoma of this species is oval and covered with a long simple type and almost equal length setae. In both adult male and female individuals have a single dorsal plate and in female with J1-J5 and j1-j6 chaetotaxy, the ventrally sternal plate (Fig. 4) bears three pairs of setae st1, st2, st3, genito-ventral plate present posterior to the sternal plate, and becomes narrower at posterior and wider at anterior. Pairs of platelets situated posterior to fourth coxae in both males and females. Male with a holo-ventral shield with an anal plate in it. The anal plate (Fig. 6) 209.33 × 181.59 µm bears one paired setae and one single setae of almost equal lengths. Paired anal setae inserted at a level with the middle of the anus. Legs with five segments, anterior margin of coxae of the second leg has spur (22.74 µm in length) in all stages.
Protonymph (Fig. 5) of this mite measures 684.69 × 590.08 µm, two dorsal shields, first dorsal shield elongated and tail like posteriorly, Posterior second dorsal shield roughly crescent like with 2 simple setae. Four pairs of platelets present parallel to the posterior end of the dorsal shield.

Relationship between population and weather factors.
The correlation analysis indicated a highly significant positive correlation between the average number of mites and maximum extramural relative humidity (r = 0.888); minimum extramural relative humidity (r =0.879); average extramural relative humidity (r = 0.885). Besides this positive and considerable significant correlation between the average number of mites and humidity inside the rearing house (r = 0.726) and rainy days (r = 0.459). Temperature (Maximum, Minimum, and Average), rainfall, and mean temperature inside the rearing house had a negligible significant effect on the population of mites. Coefficient of determination (r^2= 0.788), (r^2= 0.772) and (r^2= 0.783), explains that about 78.85%, 77.26%, and 78.32% variation in the population of mites was accounted due to the variation in the maximum, minimum and mean extramural relative humidity respectively. Similarly, (r^2=0.527) explains that about 52.70% variation in the population of mites was accounted due to the variation in the mean intramural relative humidity.

Table 1: Monthly occurrence of *Liponyssoides muris* in relation to weather factors in study area.

Months	Average number of mites	Temp, max ℃	Temp, min ℃	Average temp ℃	RH max %	RH min %	Average RH %	Temperature inside the house	Humidity inside the house (%)	Rainfall in mm	Rainy days
June	8	35.6	24.2	29.9	72	55	64	27	45	177	4
July	9	33.8	23.3	28.55	82	66	74	26	64	25	2
Aug	14	31.5	22.1	26.8	88	71	80	25	73	73	3
Sept	20	30	20.1	25.1	86	66	76	24	64	30	2
Oct	19	30.8	20.4	25.6	76	62	69	27	45	0	0
Nov	8	26.6	17.2	21.9	58	41	50	22	34	32	2
Dec	5	24.9	14.1	19.5	53	39	46	22	42	0	0
Jan	4	22.33	14.6	18.46	45	41	43	23	42	0	0
Feb	2	27.5	20.4	23.95	38	31	35	23	38	0	0
Mar	0	33.5	24	28.8	36	31	34	24	37	0	0
Apr	0	35.2	25.1	30.15	24	20	22	27	20	0	0
May	0	36.8	25.2	31	23	20	22	28	23	0	0

Table 2: Correlation co-efficient between mite and weather parameters.

Weather Parameters		Correlation co-efficient (r)	Coefficient of determination (r^2)	Coefficient of variation (%)
Temperature ℃	Maximum	-0.102	0.010	1.04
	Minimum	-0.102	0.010	1.04
	Average	-0.180	0.011	1.16
Mean temperature (℃) inside the house (Intramural)		0.041	0.001	0.16
Relative Humidity%	Maximum	0.888**	0.788	78.85
	Minimum	0.879**	0.772	77.26
	Average	0.885**	0.783	78.32
Mean relative Humidity % inside the house (Intramural)		0.726**	0.527	52.70
Rainfall (mm)	Total	0.252	0.063	6.35
Rainy days	Total	0.459	0.210	21.06

** Significant at P= 0.01 level

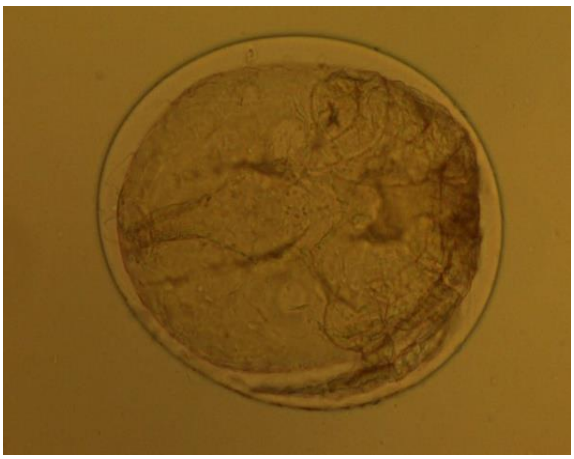

Fig 1: Egg of *Liponyssoides muris*

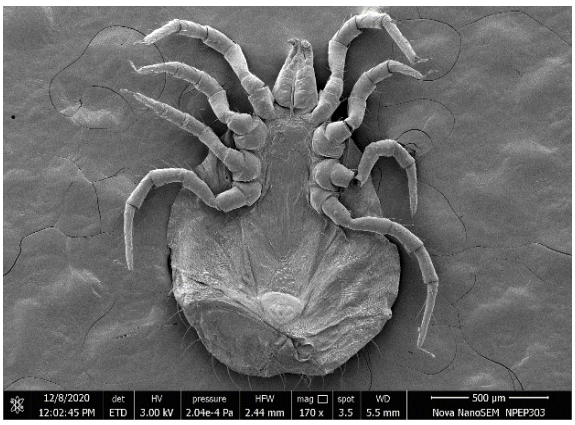

Fig 2: SEM picture of *Liponyssoides muris* Ventral view of Female.

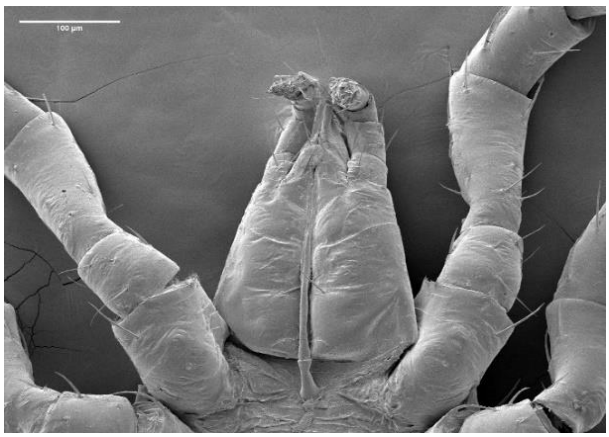

Fig 3: Gnathosoma of *Liponyssoides muris* Female

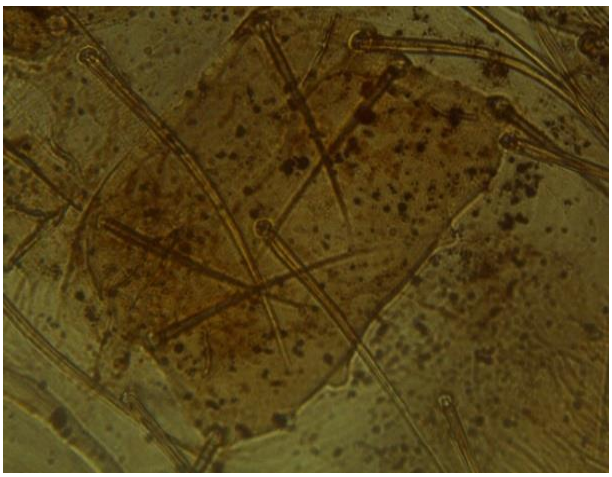

Fig 4: Sternal plate of female

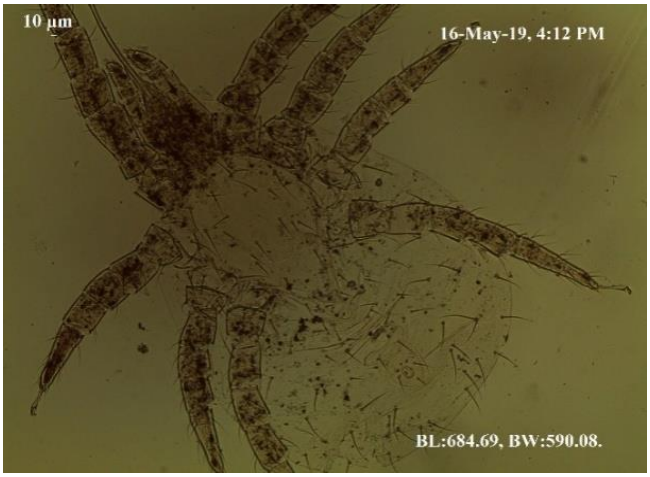

Fig 5: *Liponyssoides muris* Ventral view of Protonymph

Fig 6: Anal plate of *Liponyssoides muris* Female

Fig 7: *Liponyssoides muris* Ventral view of male

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