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Prevalence of gastrointestinal parasites of cats in Mumbai and efficacy of commonly used anthelmintics

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Abstract
This study investigates the prevalence of gastrointestinal parasites in domestic and stray cats in Mumbai, India. Cats are known hosts for various parasites that can have zoonotic implications. The research involved collecting and analyzing 360 fecal samples using sedimentation and floatation techniques to identify parasite prevalence. The study revealed a 53.06% prevalence rate, with stray cats exhibiting a higher infection rate than domestic cats. Seasonal, gender, and age-wise prevalence were examined, highlighting increased parasite presence during summer and in adult and female cats. The research also evaluated the efficacy of Pyrantel pamoate and Fenbendazole in treating hookworm infections, with Pyrantel pamoate showing slightly higher efficacy. The findings emphasize the need for regular deworming and surveillance to control parasite transmission and ensure the health of both feline and human populations.

Keywords: Cats, gastrointestinal parasites, prevalence, Mumbai, zoonotic significance

Introduction
Cats have a rich history intertwined with human civilization. In ancient cultures such as Egypt, where they were regarded as sacred beings and guardians, cats have long captivated our imaginations with their graceful movements and appearance. This is a well-documented fact that dogs, cats, rabbits, and humans have coexisted for thousands of years, establishing a symbiotic relationship that is mutually shared. What sets cats apart from other feline species is their unique inclination to live near humans, mainly due to their competence in hunting rodents and their capacity to provide companionship. As a result, this mammal has predominantly become domesticated and cherished as pets by humans.

Cats harbours a diverse range of gastrointestinal parasites, and the occurrence of parasitism varies depending on the age and gender of the animal. They also act as carriers, reservoirs, and definitive hosts for numerous gastrointestinal parasites. Their behaviour of defecating and burying their waste under soil helps to facilitate the dispersal of parasitic eggs to humans, particularly in public parks. Various gastrointestinal parasites are found in cats, with several species holding zoonotic significance. Most roundworms and tapeworms establish an attachment to the intestinal wall of felines, potentially causing severe illnesses if left untreated. The infection of cats typically occurs through the ingestion of helminthic eggs or the consumption of infected viscera.

Additionally, kittens can acquire infection of *Toxocara cati* through a lactogenic route. Clinical manifestations associated with parasitism are often nonspecific, *viz*., rough body coat, coughing, vomiting, diarrhoea, dehydration, mucoid or bloody faeces, loss of appetite, and anaemia. Cats are the primary source of a wide spectrum of parasitic diseases, including toxoplasmosis, giardiosis, visceral larval migrans syndrome and ocular larval migrans syndrome, affecting humans and other animals. Various factors, such as geographical location, prophylactic measures, season, and veterinary care greatly influence the frequency of occurrence of parasitic disease.

It is imperative to regularly monitor and deworm the animals to control the transmission of diseases. Periodic surveillance of parasite prevalence within a specific locality is indispensable for successfully formulating and implementing an effective worm control strategy.

The evaluation of the efficacy of the faecal examination techniques is crucial as it aids in diagnosing intestinal parasites and subsequently treating infected animals.

The availability of data from India concerning parasitic infections in cats is scarce. Moreover, the number of scholarly articles that have undertaken a comparative analysis between the outcomes obtained from distinct laboratory testing methodologies about cats is relatively less. This information possesses an immense potential to be of utmost value to individuals with pets, veterinary professionals, and individuals involved in policy-making processes, as it can aid in implementing essential measures required for regulating the multiplication of parasites among cats and humans. Additionally, it can facilitate the efficient management of diseases transmitted between animals and humans. Therefore, acquiring such information is crucial to guarantee the well-being and health of both feline and human populations.

Thus, this study aims to enhance our understanding of parasitic distribution, its diagnostic approach, and therapeutic management. In this study, we anticipate increasing awareness amongst pet parents, veterinarians, and the public regarding the importance of responsible pet care practices. The survey presented in this compilation was conducted to note the prevalence of gastrointestinal parasites in cats in Mumbai and to evaluate the efficacy of pyrantel and benzimidazole against feline hookworm.

Materials and Methods

Study period and study area

In the current investigation, 360 fecal samples of domestic and stray cats were collected randomly from Mumbai urban and suburban areas, considering various factors such as category, age, gender, and season from April 2023 to February 2024.

Faecal examination: The faecal samples were examined by sedimentation technique, floatation technique (ZnSO4; SG: 1.18 - 1.20), and Stoll's egg counting technique for detection of the eggs of the gastrointestinal helminths and cysts/oocysts of the protozoa. The eggs of the helminth parasites and the cysts/oocysts of the protozoa were identified by their characteristic morphological features.

Therapeutic evaluation of anthelmintic drugs

Cats (n=24) with EPG ≥ 1000 were included in the trial to test the efficacy of commonly used anthelminthic drugs (Pyrantel pamoate and Fenbendazole). The selected animals were randomly divided into two groups *viz.* Group A and Group B consisted of 12 cats in each group.

Collection of helminthological specimens during necropsy

The stray cats that died naturally or accidentally during the period were systematically necropsied to collect gastrointestinal parasites.

Data analysis

The data was entered in Microsoft Excel and analyzed using the WASP 2.0 software. The chi-square ($\chi 2$) test and two sample T-test were used to determine the variation in different treatment groups' prevalence and drug efficacy, respectively.

Results and Discussion

Prevalence of gastrointestinal parasites of cats in Mumbai

In the survey, 360 faecal samples were examined using two different concentration techniques: sedimentation and floatation. Upon comparing the overall results of both methods, it was observed that out of 191 positive cats, 177 displayed parasitic material in the faecal samples through the sedimentation technique, while 188 cats exhibited parasitic material through the floatation technique. As a result, the sensitivity of the floatation technique was determined to be slightly higher at 98.43% than that of the sedimentation technique, which showed a 92.67% sensitivity. Fourteen samples were found to be positive for coccidian oocyst through the floatation technique, yet they did not exhibit any parasitic material when subjected to the sedimentation method. Conversely, only two samples were positive for eggs of *Strongyloides* spp. through the sedimentation method while failing to demonstrate positivity through the floatation technique. A similar trend of higher sensitivity by the floatation method was observed by Malkar (2013) [23] in Mumbai. The higher sensitivity of the floatation technique in comparison to sedimentation can be attributed to the fact that the parasitic stages are segregated from the faecal debris based on the specific gravity exerted on parasitic material and faecal debris. Additionally, the efficacy of this technique is also influenced by the size and weight of parasite stages present in the faecal sample. The reduced sensitivity of the sedimentation method observed in the current investigation regarding the detection of coccidian oocysts may be due to the potential masking of these stages by faecal debris or the extended settling period required for oocysts during the sedimentation process.

As illustrated in Table 1, it is apparent that the overall prevalence rate of gastrointestinal parasitism among cats in the Mumbai region was determined to be 53.06%. However, Patil-Kulkarni (1962) [32], Malkar (2013) [23], and Lavanya *et al.* (2016) [21] conducted a survey on gastrointestinal parasites of cats in the Mumbai region, reporting the overall prevalence of 72.50%, 71.43%, and 72.22%, respectively. The current investigations suggest a decline in the prevalence rate in the last decade. There is limited literature on feline gastrointestinal parasitism in the Indian subcontinent, making it challenging to compare the results of the present study with existing research. Higher prevalence rates of 96% gastrointestinal parasitism in cats were reported by Rajavelu and Raja (1988) [33] in Uttar Pradesh. In contrast, Fazili *et al.* (2020) reported a lower prevalence of 39.43% in Kashmir. Top of Form.

The incidence of gastrointestinal parasites was higher in stray cats (77.12%) than pet cats (41.32%), regardless of the seasonal variations. These findings are statistically significant at both 5% and 1% levels of significance. A similar trend of higher prevalence of gastrointestinal parasitism in stray cats compared to pet cats was also recorded by Patil-Kulkarni (1962) [32] and Malkar (2013) [23] in Mumbai. This disparity in infection rates between stray and pet cats highlights the importance of understanding and addressing the factors contributing to the higher susceptibility of stray cats to gastrointestinal parasitism compared to their domestic counterparts. The probable cause for this occurrence can be linked to the accumulation of gastrointestinal parasites in stray cats, as they rarely undergo deworming treatment and lack easily accessible or provided nutrition, which inclines these felines to hunt rodents that act as a paratenic host. Moreover, these cats are consistently exposed to unsanitary conditions, particularly in densely inhabited urban areas such as Mumbai, where a high rodent population predisposes these animals to parasitic infections.

Seasonal fluctuations play a significant role in influencing the presence of parasitic fauna in various host species, as the survival and longevity of free-living and infective stages of parasites are determined by climatic conditions. The current research demonstrated a higher prevalence rate in the summer (72%), followed by winter (52.45%) and monsoon (47.90%) seasons. Malkar (2013) [23] in Mumbai and Fazili *et al.* (2020) in Kashmir also noted a similar pattern of increased prevalence of gastrointestinal parasitism during the summer compared to the other seasons.

Gender-wise prevalence of gastrointestinal parasites of cats in Mumbai

Investigation of the data concerning the general prevalence of gastrointestinal parasites of cats in Mumbai indicated a slightly elevated occurrence rate in females (55.81%) as compared to males (50.53%), though the values are found to be statistically non-significant. This finding is in agreement with the report published by Mehedi *et al.* (2020) [26] from Bangladesh who presented a higher prevalence in females (66.67%) than in males (57.69%). Contrary to these findings, Patil-Kulkarni (1962) [32] and Malkar (2013) [23] reported a higher occurrence of parasitism in male cats. The existing body of literature concerning different parasitic infections found in domestic animals does not exhibit significant gender bias towards either males or females, despite ongoing efforts to investigate this phenomenon. Several efforts have been made to investigate the potential gender discrepancies in the occurrence of parasitic infections to shed light on this intriguing aspect of host-parasite interactions. It has been hypothesized that the observed gender differences in the prevalence of parasitic infections could potentially be linked to hormonal influences, suggesting a complex interplay between endocrine factors and parasitic susceptibility in animal hosts (Malkar, 2013) [23].

Age-wise prevalence of gastrointestinal parasites of cats in Mumbai

In the context of the presence of gastrointestinal parasites in young and adult cats, observation revealed that the prevalence rate was higher in adult cats (68.75%) rather than in young cats (27.21%) aged ≤ one year. This data showed statistical significance at both 5% and 1%. A similar trend was reported by Patil-Kulkarni (1962) [32] and Adhikari *et al.* (2022) [1], who observed a higher occurrence of gastrointestinal parasites in adults compared to young cats in Mumbai and Pakistan, respectively. This could be because faecal samples included in this study were mostly collected from young pet cats, wherein the owners nowadays are very vigilant about their pet's health. Also, maternal antibodies could play a significant role in disease transmission, thus plunging the incidence rate. A contrasting trend was documented by Malkar (2013) [23] and Mehedi *et al.* (2020) [26], who reported a higher incidence of gastrointestinal parasites in kittens than in adult cats in the investigation carried out in Mumbai and Bangladesh.

Species-wise prevalence and intensity of gastrointestinal parasites of cats in Mumbai

In the current study, 360 faecal samples obtained from cats between April 2023 and February 2024 were subjected to qualitative and quantitative analysis to identify gastrointestinal parasites and their intensity in Mumbai. Among 360 faecal samples examined, it was found that 97 samples (50.79%) were infected with a single species of parasite. In comparison, the remaining 94 samples (49.21%) showed the presence of two or more species of gastrointestinal parasites. Remarkably, in the cases demonstrating mixed parasitic infections, 76 samples (80.85%) exhibited the involvement of two different species, 17 samples (18.09%) displayed life cycle stages of three distinct species, and only one sample (1.06%) was identified to be infected with four species of parasites. A reverse trend of a higher percentage of mixed parasitic infections than single parasitic infections in cats was noted by Malkar (2013) [23] in Mumbai and Fazili *et al.* (2020) in Kashmir. This could be due to frequent outdoor activity of the cats, which gives them free access to contaminated surroundings, and rodents, which act as paratenic hosts/intermediate hosts. This detailed analysis provides valuable insights into the prevalence and diversity of gastrointestinal parasites in cats from Mumbai during the specified period.

The predominant group of gastrointestinal parasites identified in the research was hookworms, accounting for 30.28%. Following hookworms, coccidia oocyst (25.28%) was the next most frequently observed, succeeded by *Toxocara* spp. (15.28%), *Strongyloides* spp. (11.11%), *Taenia* spp. (1.94%), *Dipylidium caninum* (0.83%) and *Capillaria* spp. (0.28%). Trematodes were absent in this investigation. The differentiation of the parasites above was based on their eggs' morphology. A high prevalence of hookworms was also reported by Patil-Kulkarni (1962) [32], Malkar (2013) [23], Lavanya *et al.* (2016) [21] in Mumbai, and Mukutmoni *et al.* (2022) [28] in Bangladesh. *Strongyloides* spp. were recorded in cats in Mumbai during the survey conducted by Patil-Kulkarni (1962) [32] about six decades ago, while Malkar (2013) [23] and Lavanya *et al.* (2016) [21] did not report any *Strongyloides* spp. infection in Mumbai during their study.

Concerning the intensity of parasitic infections denoted by EPG/OPG value, it was noted that regardless of the species, the parasitic burden was predominantly moderate in most infected cats, followed by cases with mild intensity and cats with heavy intensity. The heavy intensity of infection was only observed in cats infected with hookworms, coccidian oocyst, and *Toxocara* spp. These three gastrointestinal parasites, commonly found in the survey and exhibiting heavy intensity of infection, possess a direct life cycle that can thrive in the favourable environment of Mumbai.

Conversely, a significantly lower prevalence rate of other gastrointestinal parasites encountered in the research can be attributed to an indirect life cycle pattern involving rodents, fish, fleas, and beetles as intermediate hosts. The intensity of all these parasites ranged from mild to moderate. The evaluation of parasitic infections in cats aimed to understand the extent of environmental contamination, revealing that the surroundings and public areas are considerably contaminated with infective stages of these parasites.

Necropsy findings of cat carcasses in Mumbai

Necropsies were performed on 16 cats that died either naturally or accidentally. Out of 16 necropsied cats, parasites were harvested from solely one cat (6.25%), which exhibited three species of gastrointestinal worms *viz. Ancylostoma*spp., *Toxocara cati*, and *Dipylidium caninum* were identified based on morphological characteristics. Upon examination of the intestinal contents, eggs of hookworm, *Toxocara cati*, *Dipylidium caninum*, and *Taenia* spp. were identified, though no gross specimen of *Taenia* spp. was detected.

Histopathological findings of necropsied cat in Mumbai

The histopathological examination observed varying degrees

of inflammation and the proliferation of fibrous connective tissue. The histoarchitecture of the intestine exhibited erosion and depletion of the intestinal villi. The stomach wall showed fibroplasia and infiltration of inflammatory cells, whereas congestion and hemorrhages were noted in the hepatic parenchyma with mild fibrosis in the portal area.

Efficacy of Pyrantel pamoate against hookworm infection of cats in Mumbai

Cats infected with hookworms included in Group A were treated with Pyrantel pamoate at 5 mg/kg BW once orally. Out of 12 cats included in the study, nine cats showed a 100% reduction, while three cats showed a 90.91%, 91.67%, and 83.33% reduction in the egg count 14 days post-treatment. The collective mean egg count reduction within the group was found to be 97.16%. These results agreed with Reinmeyer *et al.* (1990) [35] and Ridley *et al.* (1991) [37], who reported 99.4% and 97.9% efficacy of pyrantel pamoate against hookworms, respectively in the USA.

Efficacy of Fenbendazole against hookworm infection of cats in Mumbai: Cats infected with hookworms included in Group B received Fenbendazole at 25 mg/kg BW once PO. Six out of the 12 cats successfully eradicated hookworm infection, while six cats showed 83.33%, 90%, 81.82%, 90%, 90%, and 83.33% reduction in egg count 14 days post-treatment. The collective mean reduction in egg count for this group was found to be 93.21%. Roberson and Bruke (1980) exhibited 99.9% efficacy of Fenbendazole against hookworms when the drug was given for three days @ 50 mg/kg BW. However, in the current study, the efficacy of Fenbendazole was found to be lower; this could be due to the administration of the drug once PO @ 25 mg/kg body weight.

Comparative efficacy of Pyrantel pamoate and Fenbendazole against feline hookworms in Mumbai

The comparison of Pyrantel pamoate exhibited greater effectiveness (97.16%) when compared with Fenbendazole (93.21%), which was statistically not significantly different.

Table 1: Prevalence of gastrointestinal parasites of cats in Mumbai

Seasons	Stray		Pet		Total	
	Screened	Positive	Screened	Positive	Screened	Positive
Summer	20	15 (75%)	30	21 (70%)	50	36 (72%)
Monsoon	54	43 (79.63%)	113	37 (32.74%)	167	80 (47.90%)
Winter	44	33 (75%)	99	42 (42.42%)	143	75 (52.45%)
Total	118	91 (77.12%)	242	100 (41.32%)	360	191 (53.06%)
Chi-square calculated: 10.262						
Chi-square Table: 5% - 5.99; 1% - 9.21						
Statistically significant at both 5% and 1% level of significance						

Table 2: Gender-wise prevalence of gastrointestinal parasites of cats in Mumbai

	Male	Female
No. of cats screened	188	172
No. of cats positive	95	96
Prevalence (%)	50.53%	55.81%
Chi-square calculated: 0.56		
Chi-square Table: 5% - 3.84; 1% - 6.64		
Statistically non-significant.		

Table 3: Age-wise prevalence of gastrointestinal parasites of cats in Mumbai

	Young	Adult
No. of cats screened	136	224
No. of cats positive	37	154
Prevalence (%)	27.21%	68.75%
Chi-square calculated: 34.57		
Chi-square Table: 5% - 3.84; 1% - 6.64		
Statistically significant at both 5% and 1% level of significance.		

Table 4: Species-wise prevalence of gastrointestinal parasites of cats in Mumbai

Species	Single	Mixed	Total	Prevalence (%)
Hookworm	34	75	109	30.28
Coccidian oocyst	35	56	91	25.28
Toxocara spp.	17	38	55	15.28
Strongyloides spp.	08	32	40	11.11
Taenia spp.	03	04	07	1.94
D. caninum	0	03	03	0.83
Capillaria spp.	0	01	01	0.28

Table 5: Intensity (EPG / OPG) of gastrointestinal parasites of cats in Mumbai

Species	Mild ≤ 500	Moderate 600 – 900	Heavy ≥ 1000
Hookworm	22	46	41
Coccidian oocyst	43	44	04
Toxocara spp.	16	30	09
Strongyloides spp.	28	12	0
Taenia spp.	04	03	0
D. caninum	03	0	0
Capillaria spp.	01	0	0

Table 6: Comparison of drug efficacy in different treatment groups (n=24)

Sr. No.	Group	Drugs Used	Percent efficacy (Mean ± SE)	T statistics	T table
1	A	Pyrantel pamoate	97.16 ± 1.59	1.46	5% - 2.07
2	B	Fenbendazole	93.21 ± 2.19		1% - 2.82

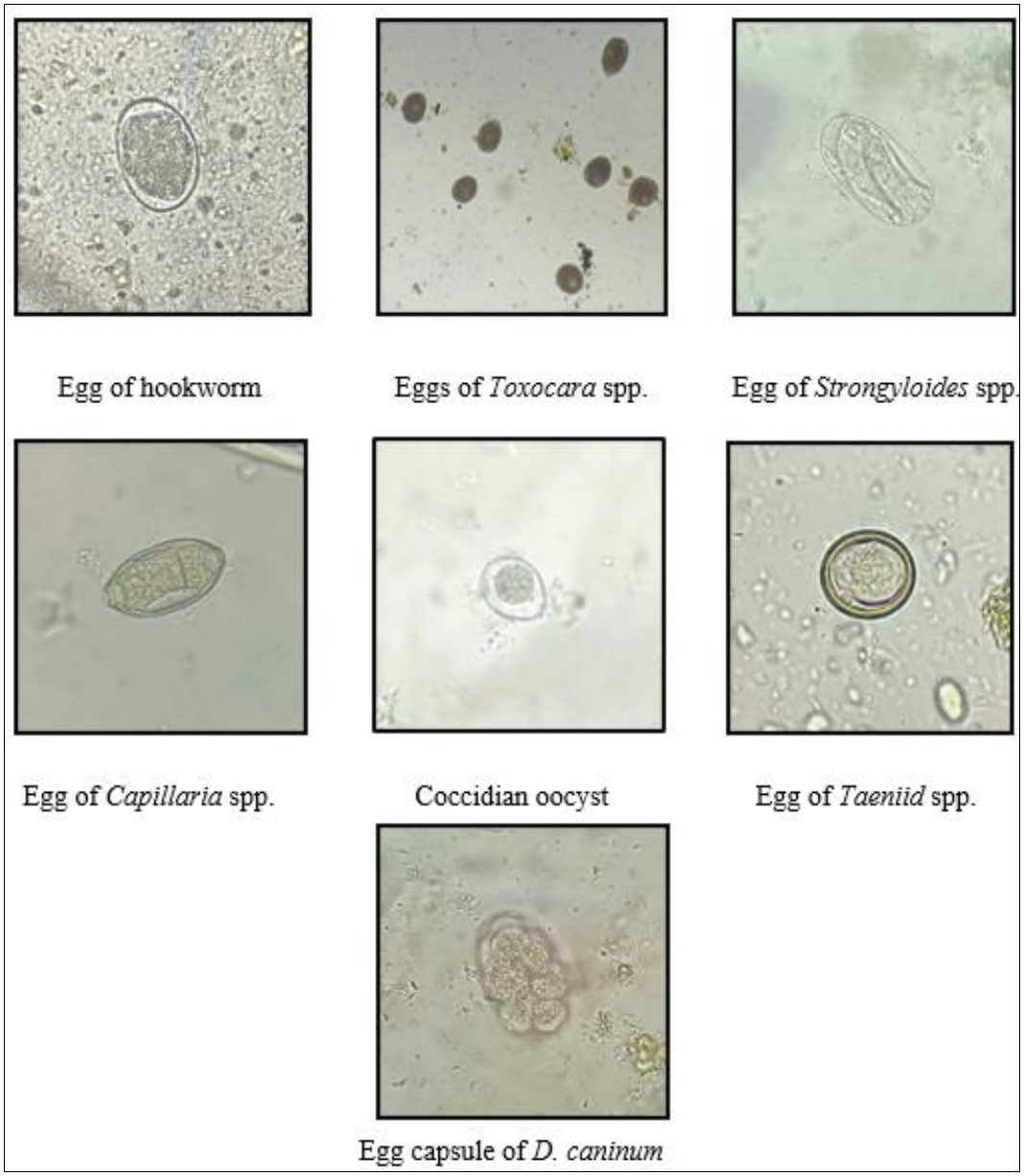

Fig 1: Parasitic eggs/oocyst encountered in faecal samples of cats in Mumbai

Conclusion

This study highlights the significant prevalence of gastrointestinal parasites among domestic and stray cats in Mumbai, India, with an overall rate of 53.06%. Stray cats exhibited a notably higher infection rate (77.12%) compared to domestic cats (41.32%). Seasonal trends were observed, with summer showing the highest prevalence (72%), followed by winter (52.45%) and monsoon (47.90%). Gender and age factors also influenced prevalence, with adult and female cats more frequently infected. The study identified hookworms as the most common parasite, along with coccidia, Toxocara spp., and others. Diagnostic techniques revealed that the floatation method was slightly more sensitive than the sedimentation method, with the former detecting more coccidian oocysts.

Therapeutically, Pyrantel pamoate and Fenbendazole were

evaluated for their efficacy against hookworm infections. Pyrantel pamoate demonstrated a higher efficacy rate of 97.16%, compared to Fenbendazole's 93.21%. This finding supports the use of Pyrantel pamoate as a more effective treatment option for hookworm infections in cats. The study underscores the importance of regular deworming and the need for enhanced public awareness about parasite control to reduce zoonotic risks and improve feline health. The data also suggest a declining trend in parasitic prevalence over the last decade, possibly due to increased awareness and better veterinary care. This research provides valuable insights for pet owners, veterinarians, and policymakers to implement effective parasite control strategies and safeguard both feline and human health.

Conflict of interest

No conflict of interest to declare.

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