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The effect of *Psoroptes cuniculi* on some blood parameters of rabbits

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ABSTRACT

The study aims to throw some light on a large diversity of mite species inhabiting domestic rabbits's manure, which is produced on a small scale or in farmers houses in the Tanta Governorate, and evaluate the changes in hematological values and biochemical parameters in rabbits infested with the *Psoroptes cuniculi* parasite. This study reports an incidence of mites (Arachnida: Acari) that inhabit domestic rabbits. A total number of ten rabbits were collected from Tanta. Rabbits were divided to two equal groups (n=5). The first group was used as the healthy group, and the second group was naturally infested with *Psoroptes cuniculi*. Chemical analyses (hematology, biochemistry). The data showed that in total, 49 mite species belonging to 17 families within three suborders under two orders were collected and identified. The order Acariformes was categorized into the suborders Actinedida, Acaridida, and Oribatida. Meanwhile, the order Parasitiformes was contained only by suborder Gamasida. The level of Hb, PCV, RBC, and eosinophils decreased significantly in all the infested rabbits, but WBC and lymphocytes were increased significantly. There were notable changes in variation in total protein, albumin, β globulin, total globulin, and creatine kinase levels between the groups. The results showed the lowest level of SOD but an increase in CAT and GST in infested groups compared to healthy groups. Mites can cause abnormal hematological and biochemical changes, with the severity of these changes influenced by the duration of the infestation and the extent of the disease.

Keywords: Rabbits - Mites, Order Acariformes, Order Parasitiformes, Oryctolagus cuniculus organic manures, Hematology- The oxidative stress -Biochemistry.

INTRODUCTION

Rabbit farming is among the fastest-growing livestock industries worldwide. Its rapid expansion can be attributed to several factors, including rabbits' high reproductive rate, early maturity, quick growth, strong genetic selection capabilities, efficient feed conversion, and economical space utilization. (Lukefahr and Cheeke, 1990). In Egypt, mange caused by Sarcoptes and Psoroptes mites in rabbits is regarded as the second most significant health issue after coccidiosis, leading to substantial losses. *Sarcoptes scabiei* var. *cuniculi* causes mange infestations in rabbits, primarily affecting the nose, feet, and regions surrounding the genitalia. This condition triggers hypertensive reactions and weight loss and can ultimately result in death. (Saha and Mukherjee, 1998). Mites are a diverse and widespread group of arthropods. They can feed on plants, fungi, or microorganisms or act as parasites, living on or

inside the bodies of other animals, often leading to significant losses in meat and fiber production. Additionally, some mites serve as predators, targeting other mites or certain insects. (Proctor and Owens, 2000). Sarcoptic mange is a highly contagious and serious disease that poses a significant global health challenge, affecting humans as well as other mammals. It is caused by the burrowing mite *Sarcoptes scabiei*. (Walton *et al.*, 2008). Initial studies on rabbits infested with S. *scabiei* var. *canis* showed irregularities in serology and blood chemistry. These findings suggest that the mite, its byproducts, or both may induce systemic effects. (Arlian, 1988). These initial findings align with reports indicating that cattle infested by the related scabies mite, *Psoroptes ovis* (Herring), may experience kidney and liver damage, along with alterations in the levels of certain biochemical constituents. (Fisher and Crookshank 1982). Oxidative stress occurs when an imbalance develops between the production of reactive oxygen species (ROS) and the body's capacity to neutralize or eliminate them, leading to increased levels of ROS that disrupt normal cellular functions. (Adwas *et al.,* 2019). Reactive oxygen species (ROS) lead to damage in cellular macromolecules, resulting in lipid peroxidation as well as alterations to nucleic acids and proteins. To ensure effective cell signaling, it is probable that various radical scavenging enzymes help regulate a baseline level of reactive oxygen species (ROS) within the cell. However, when ROS levels surpass this threshold, heightened production can result in excessive signaling activity, as well as direct damage to critical components involved in cellular signaling pathways. (Azab *et al.,* 2019). Antioxidant defense mechanisms safeguard biological systems against the harmful effects of free radical toxicity. (Jacob *et al.,* 2013). The main antioxidant enzymes include superoxide dismutase (SOD), catalase (CAT), and glutathione peroxidase (GPx). In cases where the balance between oxidants and antioxidants in animals is disturbed, inflammatory cells generate an excess of free radicals to combat parasites. This process results in the depletion of the antioxidant defense system in the affected rabbits. The objective of the study was to assess various hematological and biochemical parameters of rabbits infected with *Psoroptes cuniculi*.

MATERIALS AND METHODS

Animals: A total ten male rabbits (80-100 days of age) were collected in April 2024. Five of them were healthy and disease-free and served as the control group. The remaining five rabbits were naturally infected with *Psoroptes cuniculi* and were considered the infected group. The healthy rabbits were housed in a separate laboratory, while the infected rabbits were placed in another. Both groups were kept in cages with free access to food and water, maintained on a 12-hour light/dark cycle, and monitored for three days before blood samples were collected.

Samples were gathered randomly from farmer houses in 6 regions as (Nawag, Akhanaoay, Birma, Dafrah, Shubar and Mahallat Marhum) at Tanta – El Gharbia governorate during the year 2024, Samples were taken from surface layer of rabbit litter and feces, each sample was about 500 gm.

Each collected sample were placed separated in a plastic bag, every bag was marked by a label point to the date, the location and all the necessary information, then sent to the laboratory for mite separation by direct examination under a stereo-binocular microscope or using Modified Tullgren's funnels.

Collected mites were cleared by using Nesbitt's solution, then mounted on glass slides using Hoyer’s medium, after that the slides were heated up gently to stretch out the mites' bodies, and rendering them clear for examining.

Mites were identified and preserved within the collection at the Department of Agricultural Zoology and Nematology, Faculty of Agriculture, Al-Azhar University.

Samples collection for hematological and biochemical analyses:

Blood samples were collected from the hepatic portal vein after animals anesthetized with ether. Two blood samples were obtained from each rabbit. The first sample was anticoagulated and used for the determination of the (Hb), (PCV), (RBCs), eosinophils and (WBCs) count. The second sample was obtained to separate serum and analyze its biochemical components.

Serum was separated under cooling centrifugation and kept at -20 OC until analysis. Various chemical analyses were conducted by using Commercial kits manufactured in Egypt by Diamond Company, Stanpio Laboratory, and Pasteur Lap. Diagnostic. The bioanalyses of plasma were performed for the quantitative analysis of blood parameters using spectrophotometry analyzer SBA-200 (Celm SBA-200).

Hemoglobin concentration (Hb) is typically measured using Drabkin's reagent as per established protocols (ICSH, 1965) assay for Hb concentration. The packed cell volume the PCV was measured as a percentage using the microhaematocrit reader, focusing on the red blood cells, white blood cells, using the hemocytometer method, eosinophils, basophils and lymphocytes were carried out according to (Coles, 1986). Mean corpuscular hemoglobin concentration (MCHC) was calculated from these hematological measurements. MCHC% =Hb / Pcv×10 (%).

Total protein was established using the method described by (Henry *et al.*, 1974), albumin was established using the method described by (Doumas and Biggs, 1972), Globulin was determined by subtracting serum albumin from serum total protein, while the A/G ratio was calculated by dividing the albumin value by the globulin value. Determination of serum creatine kinase was based on the modified Jaffe method (Blass *et al.*, 1974) using the Quimica Clinica Applicada (QCA) Creatinine test kit (QCA, Spain). Catalase (CAT) activity was measured following the method outlined by Maehly and Chance (1954). The activity of superoxide dismutase (SOD) was determined following the method described by Deng *et al.* (1993). The activity of glutathione peroxidase (GSH-Px) was measured using the method of Rotruck *et al.* (1973).

Statistical analyses: Statistical analyses obtained data was conducted using Proc ANOVA, t-test and GLM in SAS (SAS Institute 1998).

RESULTS AND DISCUSSION

In this contemporary study, an incidence of mites (Arachnida: Acari) inhabiting domestic rabbit's *Oryctolagus cuniculus* organic manures in limited-resource farmers and backyard systems expressed that a total of 49 species of mites belonged to 17 families within three suborders under two orders were commonly associated with domestic rabbit's organic manures in different 6 regions at Tanta – El Gharbia governorate in Egypt during the year 2023 as follows, Table (1) and Table (2).

Table (1): Incidence of some mites inhabiting domestic rabbit's (*Oryctolagus cuniculus*) sheds belongs to suborder Parasitiformes in some regions at Tanta governorate.

Order	Sub order	Family	Species
Parasitiformes	Gamasida	Amerosiidae Evans	*Kleemania plumosus* (Oud.)
			Kleemania sp.
			Amerosius sp.
		Ascidae Voigts and Oudemans	*Proctolaelaps oriantalis* Nasr
			Proctolaelaps peygmaeus (Muller)
			Proctolaelaps pomorum (Oudemans)
			Proctolaelaps scolyti Evans
			Lasioseius penicilliger Berlese
			Lasioseius zaheri Nasr
			Blattisocius mali (Oudemans)
			blattisocius dendriticus Berlese
		Digamasellidae Evans	*Dendrolaelaps zheri* Metwally&Mersal
			Dendrolaelaps sp.
		Laelapidae Berlese	*Androlaelaps casalis* (Berlese)
			Hypoaspis baloghi Shreef & Afifi
			Hypoaspis sardou Berlese
		Macrochelidae Vitzthum	*Macrocheleus merdarus* (Berlese)
			Macrocheleus muscadomesticae Scopoli
		Parasitidae Oudemans	*Parasitus badrii* Hafez and Nasr
			Parasitius sp.
		Sejidae Berlese	*Adenosejus krantzi* Hirschmann
			Sejus sp.
		Uropodidae Berlese	*Uroobovella marginata* Berlese
			Trichouropoda patavina (Canestrini)
			Trichouropoda ovalis Koch
			Oodinychus janeti (Berlese)
		Zerconidae Berlese	*Zercon anomalus* Willmann
			Zercon carpathicus Sellnick
			Zercon triangularis Koch

The order of parasitiformes (in Table 1):

The order of parasitiformes was contained only by suborder Gamasida, which contains nine families and 29 species, as follows:

1. Family: Amerosiidae Evans, which contained three species under two genera
2. as *Kleemania plumosus* (Oud.), *Kleemania* sp. and *Amerosius* sp.
3. Family: Ascidae Voigts and Oudemans which included eight species belonged to 3 genera as *Proctolaelaps oriantalis* Nasr, *Proctolaelaps peygmaeus* (Muller), *Proctolaelaps pomorum* (Oudemans), *Proctolaelaps scolyti* Evans, *Lasioseius penicilliger* Berlese, *Lasioseius zaheri* Nasr, *Blattisocius mali* (Oudemans) and *blattisocius dendriticus* Berlese. El-Sharabasy *et al*. (2014) Desoky *et al.* (2020)
4. Family: Digamasellidae Evans which contain two species as *Dendrolaelaps zheri* Metwally & Mersal and *Dendrolaelaps* sp.
5. Family: Laelapidae Berlese which included three species follow two genera as *Androlaelaps casalis* (Berlese), *Hypoaspis baloghi* Shreef & Afifi and *Hypoaspis sardou* Berlese.

6. Family: Macrochelidae Vitzthum which included two species belonged to the same genus as *Macrocheleus merdarus* (Berlese) and *Macrocheleus muscadomesticae* Scopoli.
7. Family: Parasitidae Oudemans which included by two species as *Parasitus badrii* Hafez and Nasr and *Parasitius* sp.
8. Family: Sejidae Berlese which included two species as *Adenosejus krantzi* Hirschmann and *Sejus* sp.
9. Family: Uropodidae Berlese which which included four species belonged to three genera *Uroobovella marginata* Berlese, *Trichouropoda patavina* (Canestrini), *Trichouropoda ovalis* Koch and *Oodinychus janeti* (Berlese).
10. Family: Zerconidae Berlese which included three species belonged to the same genus as *Zercon anomalus* Willmann, *Zercon carpathicus* Sellnick and *Zercon triangularis* Koch.

The order of Acariformes (in Table 2):

The order Acariformes was showcased by six families and 13 species, and the suborder Oribatida by two families and seven species.

Data in table 1 showed that suborder Actinedida was showcased by six families as:

1. Family Bdellidae Duges, which contained three species, belonged to two genera: *Spinibdella bifurcate* Atyeo, *Spinibdella* sp., and *Bdella* sp.
2. Family Cheyletidae Leach, which contained six species belonging to four genera: *Acaropsellina docta* (Berlesese), *Arctoseius pannonicus* Willmann, *Cheyletus malaccensis* Oudemans, *Cheyletus badryi* Zaher & Hassan, *Cheyletus eruditus* (Schrank), and *Cheletomorpha lepidopterorum* (Shaw).
3. Family: Cunaxidae Thor which was contain the species *Neocunaxoides* sp.
4. Family: Raphignathidae Kramer which was contain the species *Raphignathus bakeri* Zaher & Gomaa.
5. Family: Tydeidae Kramer which was contain the species *Paralorryia* sp.
6. Family: Tarsonemidae Kramer which was showcased by the species *Tarsonemus* sp.
7. Family: Psoroptidae which was containing by the species *Psorpties cuniculi*.

Also, data in table 2 displayed that suborder Oribatida contained two families:

1. Family: Oppidae Grandjean which was contain three species belonged to two genera as; *Multioppia wilsoni* Aoki, *Oppia bayomi* Shreef and Zaher *Oppia concolor* Koch and Oppia egyptiaca El-Badry and Nasr.
2. Family: Oribatulidae Thor which was was contain three species belonged to two genera as; *Siculobata sicula* (Berlese), *Zygoribatula tameyai* El-Badry and Nasr and *Zygoribatula tritici* El-Badry and Nasr. Metwally *et al*. (2017) and Negm *et al*. (2018).

Table (2) Incidence of some mites inhabiting domestic rabbits's (*Oryctolagus cuniculus*) sheds belongs to suborder Acariformes in some regions in the Tanta governorate.

Order	Sub order	Family	Species
Acariformes	Actinedida	Bdellidae Duges	*Spinibdella bifurcate* Atyeo
			Spinibdella sp.
			Bdella sp.
		Cheyletidae Leach	*Acaropsellina docta* (Berlese)
			Arctoseius pannonicus Willmann
			Cheyletus badryi Zaher & Hassan
			Cheyletus eruditus (Schrank)
			Cheletomorpha lepidopterorum (Shaw)
			Cheyletus malaccensis Oudemans
		Cunaxidae Thor	*Neocunaxoides* sp.
		Raphignathidae Kramer	*Raphignathus bakeri* Zaher&Gomaa
		Tydeidae Kramer	*Paralorryia* sp.
		Tarsonemidae Kramer Psoroptidae	*Psorpties cuniculi*
	Oribatida	Oppidae Grandjean	*Multioppia wilsoni* Aoki
			Oppia bayomi Shreef and Zaher
			Oppia concolor Koch
			Oppia egyptiaca El-Badry and Nasr
		Oribatulidae Thor	*Siculobata sicula* (Berlese)
			Zygoribatula tameyai El-Badry and Nasr
			Zygoribatula tritici El-Badry and Nasr

The effect of *Psoroptes cuniculi* on hematological parameters in healthy and infested rabbits:

The data presented in Table (3) indicate that mite infestation had a significant effect on the hematological parameters of rabbits. Compared to the non-infested (control) group, the infested rabbits experienced a notable decline ($p < 0.05$) in Hb, PCV, RBC, and eosinophil count. No significant changes were observed in MCHC or basophil levels. However, the WBC count and lymphocyte levels experienced a considerable rise in the infested group compared to the non-infested group.

The findings align with those reported in earlier studies by several investigators. Shoyinka *et al.* (2013) and Beigh *et al.* (2016) noted a significant decrease in hemoglobin concentration, hematocrit (PCV), and total red blood cell (RBC) count, along with a notable rise in the overall white blood cell (WBC) count and lymphocytes in infested rabbits. Similarly, Mohamed *et al.* (2017) investigated Oxidative status of peripheral blood in rabbits infected with *Psoroptes cuniculi* and *Sarcoptes scabiei*, while also examining the disease's pathogenesis. Their results showed that rabbits infested with *Psoroptes* or *Sarcoptes* exhibited a considerable reduction in RBC count and PCV%, while WBC count was substantially enhance compared to the non-infested group.

However, these results are partially in agreement with the findings of Hartley (2005), Al-Saffar and Al-Mawla (2008), and Gurbuz and Kiziltepe (2013), reported that decrease in hemoglobin, hematocrit, mean corpuscular hemoglobin (MCH), total white blood cell count, lymphocyte count, and eosinophil count in rabbits infested with mites.

These results agree with Kanbur *et al*. (2008) decreased RBC counts were proposed to result from suppressed erythropoiesis and chronic dermal inflammation. And Mohamed *et al.* (2017) The study revealed that the blood of rabbits infested with *Psoroptes cuniculi* and

Sarcoptes showed a significant decrease (P<0.05) in red blood cell count and packed cell volume percentage compared to the control group.

According to Bickers and Athar (2006), the increase in lymphocyte count may be attributed to bacterial invasion through cutaneous lesions or the immunomodulatory effects of products released by the mange parasites. A decrease in eosinophil and basophil levels may indicate their migration from the circulating blood to inflamed subepithelial tissues, combined with minimal increases in cell proliferation. The observed reduction in circulating white blood cells (WBC) in severely infested rabbits could result from a combination of factors, including cell migration, sequestering, and diminished production due to the host's overall weakened state. Notably, the changes in differential white cell counts in parasitized rabbits differ from those observed in scabies-infested coyotes. (Pence *et al*., 1983). The increase in WBC and lymphocytes may be due to the different levels of infections.

Table (3): Hematological Changes in Non-Infested and Infested Rabbits.

Parameter	Non-infested	Infested
Hb g/dl	12.16±0.31^{a}	7.18±0.62^{b}
Pcv%	38.00±0.82^{a}	26.83±0.70^{b}
RBCs10^{6}/ml	3.24±0.23^{a}	2.50±0.17^{b}
MCHC g/dl	31.29±0.13	31.32±0.28
WBCs 10^{3}/ml	7.35±0.60^{b}	9.50±0.49^{a}
Eosinophils %	5.01±0.36^{a}	2.77±0.40^{b}
Basophils %	1.45±0.35	1.75±0.51
Lymphocytes %	23.61±1.58^{b}	37.62±1.71^{a}

Means annotated with distinct superscript letters are significantly different ($P \leq 0.05$). Hb: haemoglobin, Pcv: hematocrit, RBC: red blood cells, WBC: white blood cells, MCHC: mean corpuscular haemoglobin concentration.

The effect of *Psoroptes cuniculi* on biochemical changes in healthy and infested rabbits:

The data presented in Table (4) clearly demonstrate the biochemical changes observed between healthy and infested rabbits. There was a notable reduction in the levels of total protein, albumin, β-globulin, and total globulin was observed in the infested group compared to the control group. Additionally, a significant increase in creatine kinase levels was observed in the infested rabbits. However, no significant differences were noted in α-globulin, γ-globulin, or the albumin/globulin (A/G) ratio between the two groups.

These results agreement with those reported by Shoyinka *et al.* (2013), observed that elevated creatinine levels and reduced total serum protein and albumin in goats infested with Sarcoptes scabiei. Similarly, Hartley (2005) observed an elevated in globulin levels alongside a reduced in total serum protein, creatine phosphokinase (CPK), and albumin in wombats infected with mange. Serieys *et al.* (2013) also reported reduced levels of serum albumin, creatinine, globulin, and total protein in bobcats suffering from mange. Furthermore, Beigh *et al.* (2016) demonstrated that albumin was significantly decreased, while globulin was dramatically heightened infested with sarcoptic mange. The decrease in serum proteins and albumin may be attributed to the feeding behavior of mites, which involves chewing the epidermal layers of the skin, as noted by Arlian *et al.* (1988).

A low concentration of albumin in the blood suggests an elevated breakdown of muscle protein, possibly serving as a compensatory mechanism to meet the energy needs caused by advanced hyperkeratotic sarcoptic mange. These heightened energy demands stem

from the formation of scales and crusts, fluid loss through cracked skin, and the body's immune response to infection and inflammation. (Arlian *et al.*, 1995). The elevated creatinine levels may be attributed to glomerulonephritis, which is often linked to severe sarcoptic mange infestation. (Kido *et al*., 2011). These results agree with *El-Sawy, et al., 2016)* investigated the effectiveness of ivermectin, garlic, and cinnamon oils against *Sarcoptic scabiei*, along with their impact on hematology and biochemistry. The results showed a notable (P≤0.05) reduction in total protein, albumin, and globulin levels across the groups. of rabbits infested with *Sarcoptic scabiei* compared to the non-infested group.

Table (4): Biochemical changes in non-infested and infested rabbits.

Parameter	Non-infested	Infested
Total protein g/dl	6.27[a]	3.17[b]
Albumin g/dl	3.52[a]	2.81[b]
α - globulin g/dl	0.23	0.22
β- globulins g/dl	0.85[a]	0.41[b]
γ-globulins g/dl	1.71	1.70
Total globulin	2.70[a]	2.42[b]
A/G	0.95	0.70
creatinKinase Cpk U/L	79.62[b]	201.00[a]

Means followed by distinct superscript letters are significantly different (P ≤ 0.05).

The effect of *Psoroptes cuniculi* on the oxidative stress in non-infested and infested rabbits:

The data presented in table (5) indicate that, in the infested rabbits, there was an increase in the activity of catalase and glutathione-S-transferase, whereas the activity of superoxide dismutase was decreased when compared to the non-infested rabbits.

The findings indicate that infestation triggers oxidative stress, alters the antioxidant system, and elevates lipid peroxidation levels across the body as reported by Gurgoze *et al.* (2003). In comparison to healthy rabbits, infested rabbits showed increased catalase and glutathione-S-transferase activities, while superoxide dismutase activity was found to be decreased. Also agree in part with Abdelaziz *et al.* (2022). Investigated the infection rate, histopathology, and genetic characterization of *Sarcoptes scabiei* in naturally infected rabbits in Egypt. The analysis did not reveal any statistically significant differences. The results indicated a dramatic increase in White blood cells, lymphocytes, liver enzymes (aspartate aminotransferase and alanine aminotransferase), urea, total antioxidant capacity, glutathione peroxidase, and malondialdehyde. Conversely, there was a notable reduction in RBCs, hemoglobin, and MCV levels. Also, Abu Hafsa *et al. (*2021) investigated the impact of turmeric extract (TE) on the side effects observed in rabbits treated with ivermectin. Results indicated that the treated rabbits exhibited reduced levels of total antioxidant capacity (TAC), (SOD), and (GSH-Px) compared to the control group. Furthermore, serum total protein, albumin levels, and (A/G) ratio were notably reduced in the treated rabbits when compared to

the non-treated group. Mahmoud *et al.* (2014) severely infested rabbits showed a notable decrease in total white blood cell counts, as well as lower lymphocyte and eosinophil levels. The infestation, caused by mange-related skin infections, disrupted the oxidant-antioxidant balance in the animals. This imbalance likely led to the continuous production of oxidative substances within their systems (Singh *et al.*, 2012). Moreover, the immune status of the animal, nutritional status and oxidative stress are likely to significantly influence the pathogenesis of this disease (Singh *et al*., 2011). Mohamed *et al*. (2017), The oxidative status of peripheral blood in rabbits infested with *Psoroptes cuniculi* and *Sarcoptes scabiei* was analyzed to investigate the disease's pathogenesis. Results revealed that the antioxidant enzymes (GST) and (SOD) were significantly reduced in rabbits with mange compared to healthy controls.

Table (5) Effects of Psoroptes cuniculi on antioxidant activity in non- infested and infested rabbits.

Parameter	Non-infested	Infested
CAT U/ml	21.33 ± 1.135^{b}	$26.258\pm^{1.17a}$
SOD U/ml	1.98 ± 0.081^{a}	$1..86\pm0.073^{b}$
(GSH-Px) U/ml	67.783 ± 3.69^{b}	79.93 ± 3.56^{a}

Means indicated by different superscript letters are significantly different ($P \leq 0.05$). Catalase (CAT), superoxide dismutase (SOD), and glutathione peroxidase (GSH-Px).

Conclusion

Infection of rabbits with *Psoroptes cuniculi* leads to a deficiency of hemoglobin and red blood cells, which causes anemia and causes changes in the biochemical and antioxidant properties that depend on the severity and duration of the infection. Infection of rabbits with *Psoroptes cuniculi* leads to a reduction in hemoglobin levels and red blood cell count, resulting in anemia, as well as alterations in biochemical and antioxidant profiles. These findings confirm that *Psoroptes cuniculi* has a profound impact on rabbit health, with the extent of physiological disruption correlating with the severity and duration of infestation.

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